Flight Handbook

NAVY MODEL

F9F-7

AIRCRAFT

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IMPORTANT

To gain the maximum benefits from this handbook it is imperative that you read this page carefully.

FOREWORD

The function of this flight handbook is to acquaint the pilot with the airplane, furnishing information necessary for normal and emergency flight. All operating procedures in this book are based on actual flight tests.

It is most important that the pilot keep abreast of all pertinent technical directives which may have been issued since the publication of this handbook, but which may not yet have been incorporated in the form of handbook revisions.

The pilot's flying experience is recognized; these instructions are not intended to teach the basic principles of flight, but are designed to provide the pilot with a general knowledge of the airplane.

This handbook is divided into sections as follows:

SECTION I, DESCRIPTION. This section describes the airplane and its systems and controls which contribute to the physical act of flying the airplane. Also included is emergency equipment which is not part of an emergency system.

SECTION II, NORMAL PROCEDURES. Included in this section are the procedures to be followed on a nontactical flight under normal conditions, from the time the pilot approaches the airplane until the flight is completed and the airplane is left parked on the ramp.

SECTION III, EMERGENCY PROCEDURES. The procedures to be followed in meeting any emergency that the pilot could reasonably expect to encounter, except those in connection with auxiliary equipment, are described in this section.

SECTION IV, DESCRIPTION AND OPERATION OF AUXILIARY EQUIPMENT. This section includes description, normal operation and emergency operation of all equipment not directly contributing to flight but which enables the airplane to perform specialized functions.

SECTION V, OPERATING LIMITATIONS. All important limitations which must be observed during normal operation of the airplane are covered in this section.

SECTION VI, FLIGHT CHARACTERISTICS. This section describes the unique characteristics of this airplane in flight.

SECTION VII, SYSTEMS OPERATION. Operation of the various airplane systems under varying conditions is discussed in this section, with emphasis given to any special problems which must be considered.

SECTION VIII, CREW DUTIES. Not applicable.

SECTION IX, ALL WEATHER OPERATION. This section contains procedures to be followed under extreme climatic conditions. (This information will be supplied when available.)

APPENDIX I, OPERATING DATA. This section contains all operating data charts and tables necessary for preflight and inflight mission planning and explanatory text on the use of the data presented.

SECTION I
TABLE OF CONTENTS

Section I DESCRIPTION

AIRPLANE.

The airplane is a single place, single jet engine fighter, with swept-back wings and flying tail, built by the Grumman Aircraft Engineering Corporation. It is designed primarily for aircraft carrier operations and is equipped with folding wings and an arresting gear.

Rudder control on this airplane is conventional. In the landing configuration, longitudinal control is attained in the conventional manner. In the clean configuration, the airplane is controlled longitudinally by a hydraulic powered, all movable horizontal stabilizer (flying tail). Lateral control is accomplished by hydraulically operated flaperons.

The maximum allowable gross weight for this airplane is 15000 pounds for arrested landings and 20000 pounds for catapult take-offs. Its principal dimensions are:

Span	34 ft 6 in.
Span (wings folded)	14 ft 2 in.
Length	40 ft 10 in.
Height	12 ft 1-1/2 in.
Height (wings folded)	15 ft 10 in.

ENGINE.

The J33-A-16A engine is of the centrifugal flow, turbojet type. It is equipped with a fuel boost pump, a dual element main fuel pump and a fuel control unit. The fuel control unit automatically adjusts itself with engine speed and altitude changes.

ENGINE FUEL CONTROL SYSTEM.

The engine fuel system consists of an engine driven boost pump, an engine driven dual element (parallel) main high pressure pump, fuel filters, a fuel control unit, a primer valve, a differential pressure switch, a drip valve, fuel nozzles, a double check valve and a combustion chamber drain valve. The throttle lever, which actuates other switches automatically, is the only manually operated control. A red warning light, which glows if one of the dual pump elements fails, is installed on the left console.

Note

This airplane is not equipped with an emergency fuel control system.

The engine driven fuel boost pump transfers fuel from the electric fuel boost pump in the fuselage forward tank

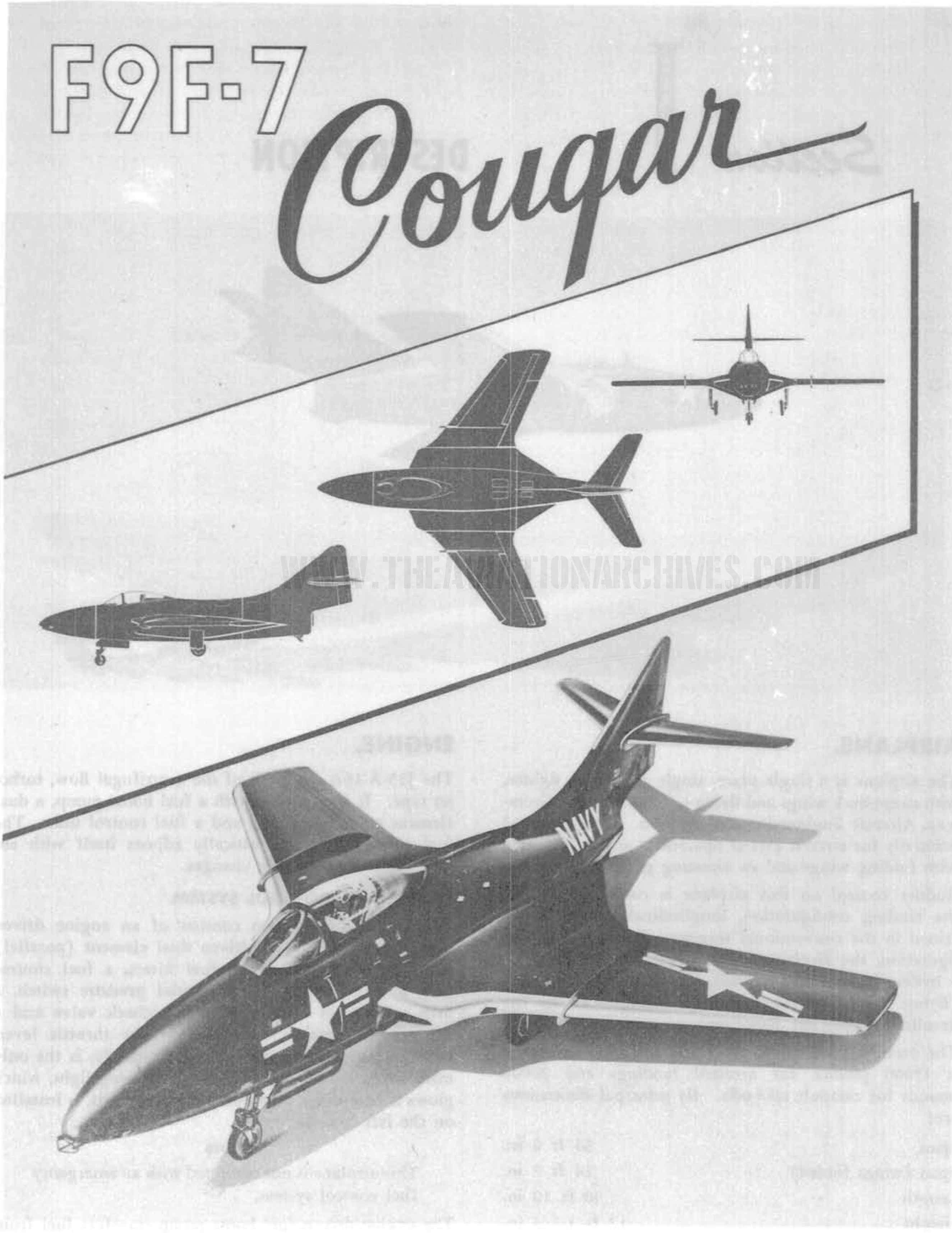


Figure 1-1. F9F-7 Airplane

to the engine driven, dual element, main high pressure pump through a low pressure filter.

The differential pressure switch on the high pressure pump is designed to detect any drop in fuel pressure due to the failure of either element in the high pressure pump. In the event of a failure, the differential pressure switch contacts close to turn on the red fuel pump warning light.

Fuel is directed from the high pressure pump to the fuel control unit through the double check valve and the high pressure filter. The double check valve prevents reverse flow through a pump element that has failed. The fuel control unit is designed to furnish metered fuel during starting and to regulate fuel flow automatically under all normal operating conditions. The fuel control unit prevents flame-out by limiting the deceleration rate of fuel flow. It also prevents excessive tailpipe temperatures and overspeeding by limiting the acceleration rate of fuel flow, and maintains a constant engine speed regardless of changes in air density.

Metered fuel is routed from the fuel control unit to the fuel nozzles in the combustion chambers via the fuel manifold. The primer valve in the fuel manifold is controlled by the primer switch in the cabin and allows unmetered fuel to flow into the manifold for starting.

The solenoid operated drip valve permits fuel to drain from the fuel manifold at engine shutdown when fuel pressure in the manifold drops below two to ten psi. The valve is closed electrically during starting and is kept shut by fuel pressure in the manifold.

The combustion chamber drain valve is provided to drain fuel from the combustion chamber automatically at engine shutdown to ensure a clean cut-off and to prevent afterfire. It also serves to drain fuel from the combustion chambers after a false start to prevent a possible subsequent hot start.

NORMAL OPERATION.

When the fuel master and the engine starting master switches are set to ON, the engine cranking switch set to START and the throttle moved outboard and forward to START, the following actions occur:

a. Fuel from the eletric fuel boost pump in the front tank flows to the engine driven boost pump, through a filter, through the dual high pressure pump and to the fuel control unit.

b. When the throttle lever reaches the START position, it actuates a switch to close the drip valve and to energize the spark igniters (ignition on). Ignition is cut off automatically as soon as the engine starts. If the engine fails to start, ignition will be cut off by a timer after one minute of operation.

c. As engine speed increases, fuel pressure increases in the fuel control unit until its by-pass valve opens and returns fuel to the dual high pressure pump. Pressure between the boost and dual high pressure pumps increases until the boost pump relief valve opens and permits recirculation in the boost pump. Fuel pressure in the manifold also increases and this pressure holds the drip valve closed.

d. As the throttle is advanced or retarded and normal operation proceeds, the fuel control unit regulates the flow of fuel, protects against flame-out by limiting the deceleration rate, prevents excessive tailpipe temperature by limiting the acceleration rate, prevents overspeeding and maintains constant speed regardless of air density changes.

ENGINE FUEL SYSTEM CONTROLS.

FUEL MASTER SWITCH.

This toggle switch (46, figure 1-5), equipped with a guard, is located on the right console electrical control panel. When set to ON, it turns on the electric fuel boost pump in the bottom of the forward tank and opens the valve in the feed line to pump fuel to the engine driven boost pump. When the switch is set to OFF, the valve is closed and pump operation is stopped.

CAUTION

This switch MUST BE ON whenever the engine is running. If the switch is set to OFF while the engine is rotating, fuel feed will be shut off, possibly causing line collapse and fuel line trouble, and since the engine fuel pumps have no dry rating, eventual pump failure. This switch must not be set to OFF until the throttle has been moved to CLOSED and the engine has stopped rotating.

FUEL SYSTEM BOOST PUMP CUT-OFF SWITCH.

This push button switch is on the fuel control panel on the left console (30, figure 1-3). With the engine operating at 50% rpm or more, pressing this button cuts out the electric fuel boost pump in the forward tank, so that the engine driven boost pump is the only source of pressure to the engine driven dual high pressure pump. If pressure from the engine driven boost pump is below that required, the low fuel boost pressure light will glow.

THROTTLE.

When the throttle lever, installed on the quadrant on the left console (34, figure 1-3), is set full aft and inboard to CLOSED, the engine is shut down. When the lever is moved outboard toward the START position, it actuates a switch to electrically close the drip valve and supply power to the igniter plugs (ignition on). (The engine starting master switch must have been set to ON and the engine cranking switch set to START.) When the throttle is moved forward and inboard to the IDLE detent, fuel is metered to the engine to operate it at the proper idle speed. When the throttle is moved toward the OPEN position, the engine will accelerate to the proper maximum rpm. At full OPEN, a switch is actuated to raise the tail skid.

1. 20 MM Guns (4)
2. AN/ARN-6 Radio Compass Loop Antenna
3. Inboard Guns Ammunition Boxes (2)
4. Battery
5. Right Cabin Electrical Distribution Box
6. AN/APG-30 Armament Control System Radar Antenna
7. IFF Detonator Impact Switch Box
8. Brake System Hydraulic Reservoir
9. Electrical System Circuit Breaker Panel
10. Gun Camera
11. ID-295/APG-30 Armament Control Tracking Indicator
12. Armament Control Gun Sight
13. Electronic System Circuit Breaker Panel
14. Ejection Seat Face Cover Handles and Head Rest
15. Air Conditioning Turbine Oil Fillerneck and Drain
16. Oxygen Bottles
17. AN/ARN-6 Radio Compass Sense Antenna
18. Canopy Unlatch (for ground operation)
19. Forward Fuel Tank Fillerneck
20. Fuselage Light
21. Aft Tank Fillerneck
22. Hydraulic System Accumulator
23. Upper Hydraulic Reservoir and Fillerneck
24. Generator Electrical Connector Box
25. Engine Oil Fillerneck
26. Engine Electrical Connector Box
27. Engine Driven Accessories
28. Flaperette Hydraulic Reservoir and Accumulator
29. J33-A-16A Engine
30. AN/ARC-1 VHF or AN/ARC-27 UHF Command Set Antenna
31. Tail Position Lights
32. Movable Stabilizer Actuator
33. Arresting Hook Recoil Strut
34. Tail Skid
35. Wing Tank Fuel Cells
36. Wing Tank Dump Valve L/R
37. Formation Light L/R
38. D-C External Power Receptacle
39. Lower Hydraulic Reservoir
40. Fuel Tank Water Drain Valve
41. Pressure Fueling Valve Wing Tanks
42. Wing Tank Fillerneck L/R
43. Approach Light
44. Fuel System Drain Valve
45. Pressure Fueling Valve Fuselage Tanks
46. AN/APX-6 IFF Antenna
47. Landing Gear Emergency Air Bottle
48. Outboard Guns Ammunition Box
49. Boarding Ladder
50. Electric Auxiliary Hydraulic Pump

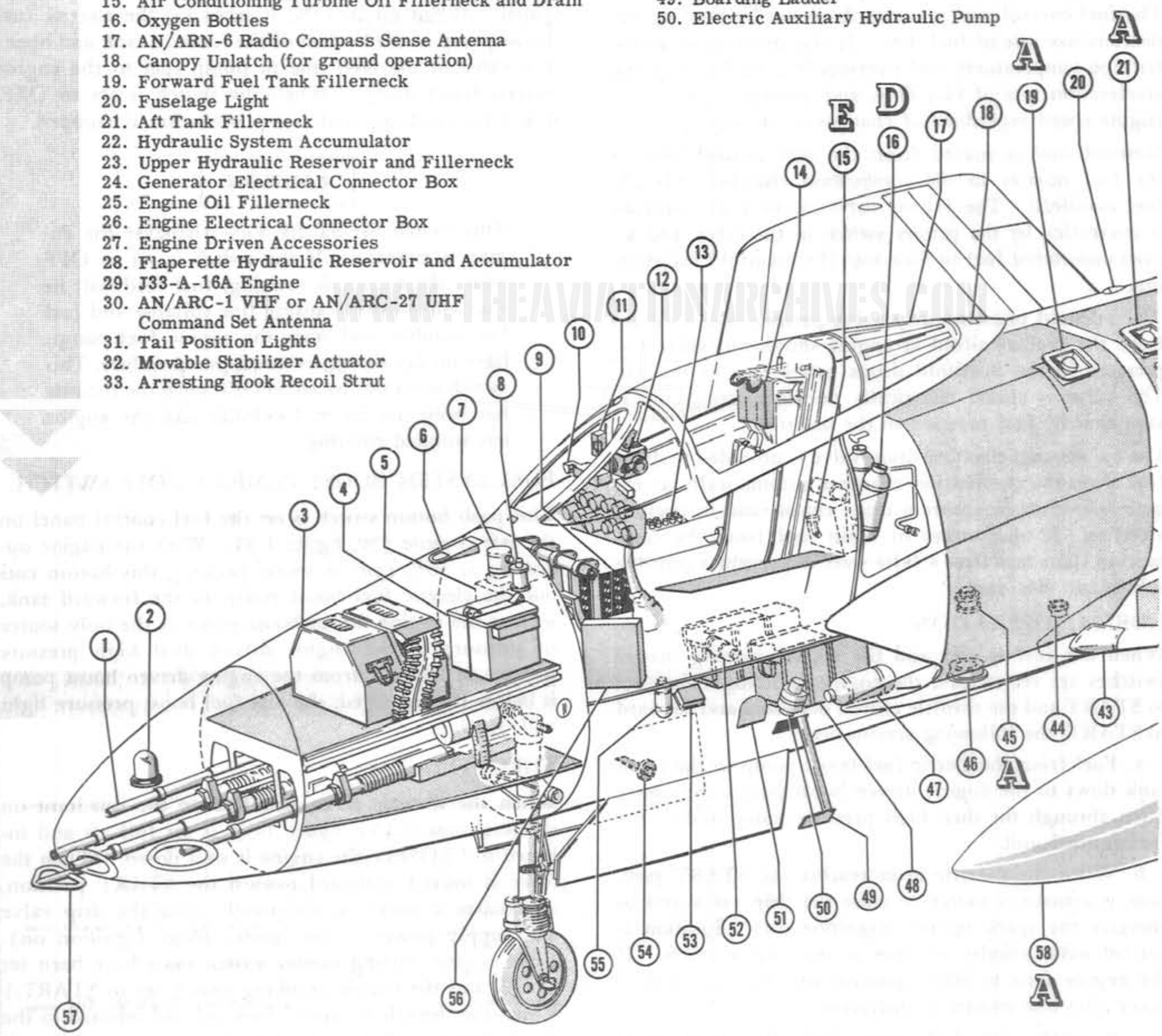
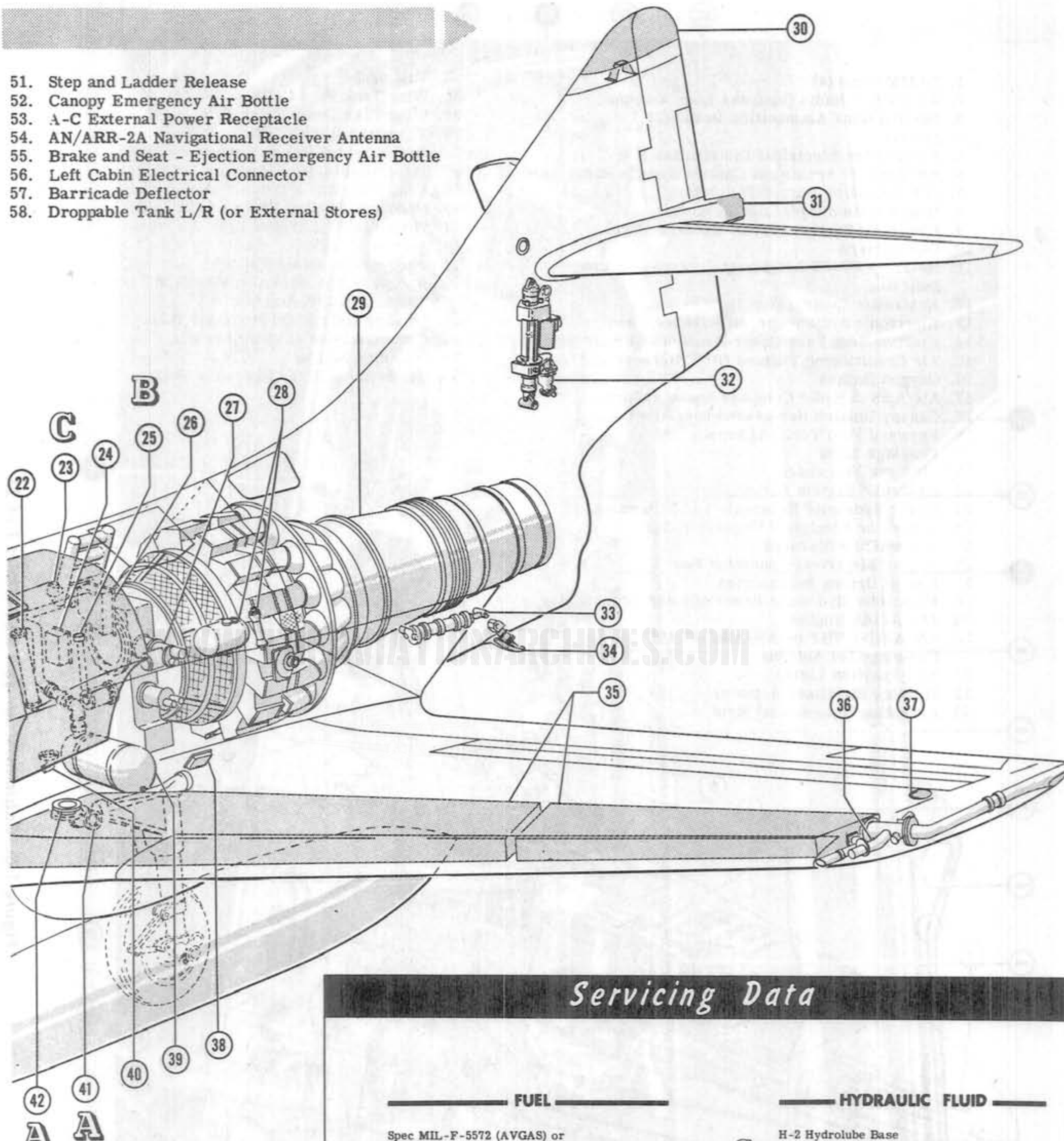


Figure 1-2. General Arrangement and Servicing (Sheet 1 of 2)

51. Step and Ladder Release
52. Canopy Emergency Air Bottle
53. A-C External Power Receptacle
54. AN/ARR-2A Navigational Receiver Antenna
55. Brake and Seat - Ejection Emergency Air Bottle
56. Left Cabin Electrical Connector
57. Barricade Deflector
58. Droppable Tank L/R (or External Stores)



Servicing Data

FUEL

A
Spec MIL-F-5572 (AVGAS) or
MIL-F-5614A, JP-3 or JP-4

Forward Fuselage Tank Capacity	530 US Gal
Aft Fuselage Tank Capacity	240 US Gal
Left Wing Tanks Capacity	78 US Gal
Right Wing Tanks Capacity	78 US Gal
Left Droppable Tank Capacity	150 US Gal
Right Droppable Tank Capacity	150 US Gal

OIL

B
Spec MIL-0-6081 Grade 1010
Tank Capacity 12 US Quarts.

HYDRAULIC FLUID

C
H-2 Hydrolube Base
Spec MIL-F-7073 (Aer) Amber Color

Main Reservoir Capacity	6 US Gal
Flaperette Reservoir Capacity	1.8 US Gal

OXYGEN

D
Pressure 1800 ± 50 psi

COOLING TURBINE OIL

E
Spec MIL-0-6085
Capacity 50 cc

Figure 1-2. General Arrangement and Servicing (Sheet 2 of 2)

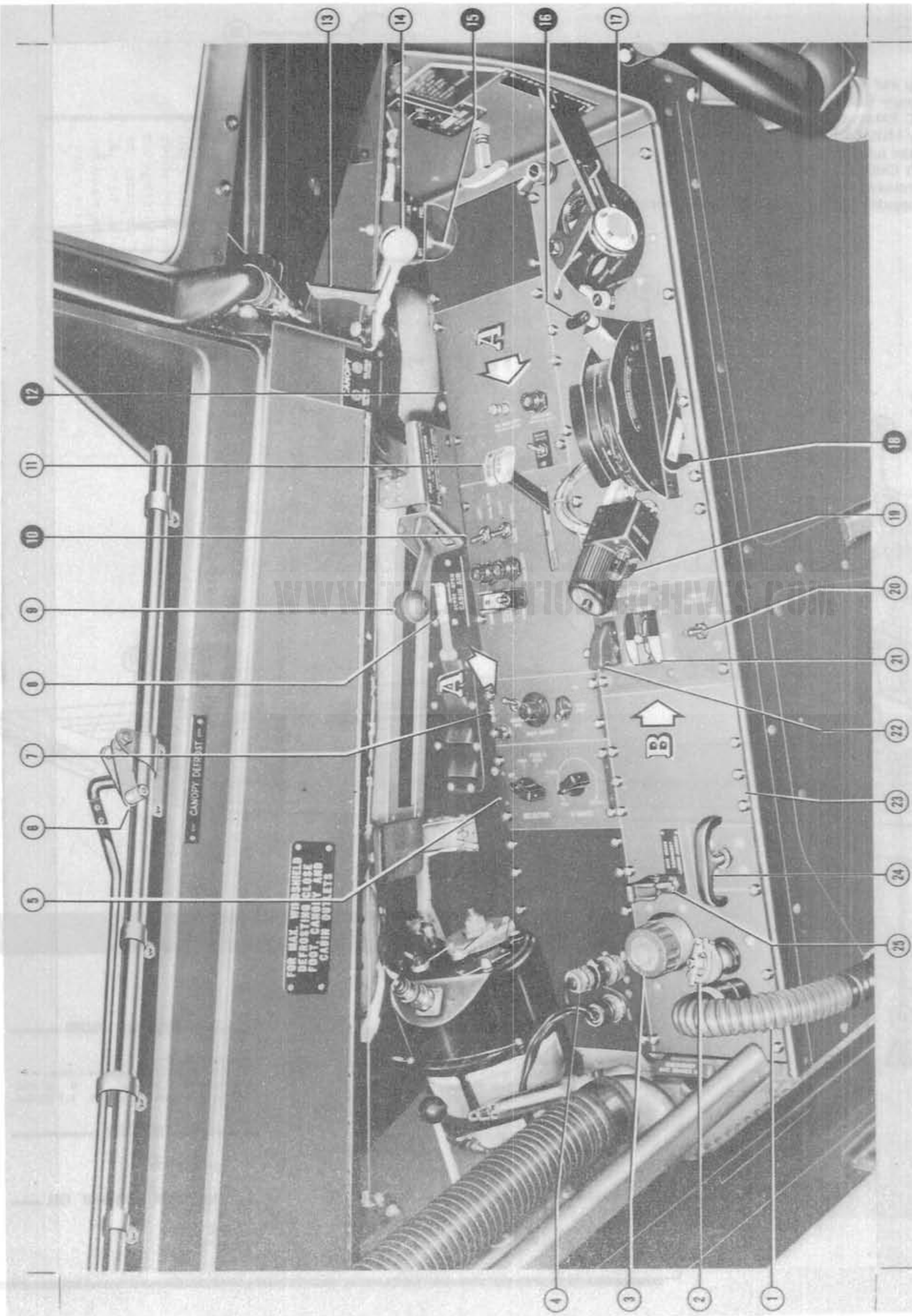
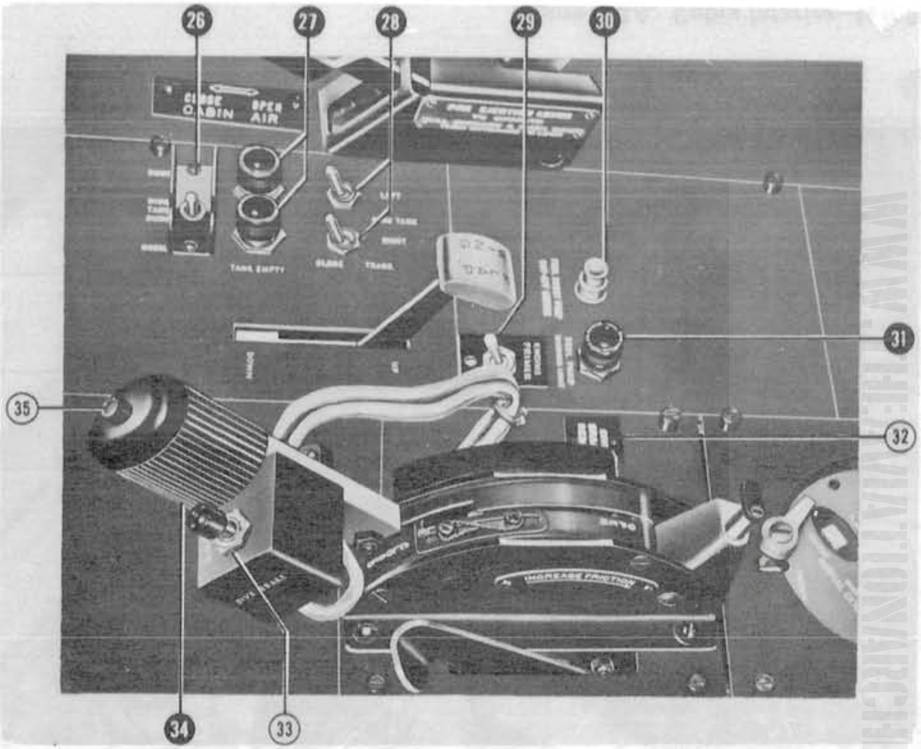
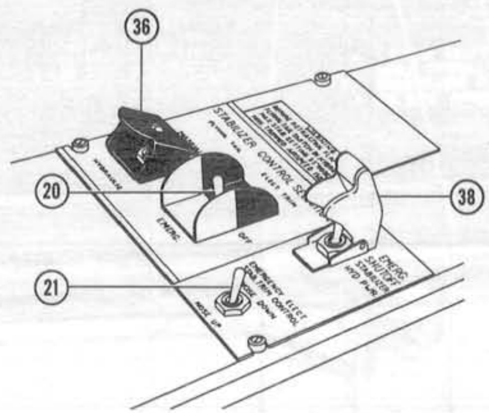


Figure 1-3. Cabin Interior—Left Side (Sheet 1 of 2)



DETAIL A



DETAIL B

1. Oxygen Tube (Personal Gear Composite Disconnect to Mask
2. Anti - "G" Suit Tube Receptacle (Personal Gear Composite Disconnect to Suit)
3. Anti - "G" Suit Pressure Control Valve
4. Microphone and Headset Plug (Personal Gear Composite Disconnect to Microphone and Headset)
5. MK 20 Mod 0 ACS Control Rheostats
6. Canopy Defroster Control Lever
7. C-775/APG-30 Gun Ranging Radar Control
8. Console Air Conditioning Outlet Control Handle
9. Ejection Seat Pre-ejection Lever
10. Airplane Fuel System Control Panel
11. Wing Flaps Control Lever
12. Engine Fuel System Control Panel
13. Emergency Canopy Control Lever
14. Normal Canopy Control Lever
15. In Flight Refueling Switch
16. Catapult Grip
17. Oxygen Regulator and Control Panel
18. Throttle Friction Control Lever
19. Stabilizer Position Indicator
20. Stabilizer Trim Emergency Control Switch
21. Stabilizer Trim Emergency Power Control Switch
22. Hydraulic (Emergency Stabilizer Shift) Control Switch
23. Location of Rudder Trim Tab Position Indicator
24. Brake Emergency Control Handle
25. Speed Brakes Emergency Landing Override Switch
26. Wing Tank Dump Switch
27. Wing Tank Empty Warning Lights
28. Wing Tank Selector Switches
29. Engine Primer Switch
30. Fuel System Boost Pump Cut-off Switch
31. Engine Driven Main High Pressure Fuel Pump Warning Light
32. Speed Brakes Circuit Breaker
33. Speed Brakes Control Switch
34. Throttle Lever and Aero 4C Radar Ranging Control (Throttle Grip)
35. Microphone Switch
36. Longitudinal Control System Selector Switch
37. DELETED
38. Stabilizer Hydraulic Power Emergency Shut-off Switch

Note

On airplanes with the interim flying tail modification installed, the panel shown as Detail B replaces the stabilizer power control panel. On these airplanes the stabilizer position indicator, item 19, is replaced by an absolute stabilizer position indicator mounted on the instrument panel.

Figure 1-3. Cabin Interior—Left Side (Sheet 2 of 2)

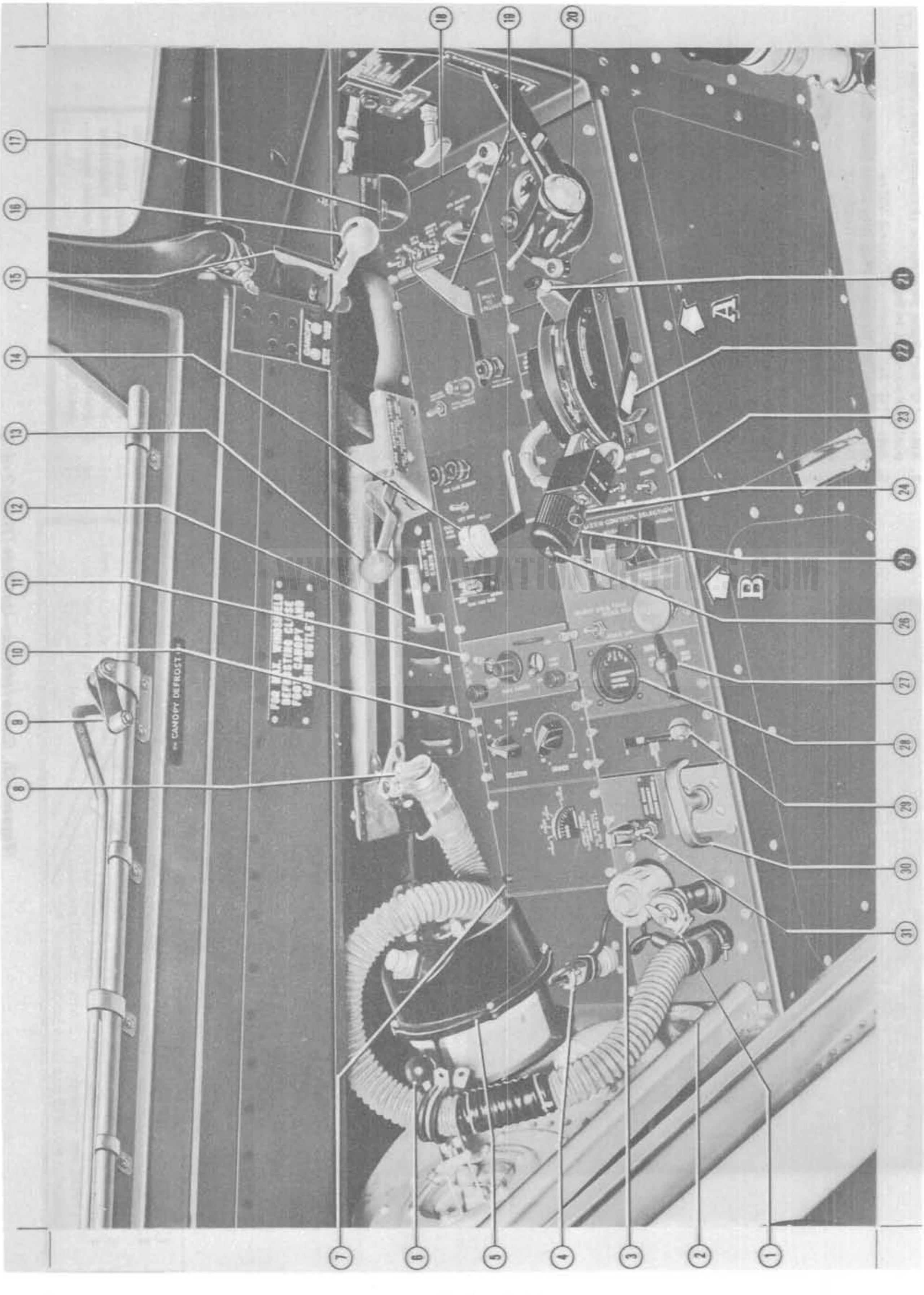
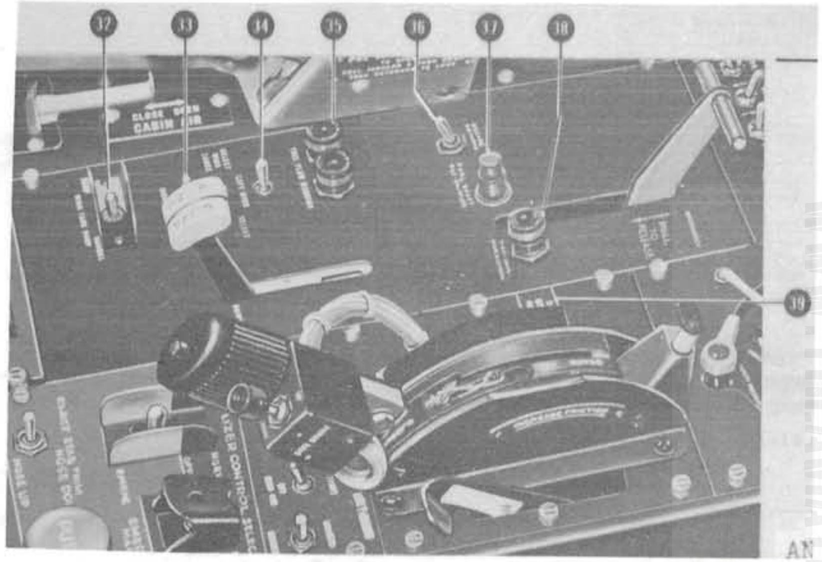
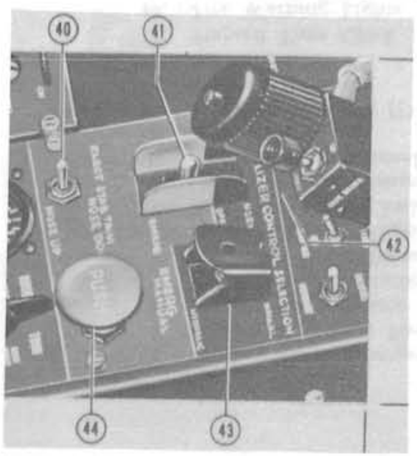


Figure 1-3A. Cabin Interior—Left Side (Sheet 1 of 2)



DETAIL A



DETAIL B

1. Anti-"G" Suit Tube Receptacle (Personal Gear Composite Disconnect to Suit)
2. Emergency Speed Brakes Up Control Handle (Override Control)
3. Anti-"G" Suit Valve Control Knob
4. Microphone and Headset Plug (Personal Gear Composite Disconnect to Microphone and Headset)
5. Cabin Pressure Regulator
6. Cabin Pressure Dump Control Lever
7. Emergency Flaperette Power Air Pressure Gage
8. Oxygen Tube (Personal Gear Composite Disconnect to Mask)
9. Canopy Defroster Control Lever
10. Mk 20 Mod 0 A. C. S. Control Rheostats
11. Gun Ranging Radar Control Panel
12. Console Air Conditioning Outlet Control Handle
13. Pre-ejection Lever
14. Wing Flap Control Lever
15. Canopy Emergency (Air) Control Lever
16. Canopy Normal (Hydraulic) Control Lever
17. In-flight Refueling Switch
18. Armament Control Panel (See Note 1)
19. External Stores Emergency Jettison Tee Handle Control
20. Oxygen Regulator and Control Panel
21. Catapult Grip
22. Throttle Friction Control Lever
23. Air Conditioning Control Panel (See Note 3)
24. Speed Brakes Control Switch
25. Throttle Lever and Aero 4C Radar Ranging Control (Throttle Grip)
26. Microphone Switch
27. Rudder Trim Control Switch
28. Rudder Trim Position Indicator
29. Emergency Flaperette Power Control Lever
30. Wheel Brakes Emergency Control Handle
31. Speed Brakes Emergency Landing Override Switch
32. Wing Tank Dump Switch
33. Wing and Droppable Fuel Tank Selector Switch, (Left Wing) (See Note 2)
34. Wing and Droppable Fuel Tank Selector Switch (Right Wing) (See Note 2)
35. Fuel Flow Warning Lights (Left and Right Wing Tanks) (See Note 2)
36. Engine Primer Switch
37. Fuel System Boost Pump Cut-off Switch
38. Engine Driven Fuel Pump Warning Light
39. Speed Brakes Circuit Breaker
40. Emergency Trim Control Switch (See Note 4)
41. Electrical Trim Selection Switch (See Note 4)
42. Flying Tail Circuit Breaker (behind throttle)
43. Longitudinal Control System Selector Switch
44. Emergency Manual Control Knob (See Note 4)

Note

1. The armament control panel is installed on airplanes ser No. 13078 and subsequent.
2. Wing and droppable fuel tank selector switches and fuel flow warning lights installed on airplanes with external stores provisions.
3. The air conditioning control panel is installed on airplanes ser No. 130850 and subsequent.
4. The stabilizer control selection panel shown as detail B is installed on airplanes ser No. 130882 and subsequent. It will be installed on all airplanes when Grumman Service Bulletin No. 225 has been incorporated.

Figure 1-3A. Cabin Interior—Left Side (Sheet 2 of 2)

KEY TO FIGURE 1-4

1. Landing Gear Emergency (Air) Control Handle
2. Wheels and Flaps Position Indicator
3. Tachometer Indicator
4. Oil Pressure Indicator
5. Low Fuel Boost Pressure Warning Light
6. Speed Brakes Position Indicator
7. Armament Master Switch
8. Outboard Guns Control Switch
9. Inboard Guns Control Switch
10. Sight Unit
11. Tracking Indicator ID-295/APG-30
12. Stand-by Compass
13. Accelerometer
14. Elapsed Time Clock
15. Fire Warning Lights
16. Fire Warning Light Circuit Test Switch
17. Low Fuel Level Warning Light
18. Fuel Quantity Indicator Push-to-Test Switch
19. Fuel Quantity Indicator
20. Clock
21. Fuel Flowmeter
22. Arresting Hook Position Warning Light
23. Cabin Altimeter
24. Arresting Hook and Barrier Guard Control Handle
25. Arresting Hook Raising Push Button Switch
26. Air Conditioning Foot Outlet Control
27. Radio Compass Indicator
28. Gyro Horizon Indicator
29. Rate of Climb Indicator
30. Turn and Bank Indicator
31. G-2 Remote Compass Indicator
32. Altimeter
33. Maximum Allowable Airspeed Indicator
34. Tailpipe Temperature Indicator
35. Landing Gear Control, Down Lock Solenoid Manual Release Knob
36. Landing Gear Normal Control Lever and Landing Gear Unlocked Warning Light

NOTE

On airplanes with the interim flying tail modification installed, an absolute stabilizer position indicator is installed on the upper left side of the instrument panel.

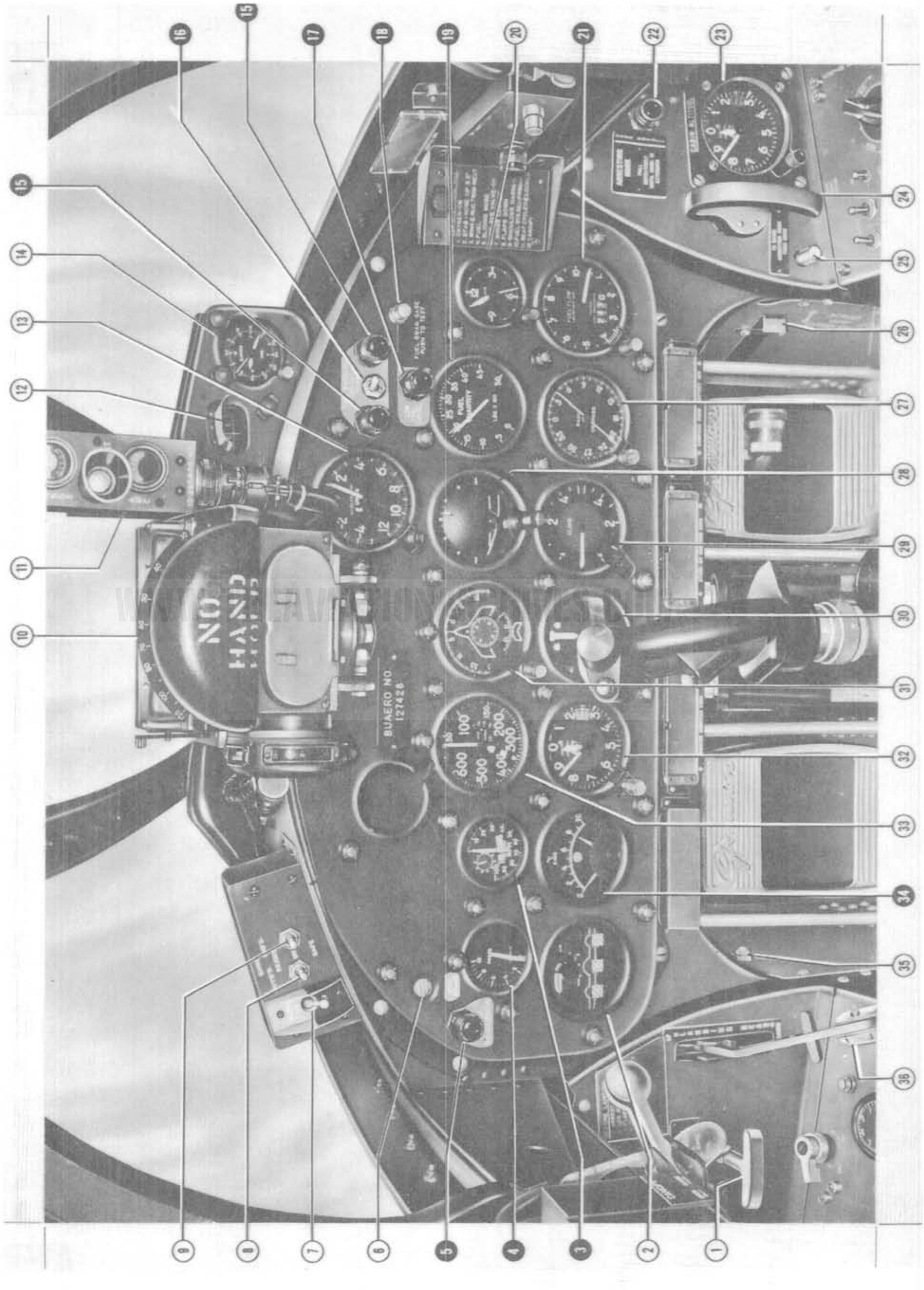


Figure 1-4. Cabin Interior—Looking Forward

KEY TO FIGURE 1-4A

1. Landing Gear Emergency (Air) Control Handle
2. Tailpipe Temperature Indicator
3. Wheels and Flaps Position Indicator
4. Tachometer
5. Low Fuel Boost Pressure Warning Light
6. Oil Pressure Indicator
7. Speed Brakes Position Indicator
8. Accelerometer
9. Armament Master Switch
10. Inboard and Outboard Guns Ready-Off-Safe Switches
11. Stores Jettison Switch
12. Location of Absolute Stabilizer Position Indicator (See Note)
13. Sight Unit Range Scale
14. Sight Unit
15. Sight Unit Target Span Handle
16. Tracking Indicator
17. Location of Stand-by Compass
18. Clock
19. Location of Elapsed Time Clock
20. Fire Warning Lights
21. Fire Warning Light Circuit Test Switch
22. Fuel Quantity Indicator Push-to-Test Switch
23. Low Fuel Level Warning Light
24. Fuel Flowmeter
25. Fuel Quantity Indicator
26. Cabin Pressure Altimeter
27. Arresting Hook and Barrier Guard Control Handle
28. Arresting Hook Raising Push Button Switch
29. Air Conditioning Foot Outlet Control
30. Course Indicator
31. Gyro Horizon Indicator
32. Rate of Climb Indicator
33. Turn and Bank Indicator
34. G-2 Remote Compass Indicator
35. Altimeter
36. Maximum Allowable Airspeed Indicator
37. Landing Gear Control, Down Lock Solenoid Manual Release Knob
38. Landing Gear Normal Control Lever and Landing Gear Unlocked Warning Light

Note

The absolute stabilizer position indicator is installed on airplanes ser No. 130882 and subsequent.

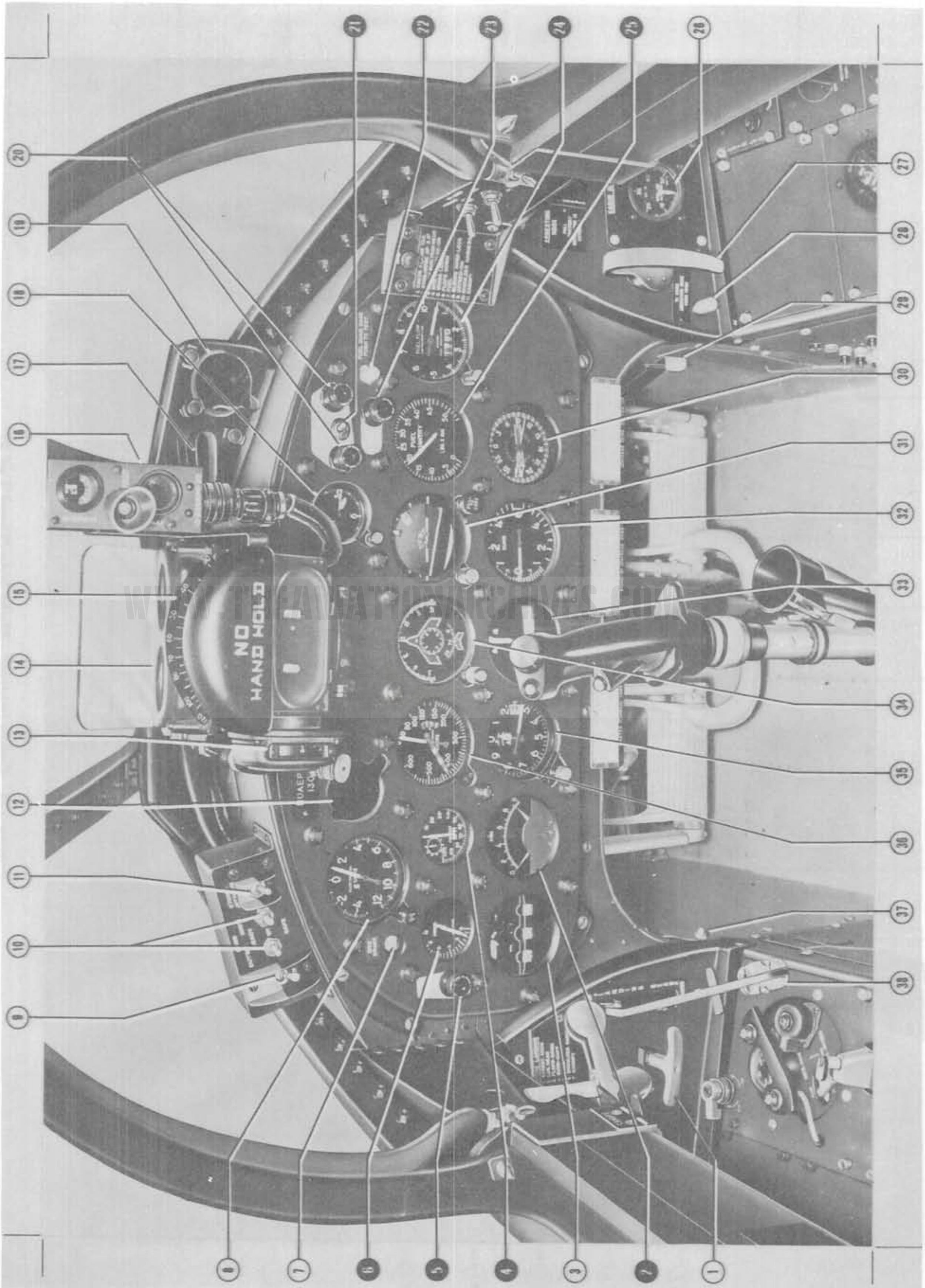


Figure 1-4A. Cabin Interior—Looking Forward

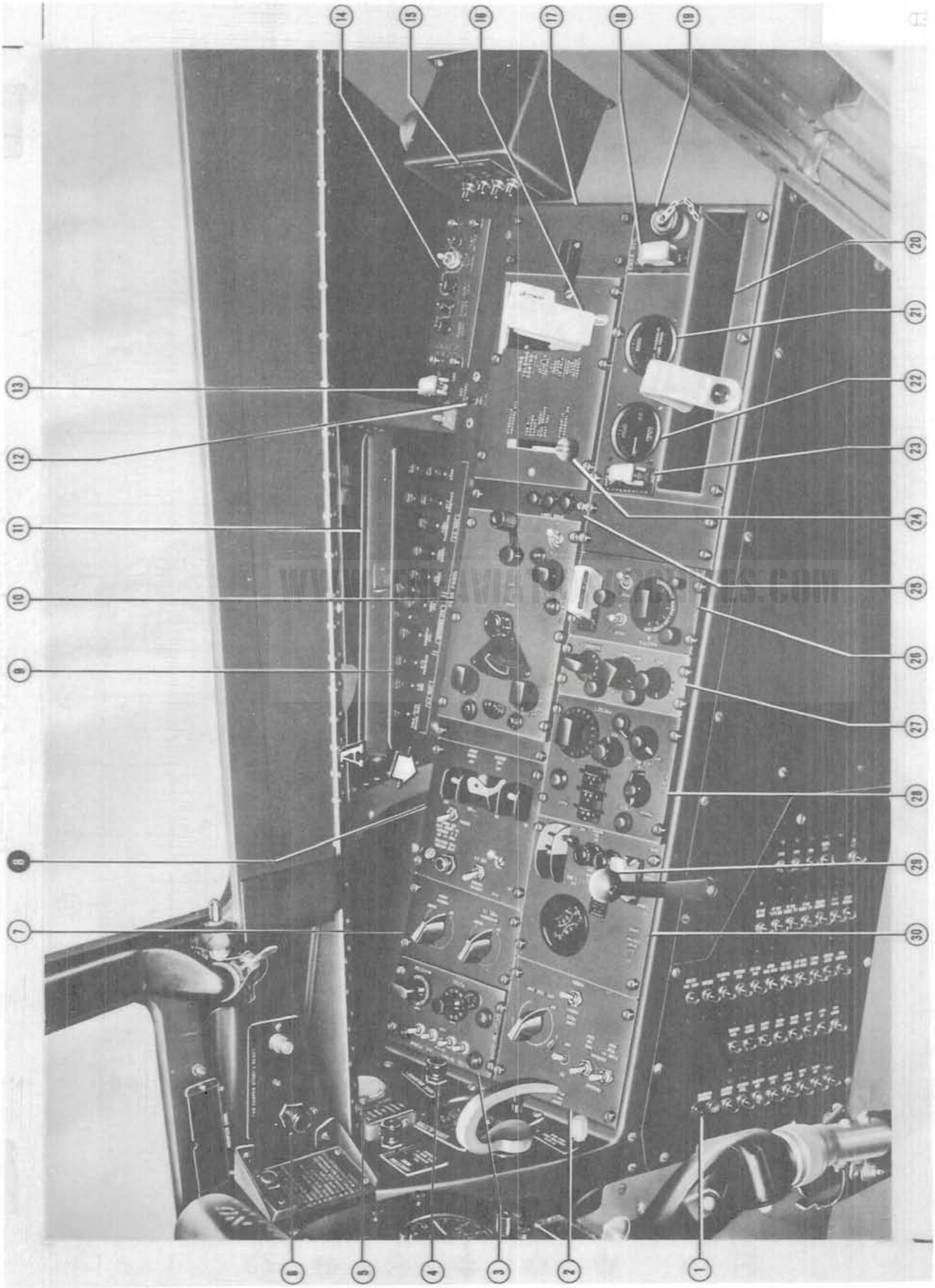
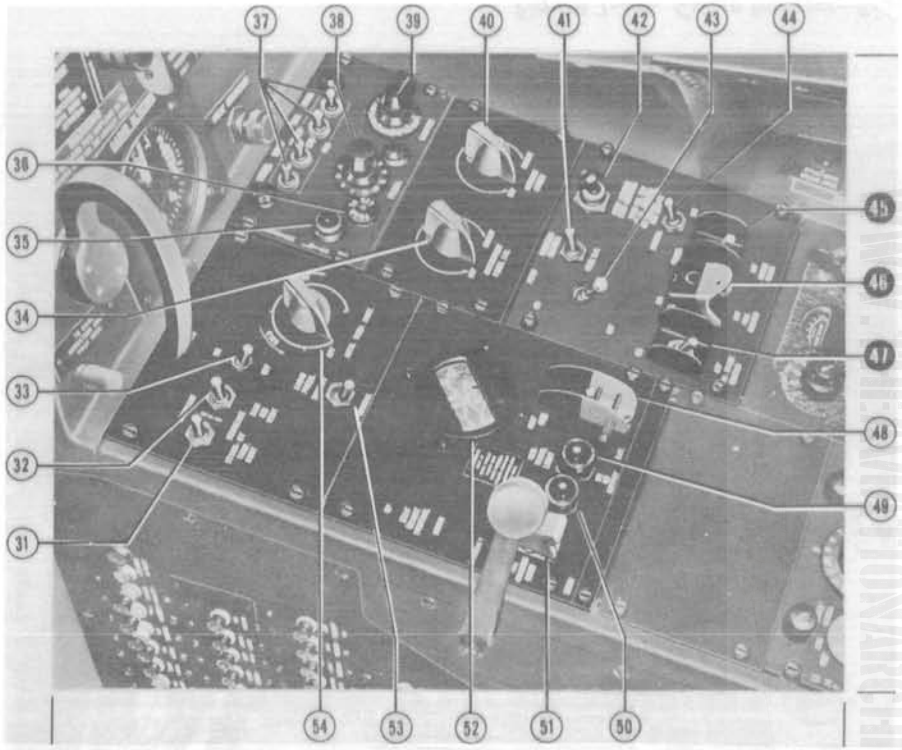


Figure 1-5. Cabin Interior—Right Side (Sheet 1 of 2)



DETAIL A

1. Circuit Breaker Panel
2. Air Conditioning System Control Panel
3. Exterior Lights Control Panel
4. Sliding Nose Unlocked Warning Light
5. Tail Skid Control Switch
6. Yaw Damper Control and Warning Light Panel (Not Used)
7. Interior Lights Control Panel
8. Engine and Miscellaneous Control Switches
9. Fuse Panel
10. AN/ARN-6 Radio Compass Control Panel
11. Chartboard Stowage Case
12. Antenna Relay Switch Circuit Breaker (See Note 1)
13. Antenna Relay Control Switch (See Note 1)
14. Unit II, Servo Radar Range Aero 1A
15. Stabilizer Control Power Circuit Breaker Panel
16. Wing Folding and Locking Control Levers
17. Spare Fuse Container
18. Auxiliary Hydraulic Pump Control Switch
19. Utility Receptacle
20. Map Case
21. Auxiliary Hydraulic Pump Pressure Gage
22. Main Hydraulic System Pressure Gage
23. Flaperette System Control Switch
24. Hydraulic Pressure On-Off Control Lever
25. Spare Lamp Stowage Panel
26. AN/APX-6 IFF Control Panel
27. AN/ARR-2 Navigational Radio Control Panel
28. AN/ARC-27 UHF Command Set Control Panel (See Note 1)
29. Seat Height Control Lever (See Note 2)
30. Electrical System Control Panel
31. Stand-by Temperature Control Switch
32. Ram Air Ventilation Control Switch
33. Air Conditioning System On-Off Switch
34. Instrument Panel Lights Control Switch and Rheostat
35. Manual Exterior Lights Coding Indicator Light
36. Manual Exterior Lights Coding Key
37. Exterior Lights Control Switches (4)
38. Automatic Coding Letter Selector Switch
39. Exterior Lights Master Control Switch
40. Console Lights Control Switch and Rheostat
41. G-2 Compass Control Switch
42. Fast Erecting Gyro Horizon Warning Light
43. Pitot Heat Control Switch
44. Fast Erecting Gyro Horizon Control Switch
45. Engine Cranking Switch
46. Fuel Master Switch
47. Engine Start Master Switch
48. Battery Switch
49. Generator Warning Light
50. Inverter Warning Light
51. Inverter Changeover Switch
52. Voltammeter
53. Cabin Pressurization Combat - Normal Switch
54. Automatic Temperature Control Rheostat

Note

1. Antenna Relay Switch is operative only when AN/ARC-27 UHF Command Set is installed.
2. AN/ARC-27 UHF Command Set may be replaced by the AN/ARC-1 VHF Command Set depending upon local communication facilities.

Figure 1-5. Cabin Interior—Right Side (Sheet 2 of 2)

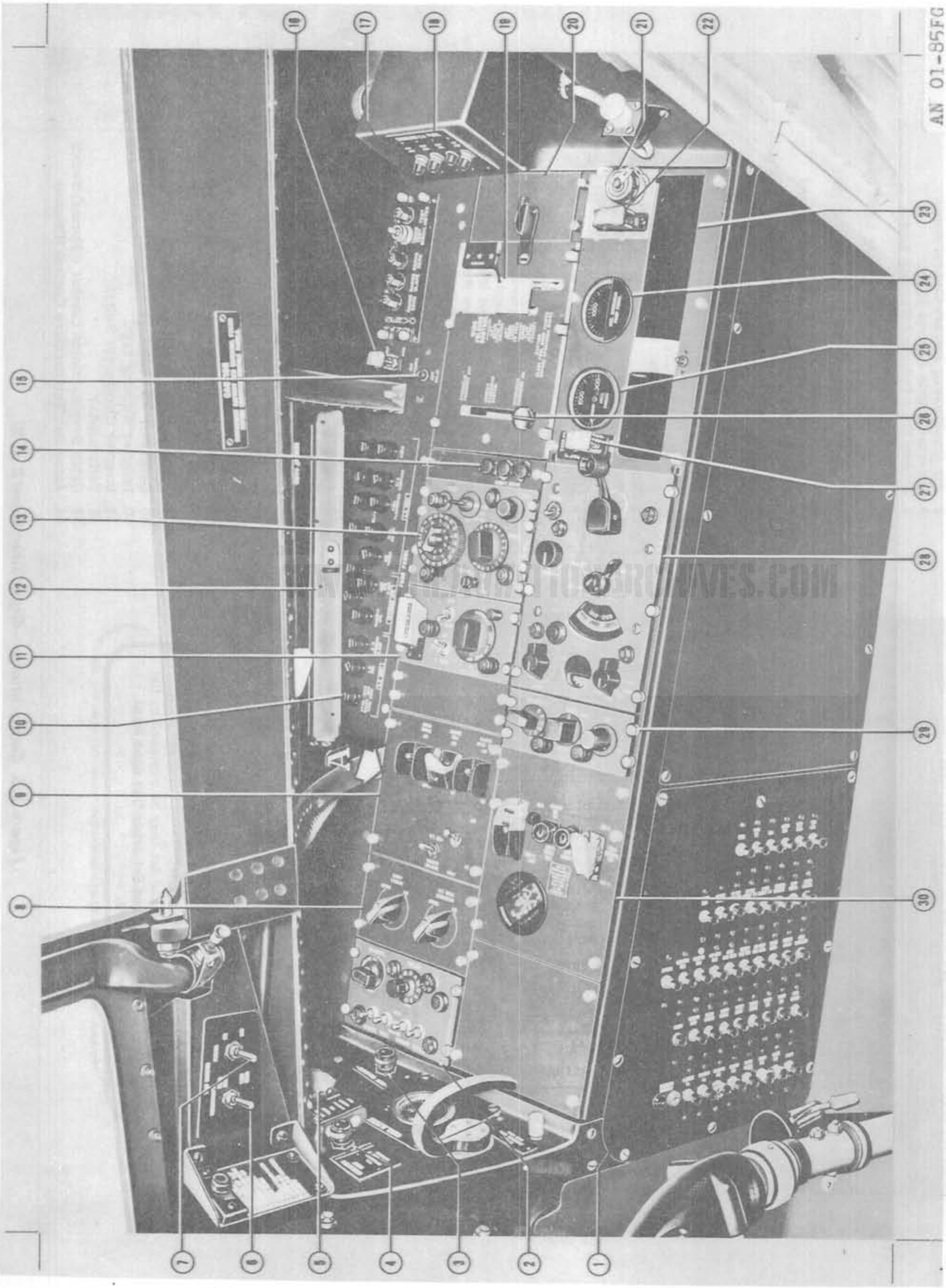
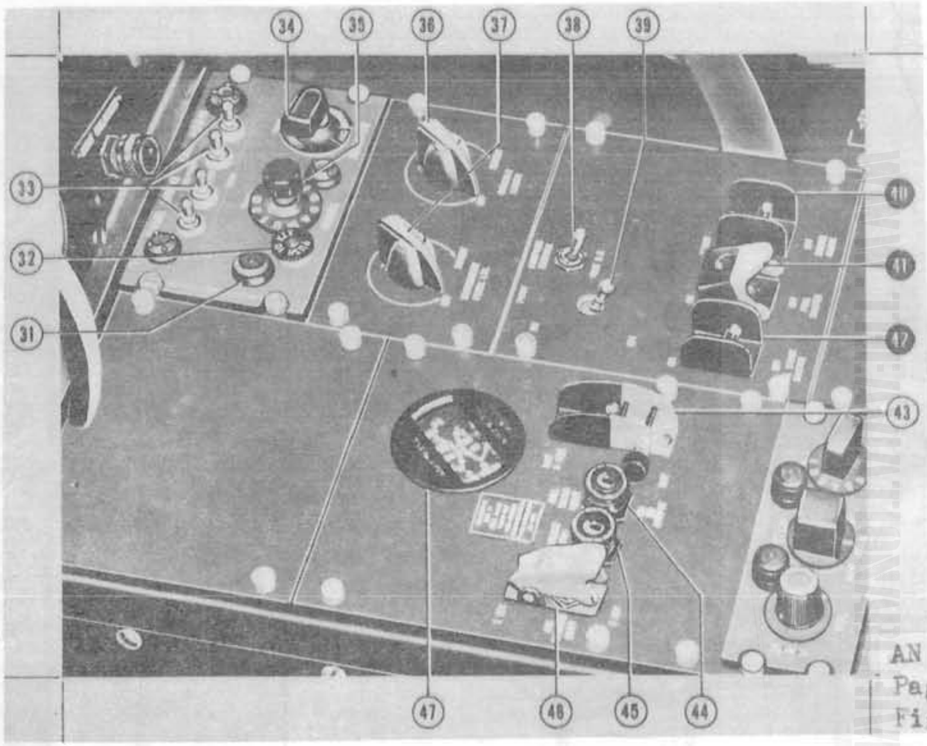


Figure 1-5A. Cabin Interior—Right Side (Sheet 1 of 2)



DETAIL A

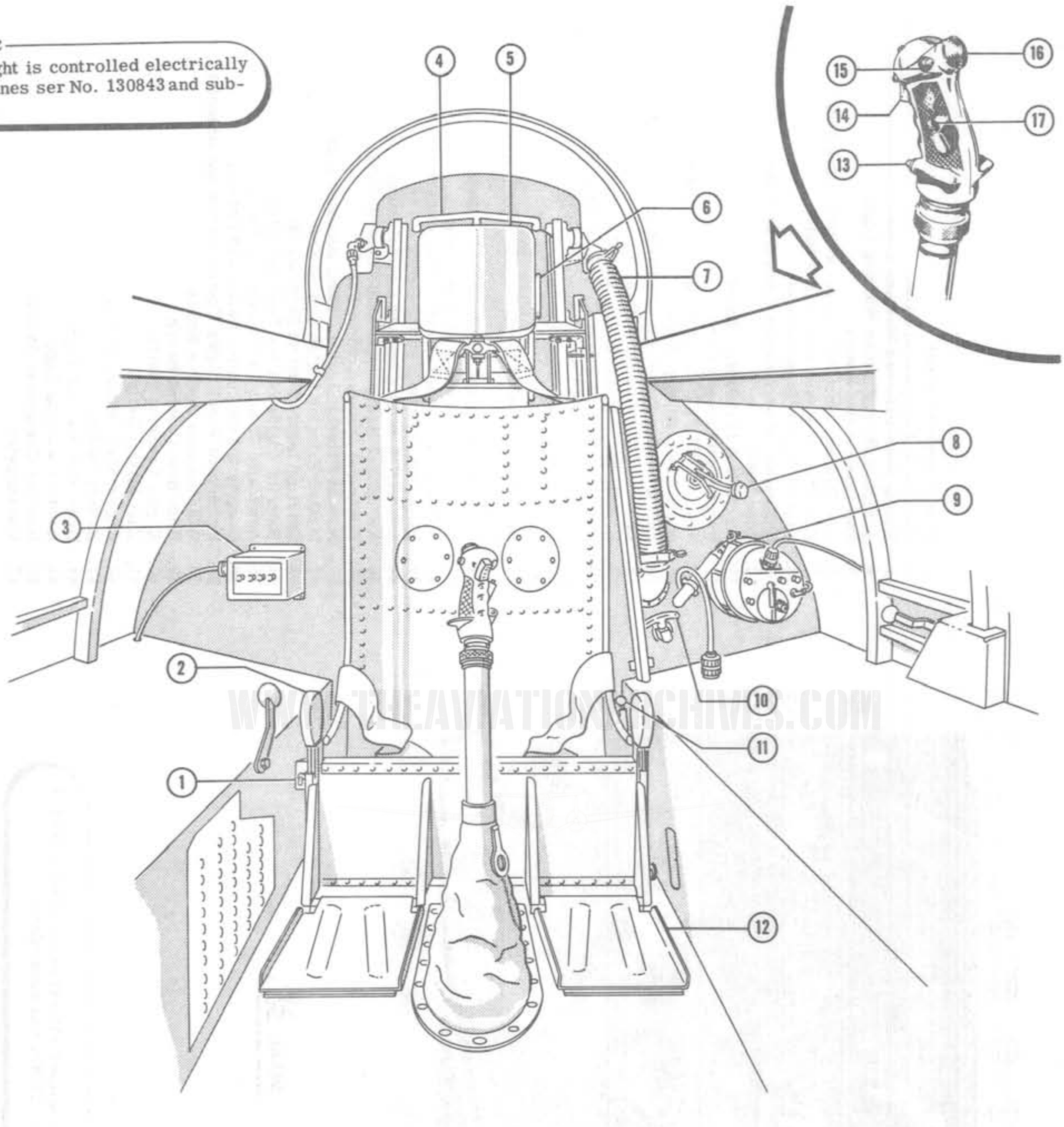
1. Circuit Breaker Panel
2. Exterior Lights Control Panel
3. Sliding Nose Unlocked Warning Light
4. Arresting Hook Position Warning Light
5. Tail Skid Control Switch
6. Yaw Damper Sensitivity Selector Switch (See Note)
7. Yaw Damper Power Switch (See Note)
8. Interior Lights Control Panel
9. Engine and Miscellaneous Control Switches
10. Fuse Panel
11. AN/APX-6 IFF Control Panel
12. Chartboard Stowage Case
13. AN/ARC-27 UHF Command Set Control Panel
14. Spare Lamp Stowage Panel
15. Antenna Relay Switch Circuit Breaker
16. Antenna Relay Control Switch
17. Unit II, Servo Radar Range Aero 1A
18. Stabilizer Control Power Circuit Breaker Panel
19. Wing Folding and Locking Control Levers
20. Spare Lamp and Fuse Container
21. Utility Receptacle
22. Auxiliary Hydraulic Pump Control Switch
23. Map Case
24. Auxiliary Hydraulic Pump Pressure Gage
25. Main Hydraulic Pump Pressure Gage
26. Hydraulic Pressure On-Off Control Lever
27. Flaperette System Control Switch
28. AN/ARN-6 Radio Compass Control Panel
29. AN/ARR-2 Navigational Radio Control Panel
30. Electrical System Control Panel
31. Manual Exterior Lights Coding Indicator Light
32. Manual Exterior Lights Coding Key
33. Exterior Lights Control Switches (4)
34. Exterior Lights Master Control Switch
35. Automatic Coding Letter Selector Switch
36. Console Lights Control Switch and Rheostat
37. Instrument Panel Lights Control Switch and Rheostat
38. G-2 Compass Control Switch
39. Pitot Heat Control Switch
40. Engine Cranking Switch
41. Fuel Master Switch
42. Engine Start Master Switch
43. Battery Switch
44. Generator Warning Light
45. Inverter Warning Light
46. Inyerter Changeover Switch
47. Voltammeter

Note

The electronic yaw damper system is installed on F9F-7 airplanes serial No. 130850 and subsequent.

Figure 1-5A. Cabin Interior—Right Side (Sheet 2 of 2)

Note
Seat height is controlled electrically on airplanes ser No. 130843 and subsequent.



1. Electric Seat Height Control (See Note)
2. Ejection Seat Knee Brace (2)
3. Stabilizer Power Circuit Breaker Panel
4. Ejection Seat Face Cover Handle
5. Headrest
6. Emergency Ejection Seat Arming Control Handle
7. Canopy Defrosting Tube
8. Cabin Pressure Dump Valve Control Lever
9. Cabin Pressure Regulator
10. Speed Brake Manual Override Control Handle
11. Shoulder Harness Inertia Reel Lock Control Lever
12. Ejection Seat Foot Rest (2)
13. Auto Pilot Emergency Off Switch (Not used)
14. Gun Trigger Switch
15. Bomb Release Switch (Not used)
16. Horizontal Stabilizer Trim and Wing Trim Control Button
17. Rocket Switch (Not used)

Figure 1-6. Cabin Interior—Looking Aft

THROTTLE FRICTION CONTROL.

A throttle friction control lever is installed on the inboard side of the quadrant (18, figure 1-3). The lever is moved forward to increase friction on throttle and aft to decrease.

CATAPULT GRIP.

A catapult grip is installed just forward of the throttle quadrant (16, figure 1-3). The grip is a spring loaded rod, normally stowed. For catapult take-off use, the tab on the top is rotated inboard, which permits pulling the grip up into position. The grip is rotated outboard and drops down to the stowed position when its use is not desired.

ENGINE FUEL SYSTEM INDICATORS.

MAIN HIGH PRESSURE FUEL PUMP WARNING LIGHT.

A red warning light for the engine driven dual element, main high pressure fuel pump is on the fuel control panel on the left console (31, figure 1-3). The light glows to indicate failure of either pump element, or when the electrical system is on and the engine is not operating.

LOW FUEL BOOST PRESSURE WARNING LIGHT.

A red warning light on the upper left corner of the main instrument panel (5, figure 1-4) glows when pressure from the electric fuel boost pump drops below 6 psi or when the fuel filter is blocked by ice or foreign matter. The latter condition indicates that the engine is operating on unfiltered fuel. Prior to engine starting, operation of the (forward tank) electric fuel boost pump may be checked by setting the fuel master switch to ON and observing that the low fuel boost pressure warning light glows momentarily, an indication that the pump has built up the required pressure. While the engine is running at 50% rpm or better, the engine driven fuel boost pump may be checked by depressing the fuel boost pump cut-off switch button and observing that the low fuel boost pressure warning light does not glow, an indication that this pump is holding the required pressure above 6 psi. "Light out" condition on both of these checks also indicates that the filter is operating normally and is unclogged.

Note

The use of a single light for the dual purpose described does not permit identification of malfunction. It warns the pilot only of trouble in the low pressure portion of the fuel system.

ENGINE INTAKE AIR SYSTEM.

The engine intake air system is entirely automatic. Air is taken in through ducts in the wing stubs and flows aft into the plenum chamber. If ram air is insufficient (while parked or during taxiing) two spring loaded auxiliary air intake doors on each side of the fuselage spine over the plenum chamber, will open automatically to relieve the slight negative pressure at the engine air inlets.

ENGINE COOLING.

Engine cooling is accomplished by two separate systems. The first system provides turbine cooling air by a process of bleeding a portion of the engine intake air and directing it aft through the engine to the face of the turbine. The second system provides cooling air for the tailpipe. Air is drawn in through the flush type ram air scoops in the tail section skin to circulate between the tailpipe and the shroud.

IGNITION SYSTEM.

The ignition system is used only during engine starting. When the engine has reached sufficient speed to permit light-up, the two igniter plugs (in combustion chambers No. 5 and 11) are energized by the throttle quadrant limit switch which is closed when the throttle is placed at START. The engine starting master switch must be on in order for the ignition circuit to be operative for both ground and airstarts. During a ground start, ignition is shut off auomatically when an engine light-up is obtained, or by an ignition timer after a 60 second cycle if a light-up does not occur. During an airstart, ignition will be shut off only by the ignition timer after a 60 second cycle. In either case, when the engine starting master switch is set to OFF to interrupt the starting cycle, the ignition system will also be shut off.

IGNITION CONTROLS.

With the engine starting master switch at ON, moving the throttle to START automatically closes a momentary limit switch to begin the timed 60 second ignition cycle. Ignition will shut off automatically when the engine starts or after 60 seconds if the engine fails to start. Moving the engine starting master switch to OFF shuts off ignition power at any point during the ignition cycle.

ENGINE STARTING SYSTEM.

The starting system is designed to rotate the engine at the speed required to obtain a successful engine light-up when fuel and ignition are introduced in the combustion chambers.

Note

An external electrical power supply must be used for ground starts.

The starter is not used for airstarts, as airspeed may be controlled by the pilot to maintain the proper engine windmilling speed for an engine light-up.

ENGINE STARTING CONTROLS.

ENGINE STARTING MASTER SWITCH.

This two position, guarded toggle switch marked ON and OFF is located on the right console (47, figure 1-5). It operates in conjunction with the engine cranking switch and the limit switch at the START position on the throttle to control the starter and ignition circuits, respectively. The engine starting master switch must be set to ON before the starter and ignition circuits can be energized by their respective control switches. Setting the switch to OFF removes power from the starter and ignition circuits when completion of a starting cycle is not desired (false start or clear engine).

Note

The engine starting master switch must be set to ON to energize the ignition system for an airstart.

ENGINE CRANKING SWITCH.

This momentary switch, equipped with a guard, is on the right console (45, figure 1-5). With the engine start master switch ON, the engine cranking switch is set forward to START to energize the starter for ground starts or for clear engine when the engine has failed to start and unburned fuel must be cleared. In this latter operation, the throttle is set at CLOSED. The engine cranking switch circuit is broken when the engine start master switch is OFF.

ENGINE PRIMER SWITCH.

The guarded momentary engine primer switch is mounted on the left console (29, figure 1-3) outboard of the fuel boost pump cut-off switch. Moving the switch forward causes additional fuel to flow into the combustion chambers to ensure that a complete light-up occurs during engine starting.

This switch is to be used only after engine has lighted off, and then only if the engine will not accelerate to idle rpm normally.

ENGINE INDICATORS.

TACHOMETER INDICATOR.

The tachometer is on the main instrument panel to the left of the center line. It indicates engine rpm in percentage of military rpm (100%=11800). The dial is numbered in tens from 0 to 100. A small pointer rotating on a sub-dial shows graduations of one per cent of engine rpm to provide more accurate reading than the large pointer (3, figure 1-4).

TAILPIPE TEMPERATURE INDICATOR.

This indicator, on the main instrument panel to the left of the center line, shows tailpipe temperature in degrees centigrade times 100. It is numbered from 0 to 10 in increments of two (34, figure 1-4). On some instruments there are two pointers on the dial face. The left one is the indicating pointer and the right one the reference pointer. The latter pointer may be set to any position by turning the screw at the bottom of the dial face. The clockwise movement of the indicating pointer is stopped by the reference pointer. When the indicating pointer contacts the reference pointer, a warning light incorporated in the indicator dial face will glow.

Note

The reference pointer should always be set at the highest tailpipe temperature limit (980°C) as the indicating pointer cannot indicate readings above the setting of the reference pointer.

On other instruments there is no reference pointer and no warning light. The indicating pointer has no stop at the upper limits.

FIRE WARNING INDICATOR LIGHTS.

Two red press-to-test fire warning lights, with a warning light circuit test toggle switch, are located on the top of the instrument panel to the right of the center line. The lights are energized by fire warning detectors located at various points around the engine to warn of engine compartment fire. The lights will glow when the fire warning test switch is actuated, indicating that the fire warning light circuit is in working order, (15, figure 1-4).

OIL SYSTEM.

The engine oil system is a self-contained high pressure system which provides pressure oil feed to the compressor shaft bearings and the accessory drives. The bulk of the oil is contained in a reservoir which is formed by the lower portion of the accessory case. The oil sump contains a two element, engine driven oil pump and oil filters. The pressure element of the pump draws oil from the sump and forces it to nozzles which lubricate the accessory case drives and the bearings. Engine drain oil from the center and aft bearings is scavenged by the scavenge element of the pump and from the forward bearing and accessory drives by gravity. The oil from the scavenge element is returned to the sump through a single line. The oil reservoir is filled through a filler-neck which contains a bayonet oil level gage. The filler-neck is accessible through the forward auxiliary air door on the right side of the fuselage. The oil system capacity is 12 US quarts. See figure 1-2 for oil grade and specification.

WARNING

Inverter flight is limited to 10 seconds by the engine oil system.

OIL PRESSURE INDICATOR.

The oil pressure indicator is on the left side of the instrument panel (4, figure 1-4). It indicates oil pressure times 10 and is numbered from 0 to 10 in increments of two.

FIGURE 1-7 DELETED.

AIRPLANE FUEL SYSTEM.

The forward (main) tank and the rear tank are of the soft, self-sealing type and are located between the cabin and the engine. Two interconnected non-sealing bladder type tanks run the length of the wing outer panel and located between the front and main beams. An electrical system is provided for dumping the fuel from the wing tanks in an emergency. See figure 1-2 for fuel grade and specification. The fuselage tanks are pressurized by ram air let into the tanks from a scoop on the fuselage bottom. The wing tanks are pressurized from ram air inlets at the wing tip leading edges which are equipped with preset valves. During fuel dumping, the dump valves are opened to permit jettisoning through the dump nozzles.

On airplanes[1] equipped for external stores, a 150 gallon drop tank may be supported by each bomb rack. Each drop tank is pressurized through a curved, scarfed vent tube protruding up through the top of the tank just forward of the support lugs.

This is a constant feed system, i.e., fuel flows from the wing and/or drop tanks and the rear fuselage tank to the forward fuselage tank. A check valve in the line connecting the fuselage tanks prevents reverse flow from the forward to the rear tank. A check valve in each drop tank line prevents fuel flow from the respective wing tank into the drop tank. The fuel level in the fuselage tanks is approximately the same until the rear tank is emptied, at which time approximately 100 gallons remain in the forward tank. All fuel feed to the engine is from the forward tank.

There are certain limitations to flying with low fuel quantities. When the fuel quantity gage indicates approximately 450 pounds, the maximum attainable engine speed at low altitude is 96%. (The engine fuel pumps warning light will be on.) As the fuel quantity decreases, the maximum attainable rpm decreases, so that it is 82% with approximately 200 pounds of fuel remaining and 70% with approximately 100 pounds. Since loss of thrust is gradual, some warning is provided. Under these low fuel quantity conditions, fuel flow is approximately 480 to 7800 pounds per hour (80 to 130 pounds per minute).

Obviously, the wave-off capabilities are decreased with less than 450 pounds of fuel on board. Since approximately 82% rpm is required for a carrier approach, a landing must be completed with at least 200 pounds of fuel remaining. (See Low Fuel Quantity paragraph, Section III.)

Note

The fuel quantities discussed above represent fuel quantity gage readings in level flight attitudes (including level coordinated turns).

NORMAL OPERATION.

When the fuel system master switch is ON, the shut-off valve is opened and the tank boost pump sends fuel to the engine at 6 to 25 psi. When a wing or drop tank is selected, a transfer pump sends fuel from that tank into the forward fuselage tank, provided the circuit to the transfer pump has been armed by action of the float switch in the forward tank when space is available in that tank. A red warning light glows when either wing tank has been emptied, provided the fuel level in the forward tank is below full and the transfer pump is operating. On airplanes equipped for external stores, a fuel flow indicator switch, located upstream of the transfer pump in each wing fuel line, will illuminate warning light when fuel flow through that line drops to less than 1.0 gpm. If the forward tank is full, its float switch will not permit the transfer pump to operate and the lights will not glow, having been deenergized temporarily by pump stoppage. A seven gallon reservoir in the bottom of the forward tank maintains constant feed for inverted flight or maneuvers for approximately 10 seconds when 90 gallons of fuel remain in the tank. With less than 90 gallons, there will be proportionately less fuel in the reservoir. Fuel quantity in the fuselage tanks is measured by capacitance units. A fuel flowmeter shows rate of flow and amount of fuel remaining (both in pounds) in the system.

FUEL SYSTEM CONTROLS.

WING TANK SELECTOR SWITCHES.

Two switches on the fuel control panel of the left console (28, figure 1-3) control the transfer pump. The outboard switch is for the left wing tank, the inboard for the right tank. Moving either switch forward to the TRANS position turns on the electric transfer pump which sends fuel from the selected wing tank to the forward fuselage tank. If the forward tank is full, a float switch will prevent the transfer pump from operating. Setting either switch aft to CLOSE stops transfer of fuel from the selected tank by shutting off the wing tank shut-off valve. When a tank shows empty, its transfer switch should be set to CLOSE. Both switches must be set to CLOSE to turn off the electric transfer pump.

On airplanes equipped for external stores, the selector switches are identified left wing and right wing, and each has three positions; WING TANK, OFF, and DROP TANK. Moving either switch out of the OFF position sets a wing tank selector valve to the selected wing or drop tank position, opening the line for fuel flow, and turns on the transfer pump. Final stages of transfer will result in a passage of air and fuel which will cause intermittent operation of the fuel flow switch and a corresponding flicker in the warning light. This is a normal

[1]Airplanes ser No. 130780 and subsequent.

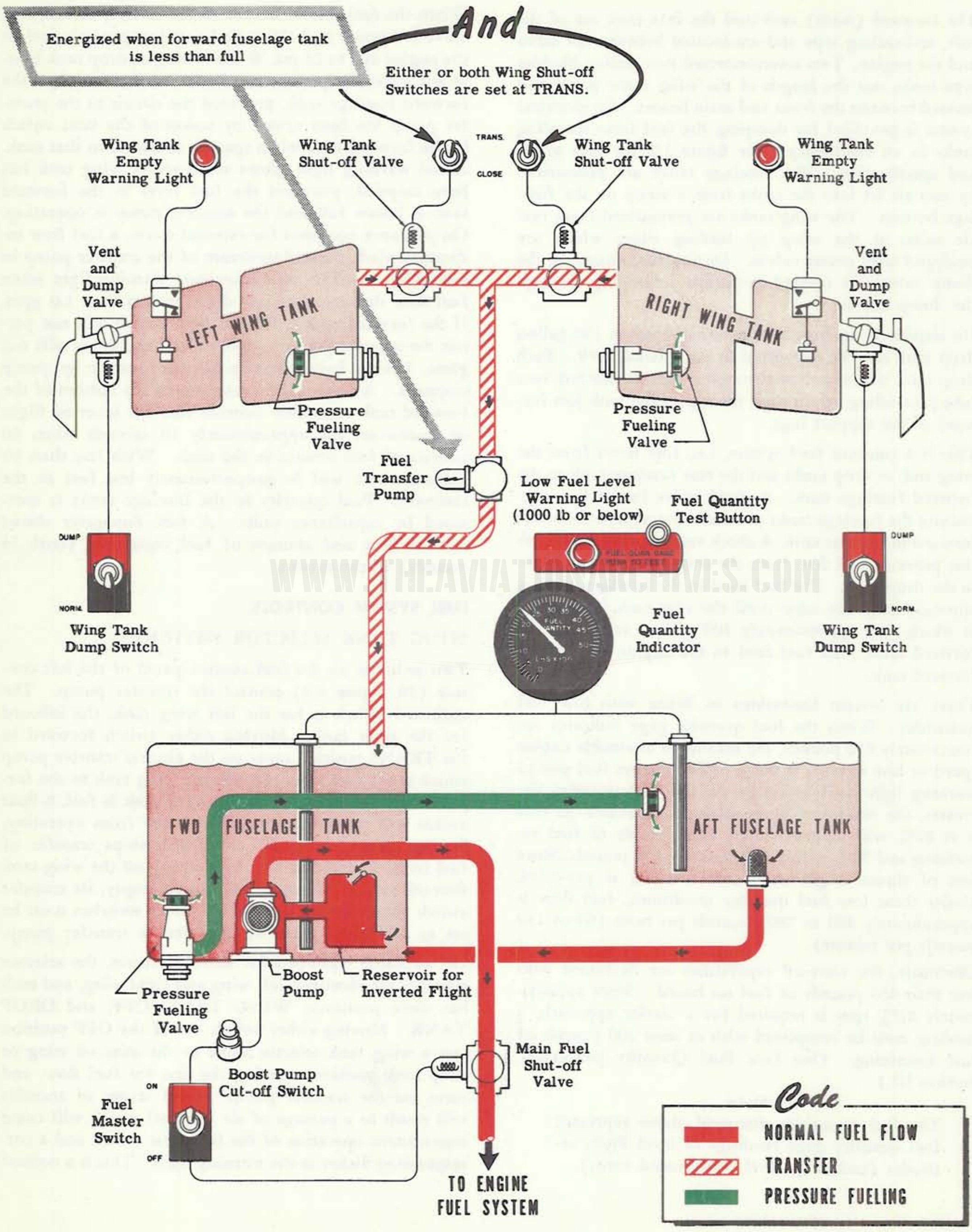


Figure 1-8. Airplane Fuel System Schematic Diagram (Sheet 1 of 2)

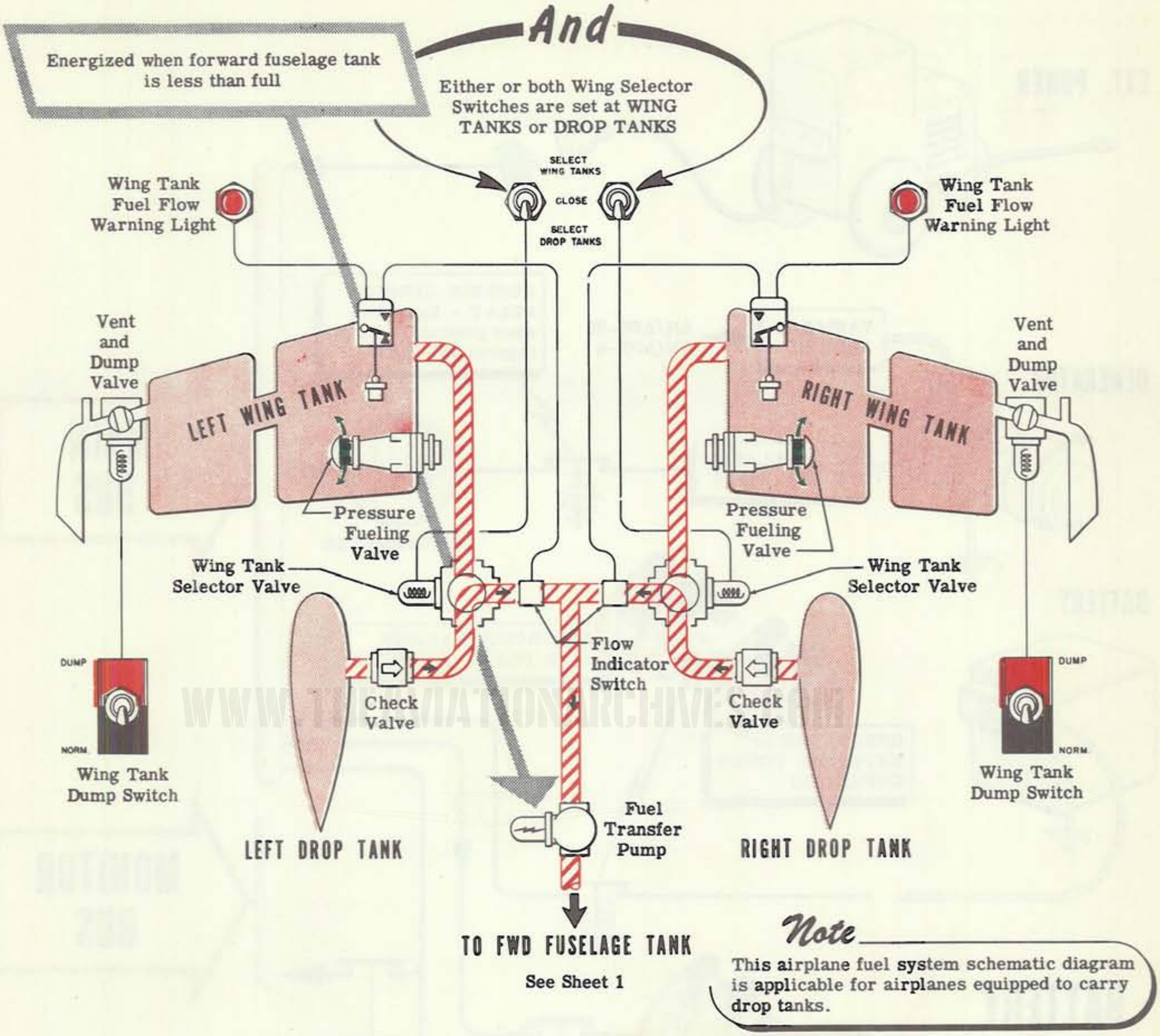


Figure 1-8. Airplane Fuel System Schematic Diagram (Sheet 2 of 2)

condition. When either light glows steadily, the associated switch should be set to OFF. The other switch should be left in the selected position until the light glows steadily again. Failure to turn either switch off when its light glows may result in leaving some unused fuel in one tank, as the transfer pump will suck air from the empty tank. This will decrease the flow from the tank containing fuel, possibly below the flow indicator switch setting of 1.0 gpm, and result in a false indication of empty.

WING TANK DUMP SWITCH.

This two position switch is mounted in a channel type guard on the fuel control panel of the left console (26, figure 1-3). Movement of the switch outboard to DUMP actuates an electric motor which opens the dump valves in both wing tanks and allows ram air to force the fuel out the nozzles into the airstream. This switch is left at the NORMAL position until it is desired to dump wing tank fuel or to purge the tanks after wing tank fuel has been exhausted. In either case, after the switch has been set to DUMP, it must be left there to ensure complete purging, but must be reset to NORMAL before landing.

FUEL SYSTEM INDICATORS.

Also see Engine Fuel Control System.

FUEL QUANTITY INDICATOR.

The quantity indicator, on the right side of the main instrument panel (19, figure 1-4), shows quantity of fuel in pounds. The dial is marked 0-53 and indicates pounds times 100. The indicator is operated by electric capacitance units in the front and rear tanks (there is

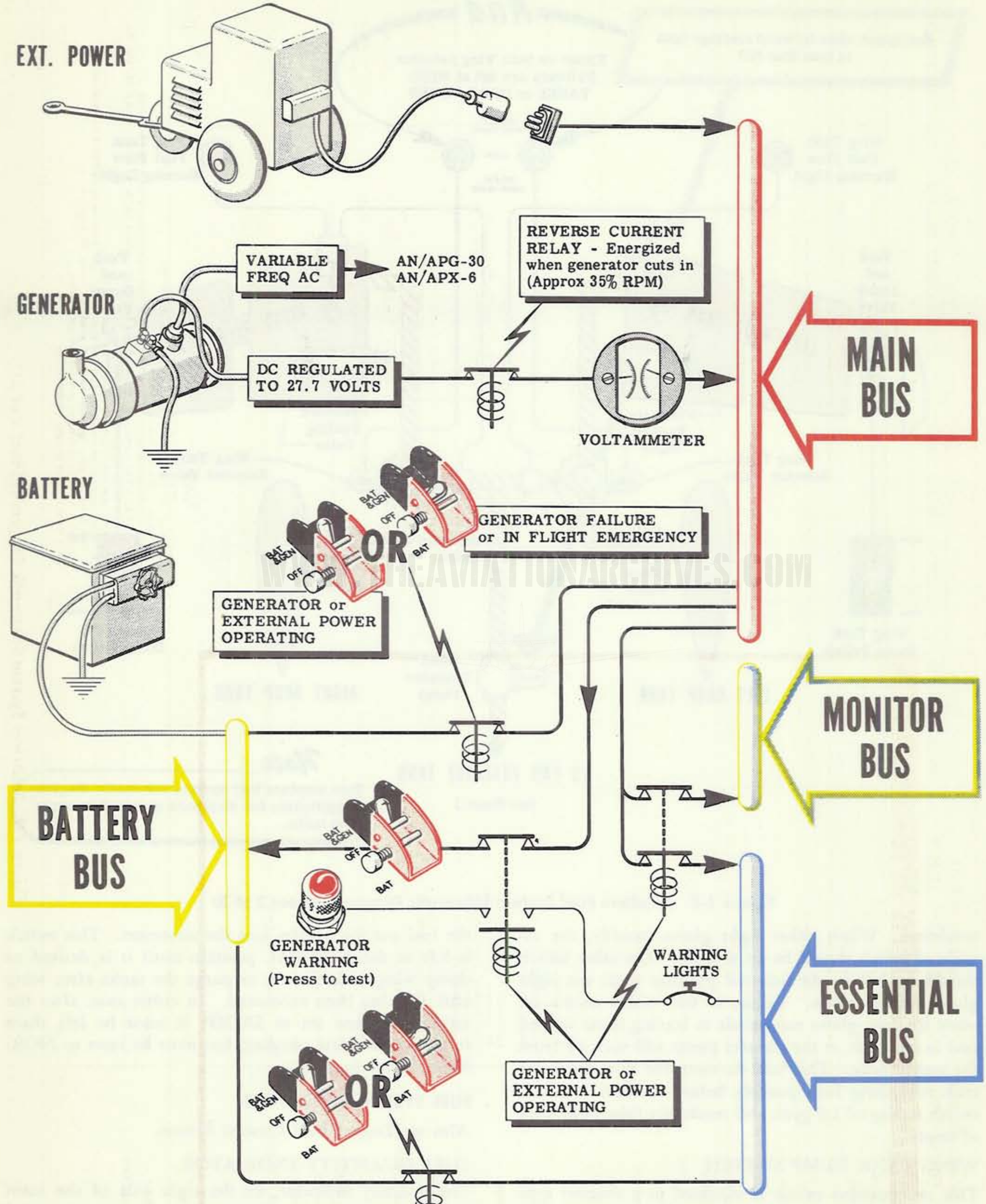


Figure 1-9. Electrical System Schematic Diagram (Sheet 1 of 2)

CIRCUIT BREAKER ON MAIN CIRCUIT BREAKER PANEL	EQUIPMENT POWERED THROUGH CIRCUIT BREAKER	APPROX CURRENT DRAIN (AMPERES)
	MAIN BUS	
RADAR APG-30	AN/APG-30 Radar Equipment	3.6
I.F.F. POWER	AN/APX-6 IFF Equipment	1.4
NAV.	AN/ARR-2A Radio Navigation Set	2.0
A.D.F.	AN/ARN-6 Radio Compass	4.0
U.H.F. (See Note 5)	AN/ARC-27 Command Set Band Change Receiver Transmitter	 9.0 17.0 20.0
ANT. RELAY (See Note 6)	AN/ARC-27, AN/ARR-2A Antenna Selector Relay	2.3 (See Note 3)
GROUND LOCK	Ground Lock Solenoid	0.4
HYDRAULIC PUMP	Auxiliary Hydraulic Pump	37.6 (See Note 3)
EMER. HYD. PUMP (See Note 7)	Auxiliary Hydraulic Pump Relay	0.4 (See Note 3)
HOOK CONTROL	Arresting Hook Retracting Valve Arresting Hook Indicator Light Control Relays	.1 (See Note 3) 0.2 (See Note 3) 0.9 (See Note 3)
EXT. LIGHTS (2)	Approach Light Flasher Coder Wing Running Lights Wing Formation Lights Tail Lights Fuselage Lights Control Relays	0.8 (See Note 3) 0.3 1.5 0.3 0.8 5.4 0.2
CABIN PRESS.	Air Conditioning System Main Shut-off Air Conditioning System Ram Air Valve Cabin Pressure Regulator Temperature Control Valve Temperature Control Box	0.3 1.1 0.5 1.1 0.2
GUN CHARGING	Gun Charging Valve Hydraulic Pressure Switch and Control Relays	0.6 (See Note 3) 0.7 (See Note 3)
(Armament) MASTER (See Note 8)	Armament Master Relay	0.6
A.F.C.S.	Armament Control System Gun Sight Recorder	4.5 0.2
STANDBY INVERTER	Stand-by Inverter	17.8
PITOT (See Note 9)	Pitot Tube Heater	4.2
FLIGHT DEVICES	Speed Brake Limit Relay	0.1 (See Note 3)
DIVE BRAKE (See Note 10)	Speed Brake Hydraulic Valve	.2 (See Note 3)
	MONITOR BUS	
GUN CAMERA	Gun Camera	1.6
UTILITY RECEPT.	—	—

CIRCUIT BREAKER ON MAIN CIRCUIT BREAKER PANEL	EQUIPMENT POWERED THROUGH CIRCUIT BREAKER	APPROX CURRENT DRAIN (AMPERES)
	ESSENTIAL BUS	
FLIGHT INSTRS.	Wheels and Flaps Position Indicator Speed Brakes Position Indicator Stabilizer Position Indicator Rudder Trim Tab Position Indicator G-2 Compass	0.2 0.1 0.1 0.1 0.9
ENGINE INSTRS.	Tailpipe Temperature Indicator Low Fuel Level Warning Light	0.2 (See Note 3) 0.2 (See Note 3)
MAIN INVERTER	Main Inverter and Control Relays	20.3
COCKPIT LIGHTS	Cabin Lights Radio Panel Edge Lights Check-off List Lights Exterior Lights Panel Edge Lights	0.7 0.4 0.1 0.1
INSTR. LIGHTS	Instrument Panel Lights	1.4
FLAPERETTE	Flaperette System By-pass Valve and Control Relay	1.1 (See Note 3)
FUEL TRANSFER	Fuel Transfer Pump	15.0
WING TANK DUMP	Wing Tank Dump Valves	1.5 (See Note 3)
WING FUEL SHUT-OFF	Wing Tank Fuel Shut-off Valves Fuel Transfer Pump Relay Wing Tank Empty Warning Lights	4.0 (See Note 3) 0.3 0.3 (See Note 3)
FUEL SHUT-OFF	Main Fuel Shut-off Valve Fuel Transfer and Fuel Boost Pump Relays	2.0 (See Note 3) 0.7
FUEL BOOSTER	Fuel Boost Pump	30.5
ENG. FUEL SYSTEM	Low Fuel Pressure Warning Light Main High Pressure Fuel Pumps Warning Light	0.2 (See Note 3) 0.2 (See Note 3)
STARTING CONTROL	Ignition System and Control Relays	10.2 (See Note 3)
WARNING LIGHTS	Inverter Indicator Light Generator Warning Light Fire Warning Lights	0.2 0.2 0.2
EMER CONT (See Note 4)	Stabilizer Up or Down Control Relays	4.6 (See Note 3)
PRIM CONT (See Note 4)	Stabilizer Up or Down Control Relays Wing Trimmer Actuator	4.6 (See Note 3) 1.1 (See Note 3)
EMER PWR (See Note 4)	Stabilizer Actuator and Control Relay Flying Tail Shut-off Valve	25.1 (See Note 3) 1.0 (See Note 3)
PRIM PWR (See Note 4)	Stabilizer Actuator	25.0 (See Note 3)
	BATTERY BUS	
IFF DET.	IFF Destructor	—

Note

1. System shown in operating condition.
2. Generator cuts in at 35% rpm; carries load at 46% rpm.
3. May be on during cruise condition.
4. Circuit breaker mounted on stabilizer power circuit breaker box on cabin after bulkhead.
5. AN/ARC-1 VHF command set with current drain of 10 amperes may be installed in place of AN/ARC-27.
6. Circuit breaker mounted on right console.
7. Switch type circuit breaker mounted on right console.
8. Switch type circuit breaker mounted on armament control panel on windshield deck. With switch set to ON and guns fired, current drain is approximately 102 amperes.
9. Switch type circuit breaker mounted on right console.
10. Circuit breaker mounted on left console.

Figure 1-9. Electrical System Schematic Diagram (Sheet 2 of 2) no quantity indication for the wing tanks). A push button (18, figure 1-4) is installed above the indicator to check operation of the system. With the battery switch set to BAT. & GEN., pushing this button will cause the indicator pointer to move to the low end of the dial. If the system is operating properly, the pointer will return to its original indication when the button is released.

Note

Fuel varies in weight per gallon, dependent upon its specific gravity and temperature. Therefore, the notation FULL does not appear on the indicator dial and the pilot should anticipate variations in the instrument readings when the fuel tanks are full.

LOW FUEL LEVEL WARNING LIGHT.

This red warning light, on the right side of the main instrument panel (17, figure 1-4), glows when approximately 1000 pounds (or less) of fuel remain in the system.

WARNING

Descents with the low fuel level warning light on must be made in accordance with the procedure given in Appendix I, Description of Charts and Tables paragraph, step h.

WING TANKS EMPTY WARNING LIGHTS.

Warning lights for each wing tank, (27, figure 1-3) operated by float switches, glow when the tanks are empty. On airplanes equipped for external stores, the lights are operated by fuel flow switches located in the wing fuel lines. The lights will flicker intermittently in the final stages of fuel transfer from either wing, and glow steadily when fuel flow through the line drops to less than 1.0 gpm.

FLOWMETER.

The fuel flowmeter is on the right side of the main instrument panel (21, figure 1-4). The indicator has a pointer which shows the rate of flow (in pounds) and a counter which shows the amount of fuel remaining (in pounds). The counter must be reset at each refueling to indicate total fuel aboard at the start of a flight.

ELECTRICAL SYSTEM.

The basic system is a 28 volt, direct current, open wire system which uses the aircraft structure for a ground. Power is provided by a combination a-c—d-c generator and a battery. These, plus an a-c voltage regulator, a d-c voltage regulator, a reverse-current relay, wiring and bus bars, make up the main supply circuit. The controls, with the exception of armament, engine and certain special items are on the right console. See figure 1-9 for additional information on electrical system.

A-C POWER.

In addition to the a-c output of the engine driven generator, two inverters are provided to supply three phase, 115 volt, 400 cycle alternating current. Both inverters are powered by dc and each one is protected from overloads by a circuit breaker. The two inverters are the No. 1 inverter and the No. 2 inverter.

Note

On the first twelve airplanes,[1] the inverters are called main (instead of No. 1) and stand-by (instead of No. 2) and the two positions of the inverter changeover selector switch are MAIN and STANDBY. Except for the difference in nomenclature, this inverter system is identical to that installed in later airplanes.

Both inverters operate continuously. Normally, the No. 1 inverter powers the G-2 compass, gyro horizon, fuel flowmeter and fuel quantity indicators and, through a 26 volt transformer, the oil pressure indicator. The No. 2 inverter normally powers certain circuits of the AN/APG-30 system. A guarded inverter changeover selector switch and an inverter indicator light are provided on the right console. The inverter changeover selector switch has two positions: #1 INV. and #2 INV. When this switch is set to #1 INV., equipment normally powered by the No. 1 and No. 2 inverters, as described above, is energized. In the event of No. 1 inverter failure with the inverter changeover selector switch set at #1 INV., the inverter indicator light will glow. Setting the inverter changeover selector switch to #2 INV. diverts the output of the No. 2 inverter to equipment normally powered by the No. 1 inverter. However, power is no longer available to energize the AN/APG-30 circuits. In the event of No. 2 inverter failure with the inverter changeover selector switch at #2 INV., the inverter indicator light will glow.

Note

The inverter indicator light will only indicate the failure of the No. 1 inverter when the inverter changeover selector switch is set at #1 INV. and the failure of the stand-by inverter when the switch is set at #2 INV.

D-C POWER.

An engine driven combination a-c—d-c generator, rated at 200 amperes at a potential of 30 volts, is regulated to 27.7 + 0.2 −0.0 volts and forms the principal direct current power source. It provides the required electrical energy to operate the various units of electrical equipment, and in addition, maintains the battery in a charged condition. A 24 volt, 34 ampere-hour storage battery serves as a stand-by or emergency source of power. An external source of direct current may be connected to the airplane for ground operation and

[1] Airplanes ser No. 130752 through 130763.

test purposes. Power distribution is accomplished through a multiple bus network; i.e., battery, essential, main and monitor. The three position battery and generator switch controls system operation and provides manual override in emergencies to permit operation of certain equipment normally deenergized when generator failure occurs. The generator system is equipped with standard controls; i.e., generator control relay and voltage regulator. The battery relay, battery relay transfer switch, monitor bus relay "A", monitor bus relay "B", essential bus relay, ammeter shunt, voltammeter, generator warning light and system external power receptacle complete the d-c power supply system.

The battery, generator and the external power source are connected in parallel with the main bus. The battery is connected through the battery relay, the generator through the generator control relay and external power through the system external power receptacle. The main bus, therefore, serves as the main distribution point for d-c power. The battery relay may be energized directly from the storage battery or from the generator, depending upon system requirements.

Monitor bus relays "A" and "B" are energized from the IND terminal of the generator control relay when the generated potential is above battery potential, or from the system external power receptacle when an external source of electrical power is connected to the airplane. Monitor bus relay "A" transfers generator or external power from the main bus to the essential and monitor busses. Monitor bus relay "B" functions to control the battery relay through the battery relay transfer switch when the landing gear control lever is set to UP. In this condition, the battery relay is energized by the generator power received from the monitor bus. Since the main bus is connected to the battery bus through the battery relay contacts, the main bus and connecting circuits are automatically deenergized when generator operation is interrupted. Monitor bus relay "B" also serves to control the generator warning light circuit.

The essential bus relay transfers power from the battery bus to the essential bus. The essential bus relay is energized from either the battery bus or the main bus when the battery and generator switch is set to BAT. & GEN. position. The essential bus relay is energized by battery power on the battery bus, or by generator or external power on the main bus, providing this potential is greater than that of the battery.

EXTERNAL POWER RECEPTACLES.

A-C EXTERNAL POWER RECEPTACLE.

An external a-c power receptacle (53, figure 1-2) is provided in the nose wheel well for ground operation and testing of the AN/APG-30 gun ranging radar equipment and the AN/APX-6 IFF equipment.

D-C EXTERNAL POWER RECEPTACLES.

Two external d-c power receptacles (38, figure 1-2) are provided on the underside of the fuselage aft of the main wheels. One receptacle is for engine starting only, the other supplies power to the entire d-c system with the exception of the starter. When external d-c power is plugged in for the d-c system, the battery, main, essential and monitor busses are automatically energized and all equipment normally powered by these busses may be operated.

Note

On certain airplanes,[1] with the battery and generator switch set at OFF, the battery bus is not energized when d-c system external power is plugged in.

NORMAL CONTROLS.

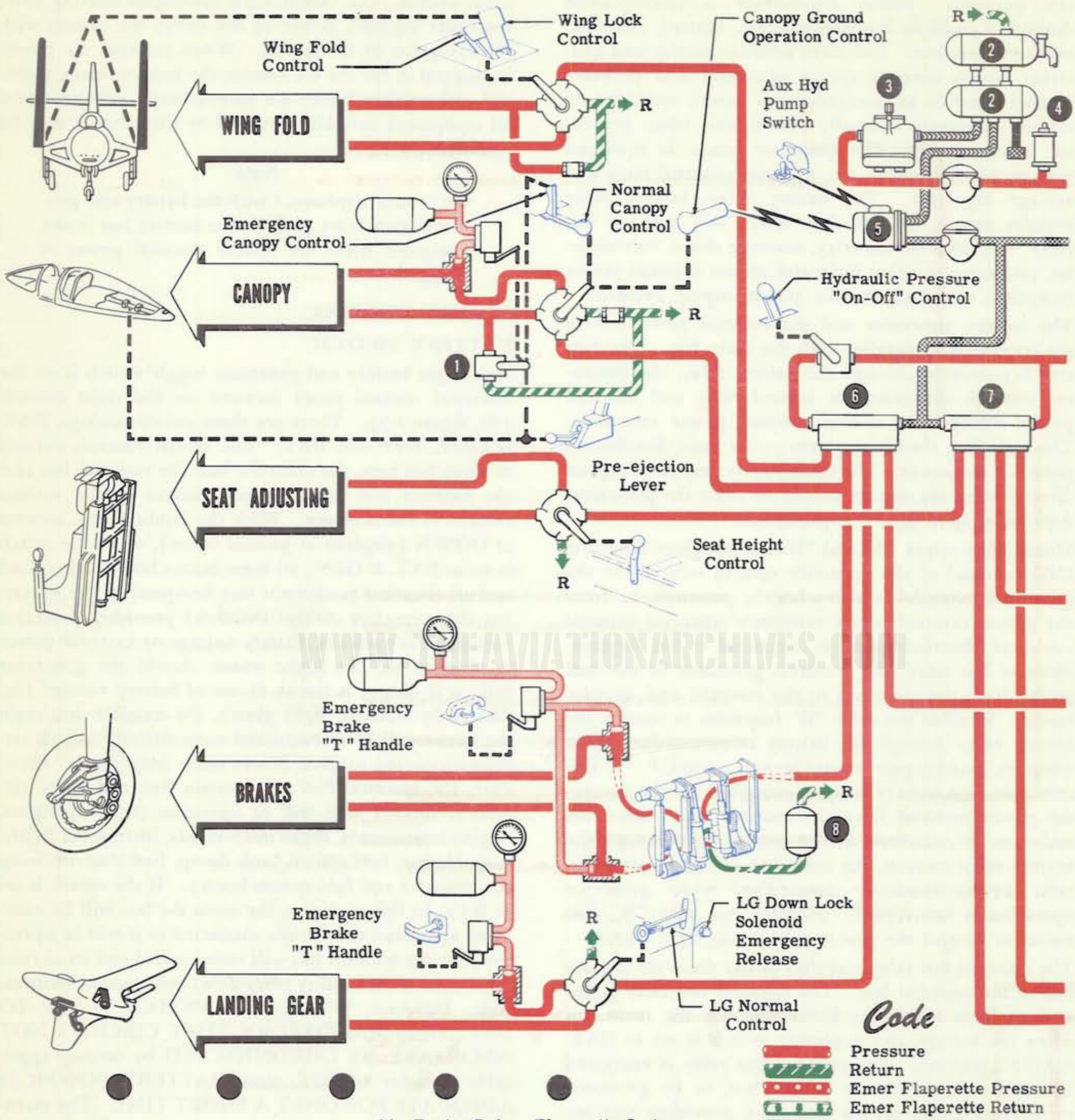
BATTERY SWITCH.

The single battery and generator toggle switch is on the electrical control panel forward on the right console (48, figure 1-5). There are three switch settings, BAT. & GEN., OFF and BAT. The switch controls current to three bus bars, the main d-c bus, the essential bus and the monitor bus, which supply current to the various circuits in the airplane. With the landing gear control at DOWN (airplane in ground status), when the switch is set at BAT. & GEN., all three busses become energized and all electrical equipment may be operated (by operating the respective control switches) provided generator voltage is in excess of battery voltage or external power is plugged in. In flight status, should the generator fail, or if output is not in excess of battery voltage (indicated by warning light glow), the monitor and main d-c busses will be disconnected automatically and all circuits connected to these busses made inoperative. However, the essential bus will remain live and those circuits connected to it will be operative (warning lights, engine instruments, flight instruments, instrument lights, fuel selector, fuel system, tank dump, fuel shut-off, wing fuel transfer and fuel system boost). If the switch is set at BAT. in this situation, the main d-c bus will be energized again and the circuits connected to it will be operative, but the monitor bus will remain dead and its circuits (gun camera and utility receptacle) will remain inoperative. However, WHEN THE SWITCH IS SET TO BAT., IT IS MANDATORY THAT CIRCUITS NOT NECESSARY BE DISCONNECTED by setting applicable switches to OFF, since BATTERY POWER IS ADEQUATE FOR ONLY A SHORT TIME. The essential bus supplies all circuits necessary to flight and is energized in both BAT. & GEN. and BAT. switch positions. Setting the switch to OFF cuts off all equipment except the IFF detonator and canopy external control circuits.

CIRCUIT BREAKER RESET BUTTONS.

The reset buttons are grouped together on a panel on the inboard side of the right console (1, figure 1-3B). The button must be pushed in for operation of its respective circuit; if operation is desired without certain circuits, their applicable buttons may be pulled out.

[1]Airplanes ser No. 130772 and subsequent.



1. Canopy Dump Valve
2. Reservoir (Top and Bottom)
3. Engine-driven Main Hydraulic Pump
4. Main System Accumulator
5. Electric Auxiliary Hydraulic Pump
6. Service Manifold
7. Combat Manifold
8. Brake Reservoir
9. Flight Manifold
10. DELETED
11. Flaperon Hydraulic Pressure Sensing Switch
12. Vent and Relief Valve
13. Flaperette System Reservoir
14. Engine Driven Flaperette System Hydraulic Pump
15. Flaperette System Accumulator
16. Flaperette Emergency System Air Gage
17. Flaperette Emergency System Air Bottle
18. Flaperette Emergency System Air Pressure Control Valve
19. Flaperette Emergency System Accumulator
20. Flaperette System By-Pass Valve
21. Flaperette System Relief Valve
22. Armament System Pressure Switches

Code

- Pressure
- Return
- Emer Flaperette Pressure
- Emer Flaperette Return
- Aux Pump Pressure
- Pump Suction
- Drain
- Emergency Air

- Check Valve
- Release Valve
- Shuttle
- Filter

Figure 1-10. Hydraulic System Schematic Diagram (Sheet 1 of 3)

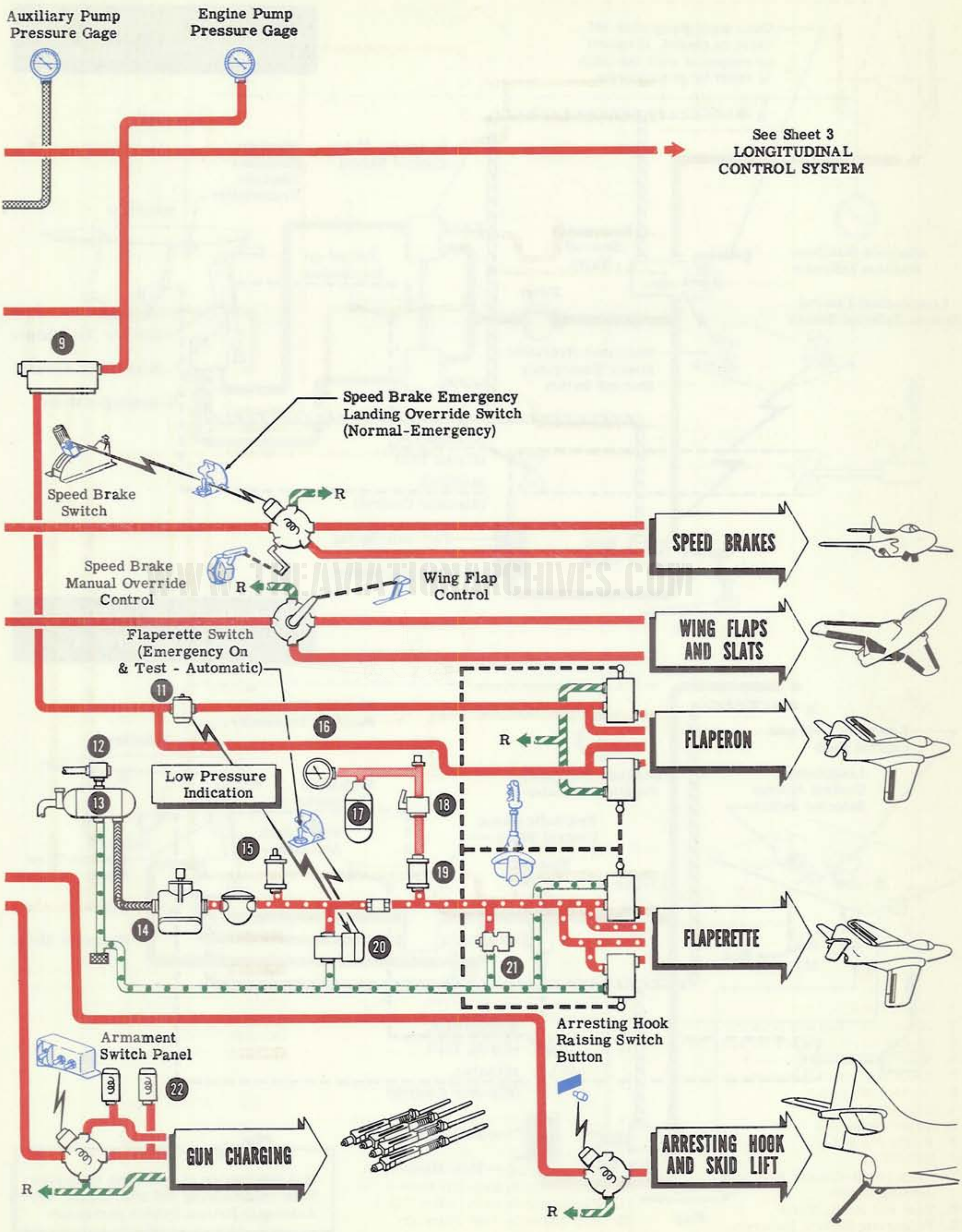
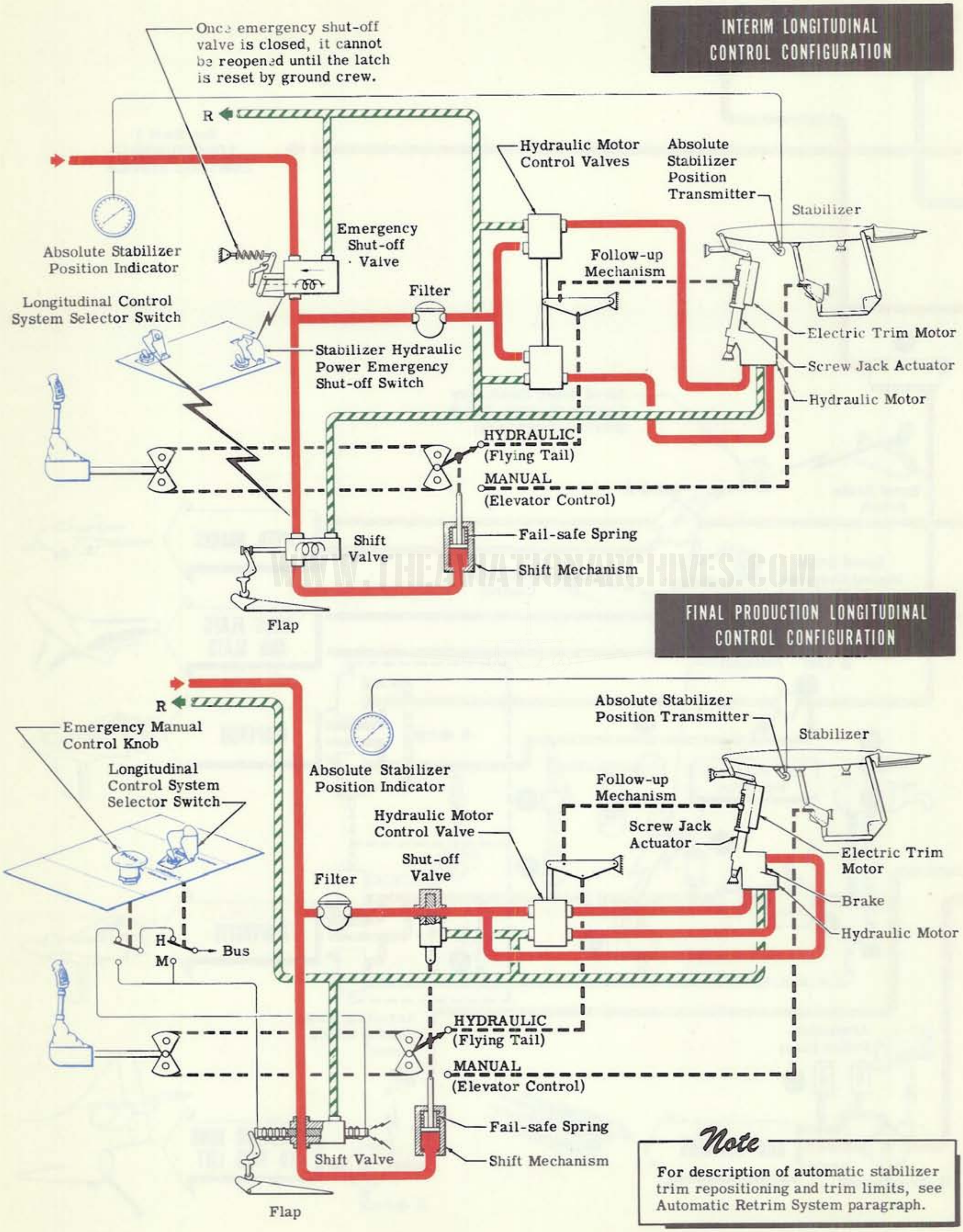


Figure 1-10. Hydraulic System Schematic Diagram (Sheet 2 of 3)



Note

For description of automatic stabilizer trim repositioning and trim limits, see Automatic Retrim System paragraph.

Figure 1-10. Hydraulic System Schematic Diagram (Sheet 3 of 3)

INVERTER CHANGEOVER SWITCH.

This guarded switch (51, figure 1-5), located on the right console inboard of the battery switch, has two positions: #1 INV. and #2 INV. Normally, the switch is placed at its guarded #1 INV. position, wherein the No. 1 inverter supplies power to the G-2 compass, gyro horizon indicator, fuel flowmeter, and fuel quantity and oil pressure indicators. With the switch set at #1 INV., the No. 2 inverter powers certain circuits of the AN/APG-30 equipment. In the event of No. 1 inverter failure, as indicated by a glowing inverter indicator light, raising the guard and setting the switch to #2 INV. automatically diverts the output of the No. 2 inverter to the equipment powered by the No. 1 inverter. This switch may also be used for testing the No. 2 inverter by setting the switch at #2 INV. Successful change-over from the No. 1 to the No. 2 inverter is indicated by the inverter indicator light remaining out.

FUSES.

Fuses (three groups—DC INST, INTERIOR LTS and AC INST) are installed on the outboard edge of the right console (9, figure 1-5). They are installed for additional protection to certain circuits. Failure of a unit will not blow a fuse if there is no circuit overload. Failure will cut out the portion of the circuit protected by fuses, and the remainder of the units on that circuit will remain operative.

SPARE FUSES.

Spare fuses are stored in a receptacle aft of the wing folding controls (17, figure 1-5).

UTILITY RECEPTACLE.

A standard utility receptacle is on the right console aft (19, figure 1-5).

EMERGENCY CONTROLS.

The battery and generator switch should be left at BAT. & GEN. position for emergency operation. To operate equipment connected to the main d-c bus, such as radio, it is necessary to set the switch to BAT. To conserve electrical power, IT IS MANDATORY THAT ALL UNNECESSARY EQUIPMENT BE TURNED OFF WHEN THE SWITCH IS SET TO BAT.

INDICATORS.

VOLTAMMETER.

A dual dial, constant reading voltammeter is on the right console adjacent to the battery and generator switch. The meter indicates voltage at the main d-c bus and generator output amperage (52, figure 1-5).

GENERATOR WARNING LIGHT.

A generator red warning light on the right console (49, figure 1-5), adjacent to the battery and generator switch, will glow in the event of generator failure, or if output is below battery potential.

INVERTER WARNING LIGHT.

When the inverter changeover switch is in its normal #1 INV. position, the red inverter indicator light on the right console (50, figure 1-5) glows if the No. 1 inverter fails. When the inverter switch is set to #2 INV., the light will go out if this inverter is producing ac.

HYDRAULIC POWER SUPPLY SYSTEM.

NORMAL CONTROLS AND OPERATION.

Fluid from the dual reservoir in the plenum chamber is pumped by a variable volume engine driven pump. The selector valve controls are in the cabin; most of the valves are outside the cabin and are operated through shafts and right angle drives. The power assist brake valves are on the brake pedals. The landing gear, wing folding, seat adjustment, canopy, gun charging, arresting hook and tail skid, and speed brakes selector valves are in the forward section of the fuselage; these last three are electrically controlled. In addition to the system reservoir, a small reservoir is provided for the wheel brakes. Pressure is distributed via two manifolds, a service manifold and a combat manifold, and a selector valve is installed which may be set to shut off pressure to all systems not essential to flight, for combat operation. The auxiliary hydraulic pump is powered by the airplane electrical system. See figure 1-2 for hydraulic fluid specification and figure 1-10 for system schematic diagram.

Note

> Hydraulic fuses, actuated by flow, are installed in the system to prevent excessive loss of fluid in case of failure of lines and/or units.
> If a malfunctioning fuse should stop landing gear operation, the selector valve should be reversed momentarily to reset the fuse.

HYDRAULIC SYSTEM CONTROL.

This control lever is on the right console, forward of the wing folding controls (24, figure 1-5). It is moved outboard to HYDRAULIC PRESSURE OFF (combat operation), inboard to HYDRAULIC PRESSURE ON (normal operation—all hydraulic equipment operative). When the control is moved to HYDRAULIC PRESSURE OFF, only the following units are operative: speed brakes, gun chargers, seat adjustment, arresting hook, tail skid raising, and flaperons. The following units are cut off when the control is moved to HYDRAULIC PRESSURE OFF to prevent loss of fluid due to damage to a non-essential system: canopy control, wing flaps, wing slats, wing folding, wheel brakes, and landing gear.

AUXILIARY HYDRAULIC PUMP SWITCH.

This ON-OFF toggle switch, equipped with a guard, is on the right console aft, adjacent to the wing folding controls (18, figure 1-5). If there is no action when some part of the system is operated, or if no pressure is indicated on the main system gage, the guard should be raised and the switch set to ON.

CAUTION

Do not use auxiliary pump on the ground without connecting external d-c power.

Do not leave auxiliary pump switch at ON during flight.

Note

Auxiliary pump operation of any system will be considerably slower than normal operation.

INDICATORS.

SYSTEM PRESSURE GAGE.

This gage is on the right console aft, adjacent to the map case (22, figure 1-5). The dial shows pressure in psi, and is numbered from 0 to 2000. It should show 1500 psi when the engine is running and no hydraulic units are operating but pressure indication may drop momentarily considerably below this figure when a system or systems are being operated.

AUXILIARY PUMP PRESSURE GAGE.

This gage is on the right console, aft of the system gage and forward of the auxiliary pump switch (21, figure 1-5). The dial shows pressure in psi and is numbered from 0 to 2000. It should indicate approximately 1700 psi with no hydraulic device operating but may show very low readings, depending on the number of units being operated by the pump.

FLIGHT CONTROLS SYSTEM.

This airplane is controlled in the conventional manner using a control stick and pedals. Lateral and longitudinal control is achieved by the use of flaperons and the flying tail. Flaps and slats are used to facilitate low speed flight. Speed brakes are provided to decelerate the airplane at any airspeed. In addition, an adjustable stabilizer, a rudder trim tab[1] and a wing trimmer are installed for trim.

NORMAL LATERAL CONTROL SYSTEM—FLAPERONS.

The control stick in the cabin is linked hydraulically to the flaperons which provide lateral control. For normal operation, lateral movement of the stick raises a flaperon from the wing surface. Hydraulic pressure to the flaperon valves and operating cylinders is derived from a direct line to the engine driven hydraulic pump.

EMERGENCY LATERAL CONTROL SYSTEM—FLAPERETTES.

The aft halves of the flaperons are called flaperettes. The flaperettes are hinged to the flaperons and provide a reduced amount of lateral control when the flaperon system is inoperative. Normally, the flaperettes are locked in line with the flaperons and move as part of the flaperon surfaces. In the event of a hydraulic failure the changeover to the flaperette system is automatic. This emergency system is essentially an independent hydraulic system which duplicates the operation of the normal system and includes an additional engine driven pump, a by-pass valve, a reservoir, an accumulator, operating valves and cylinders. As long as hydraulic pressure is available for the flaperon system the by-pass valve opens electrically to by-pass flaperette pump pressure to the flaperette system reservoir. The by-pass valve is deenergized either by the opening of a main hydraulic system pressure sensing switch due to main system hydraulic pressure failure, or by setting the flaperette switch to EMERG. ON & TEST. When the by-pass valve is deenergized, it closes, thus diverting hydraulic pressure to operate the flaperettes.

FLAPERETTE SYSTEM CONTROL SWITCH.

A two position guarded flaperette system switch is located on the right console (23, figure 1-5). Normally, the switch is left in the AUTO position, wherein lateral control will automatically change over to the flaperette system in the event of main hydraulic system failure. Moving the switch to its other position (EMERG. ON & TEST) serves two purposes. Primarily, it permits changing lateral control over to the flaperette system in the event that automatic changeover does not occur, due to the failure of the main hydraulic system pressure sensing switch. Secondly, it permits the flaperette system to be checked for proper operation on the ground after the engine is started.

EMERGENCY FLAPERETTE CONTROL SYSTEM.

The emergency flaperette control system provides the pilot with an increase in the number of flaperette operating cycles available during landing approach under flame-out conditions. The system is installed because the engine windmilling rpm at low airspeeds is too low to provide sufficient hydraulic pressure for proper control. This system includes an air bottle, an additional hydraulic accumulator, a check valve, an emergency flaperette power control handle in the cabin, an air pressure gage in the cabin and interconnecting tubing.

EMERGENCY FLAPERETTE POWER CONTROL.

This control is located on the left console and is actuated in a slot which has an ON detent and an OFF detent. Placing the control to ON opens a valve which releases air pressure to the accumulator. Pressurized hydraulic fluid in the accumulator is directed to the flaperette system operating valves and cylinders. The number of flaperette operating cycles is 22. The control valve may be placed to OFF at any time to shut-off air pressure to the accumulator.

AIR PRESSURE GAGE.

This gage is located on the left console and is calibrated in the number of flaperette operating cycles available. When the system is turned on with a fully charged air bottle, the gage needle will indicate that 22 operating cycles are available. As the flaperette system is operated, the needle will move towards zero to show the number of available cycles remaining.

ARTIFICIAL FEEL.

Lateral stick forces are simulated by a cam-driven, spring loaded mechanism. The artificial feel thus induced in the lateral control system is necessary, since hydraulic operation of the flaperons and flaperettes prevents feedback of air loads to the control stick. To replace normal air load—"feel", a cam attached to the artificial feel sector moves against a spring loaded arm, inducing a force in the system which opposes stick movement. This lateral force is independent of airspeed and is the same when either the normal flaperon system or the emergency flaperette system is being operated. Artificial feel is light and amounts to 16 pounds for full stick travel.

WING TRIMMER.

The wing trimmer is a movable surface on the left wing tip provided to control lateral out-of-rig conditions. It is operated electrically by an actuator in the wing and controlled by left and right movement of the spring loaded thumb switch on the control stick (16, figure 1-6).

Note

Fore and aft movement of this switch is used for longitudinal trim.

Holding the switch to the left causes the wing trimmer surface to rise and the left wing to lower. Movement to the right causes the trimmer to lower and the left wing to rise. The switch is spring loaded to return to the central (off) position.

[1] Airplanes ser No. 130756 and subsequent.

LONGITUDINAL CONTROL SYSTEM—INTERIM MODIFICATION.[1]

Note

The interim longitudinal control system modification may be installed on these airplanes by G.A.E.C. Service Bulletin No. 224. Until this interim or the final production modification is incorporated, all these airplanes are controlled by a conventional geared tab elevator control system. For airplanes equipped with the final production longitudinal control system modification, see Longitudinal Control System—Final Production Modification paragraph.

DESCRIPTION.

Longitudinal control is provided by two separate systems. These are: the hydraulic pressure operated, all movable horizontal stabilizer control system for high speed clean configuration flight; and the manual elevator control system for low speed flight and emergency high speed flight. The shift from one system to the other is accomplished by one of two (normal and emergency) switches. An absolute stabilizer position indicator provides a means of checking stabilizer movement and position at all times.

FLYING TAIL (HYDRAULIC POWER OPERATED ALL MOVABLE HORIZONTAL STABILIZER) CONTROL SYSTEM.

The powered longitudinal control system (flying tail) may be activated in one of two ways: First, in the clean configuration (flaps up), by moving the longitudinal control system selector switch to HYDRAULIC; and second, by raising the wing flaps, with the longitudinal control system selector switch set to HYDRAULIC. In both cases, hydraulic pressure is directed to the shift valve to transfer the longitudinal control system to the hydraulic power operated all movable horizontal stabilizer with leading or helping elevators. In this configuration, moving the control stick mechanically actuates valves which direct hydraulic pressure to a hydraulic motor. The motor rotates a screw jack which moves the leading edge of the stabilizer up or down. As the stabilizer pivots, a mechanical linkage deflects the elevators to provide additional control effectiveness. Thus, moving the control stick aft lowers the leading edge of the stabilizer and raises the trailing edge of the elevators. Moving the control stick forward raises the leading edge of the stabilizer and lowers the trailing edge of the elevators. An absolute stabilizer position indicator is mounted on the upper left side of the instrument panel.

A follow-up mechanism is provided to stop the hydraulic motor when stabilizer position corresponds to the control stick position. Since there is no aerodynamic force feedback to the control stick, an artificial feel system is installed. This artificial feel consists of an initial torsion bar spring which provides stick centering near neutral, and a second preloaded feel spring which, with system bob weights, provides realistic control force for stability and maneuvering.

The stabilizer hydraulic power emergency shut-off switch, located on the inboard side of the stabilizer control selection panel on the left console, operates a shut-off valve between the pressure source and the hydraulic components of the flying tail. When the shut-off valve is closed it prevents further hydraulic pressure from reaching any flying tail components, and at the same time, transfers longitudinal control to manual operation.

NORMAL CONTROL.

LONGITUDINAL CONTROL SYSTEM SELECTOR SWITCH.

The longitudinal control system selector switch, located on the outboard side of the stabilizer control selection panel on the left console (36, figure 1-3), controls the operation of the shift valve. When the switch is in the HYDRAULIC position, the shift valve permits hydraulic pressure to act upon the shift actuator mounted on the aft control sector. The hydraulic control rod is attached to this sector and linked to the stabilizer control valves. The position of the valve pistons is controlled by movement of the control stick through the control rod linkage. Hydraulic pressure is transmitted through the valves to a hydraulic motor which operates the screw jack stabilizer actuator. During hydraulic operation, both the stabilizer and elevators move in response to control stick movement. When the switch is set into the MANUAL position, the shift valve is closed, and no pressure is exerted upon the shift actuator. The manual control rod attached to the aft control sector, being spring loaded, returns to the operative position. During manual operation, the stabilizer remains stationary and the elevators move in response to control stick movement.

EMERGENCY CONTROL.

STABILIZER HYDRAULIC POWER EMERGENCY SHUT-OFF SWITCH.

The guarded emergency shut-off switch is mounted on the inboard side of the stabilizer control selection panel on the left console (38, figure 1-3). This switch normally remains in the guarded position If there is a malfunction of the hydraulic components of the flying tail, the switch is placed in the emergency position. Actuating this switch closes the shut-off valve, which shuts off hydraulic pressure to the stabilizer control valves and the shift valve. The stabilizer control system will then automatically shift to manual operation and the electric trim must be used to move the stabilizer to the proper trim position.

[1]Airplanes ser No. 130752 through 130881.

CAUTION

If, during flight, the shut-off switch has been actuated, the flying tail control mechanism must be completely checked to determine the reason for the malfunction. Any improper condition of the mechanism must be corrected and the solenoid latch on the shut-off valve must be reset by the ground crew before making the flight in the airplane.

MANUAL ELEVATOR CONTROL SYSTEM.

Lowering the wing flaps actuates a valve to relieve hydraulic pressure in the stabilizer control system shift actuator. This permits the shift actuator spring to change control automatically from the hydraulic power operated, all movable horizontal stabilizer configuration to the manual elevator control configuration. In addition, when the flaps are lowered, the balancing tab neutral position is repositioned to 8-3/4 degrees down and a system bungee is automatically connected into the manual control system to improve airplane stability in the flaps down configuration.

Note

At airspeeds over 150 knots, if the speed brakes are kept extended when the flaps are lowered (by placing the speed brakes emergency landing override switch in its emergency position), automatic shifting from powered longitudinal to manual elevator control will not occur. Shifting will not occur, because the increased air loads upon the flaps with speed brakes extended, prevent the flaps from lowering sufficiently to actuate the shift valve.

Longitudinal trimming by means of the stabilizer is performed in the same manner as with the powered control system except that the control stick trim position varies with airspeed.

EMERGENCY MANUAL ELEVATOR CONTROL.

In the event of mechanical failure while flying in the hydraulic power operated, all movable horizontal stabilizer (flying tail) configuration, placement of the longitudinal control system selector switch to MANUAL, relieves hydraulic pressure in the stabilizer control system shift actuator. This permits the shift actuator spring to change control automatically from the hydraulic power operated, all movable horizontal stabilizer configuration to the manual elevator control configuration.

ABSOLUTE STABLIZER POSITION INDICATOR.

This indicator is mounted on the upper left side of the instrument panel. It is calibrated in degrees to indicate absolute stabilizer position, as determined by control stick movement. The range of the indicator is 0 to 4-1/2 degrees airplane nose-down, and 0 to 6-1/2 degrees airplane nose-up. On the manual control system, the indicator always denotes the trim position of the stabilizer and will move only when the stabilizer trim setting is changed. When operating on the hydraulic powered control system, the indicator continuously denotes the true stabilizer position and moves not only when the stabilizer trim adjustment is changed, but also whenever the control stick is displaced from neutral. Thus, when operating on the hydraulic powered control system, IT IS IMPORTANT TO REALIZE THAT THE ABSOLUTE STABILIZER POSITION INDICATOR DENOTES TRIM POSITION ONLY WHEN THE CONTROL STICK IS IN NEUTRAL AND NO FORE OR AFT CONTROL STICK FORCE IS BEING APPLIED.

WARNING

Prior to take-off, shift longitudinal control system to manual control and adjust stabilizer (3-1/2 degrees airplane nose-up trim).

ADJUSTABLE STABILIZER.

Longitudinal trim is obtained through movement of the entire horizontal tail surface by an electrically operated stabilizer actuator mounted in the tail section. Limit switches in the stabilizer actuator restrict the stabilizer within the limits of its electrical adjustment range. D-C power to operate the electric motor is taken off the essential bus which remains energized despite generator failure. Normally stabilizer adjustment is controlled by a momentary type thumb switch on the control stick grip. An emergency stabilizer adjustment control system is provided which includes a duplicate electric circuit and two control switches. A stabilizer trim position indicator is mounted on the left console.

ADJUSTABLE STABILIZER NORMAL CONTROL.

The system is normally operated by the momentary thumb switch on top of the control stick grip (16, figure 1-6). It is moved forward for nose-down trim, aft for nose-up trim and is spring loaded to return to the central (off) position. Stabilizer position in degrees is indicated by a stabilizer position indicator.

Note

Lateral movement of this switch controls the wing trimmer.

The range of stabilizer travel available is from 6 degrees airplane nose-up trim to 1-3/4 degrees airplane nose-down trim.

Note

It is necessary that the stabilizer adjustment emergency power switch be set at NORM. in order to energize the normal stabilizer adjustment control system.

ADJUSTABLE STABILIZER EMERGENCY CONTROL SYSTEM.

In the event of an open or short circuit in the normal wiring system, the stabilizer may be adjusted by means of two switches on the left console. These switches control power from the essential bus to the electric motor through a duplicate electric circuit.

ADJUSTABLE STABILIZER EMERGENCY CONTROLS.

EMERGENCY ELECTRIC POWER CONTROL SWITCH.

This guarded switch, mounted on the stabilizer power panel on the left console (21, figure 1-3), has three positions, NORM., OFF, and EMER. In the NORM. position, the stabilizer is adjusted by the momentary thumb switch on the control stick grip. In the OFF position neither the normal or emergency systems can be operated. In the EMER. position, the stabilizer is adjusted by the stabilizer emergency control switch.

STABILIZER EMERGENCY CONTROL SWITCH.

This two position momentary type toggle switch, mounted on the stabilizer power panel on the left console (20, figure 1-3), has two positions; forward, NOSE DOWN; aft, NOSE UP. Holding the switch in either of these two positions permits adjustment of the stabilizer to obtain desired airplane trim.

Note

The emergency electric power control switch must be set at EMER. to adjust the stabilizer with the stabilizer emergency control switch.

Stabilizer position in degrees is indicated by the stabilizer position indicator.

STABILIZER POSITION INDICATOR.

This indicator is mounted on the left console (19, figure 1-3). It is calibrated in degrees to indicate stabilizer position. The range of the indicator is 0 to 2-1/2 degrees airplane nose-down trim and 0 to 6-1/2 degrees airplane nose-up trim.

Note

When the flying tail modification is installed, the stabilizer position indicator will be replaced by an absolute stabilizer position indicator mounted on the instrument panel. See Absolute Stabilizer Position Indicator paragraph.

LONGITUDINAL CONTROL SYSTEM—FINAL PRODUCTION MODIFICATION.[1]

Note

The final production longitudinal control system may be installed on prior airplanes by G.A.E.C. Service Bulletin No. 225.

DESCRIPTION.

Longitudinal control is provided by two separate systems. These are: the hydraulic pressure operated, all movable horizontal stabilizer control system for high speed clean configuration flight; and the manual elevator control system for low speed flight and emergency high speed flight. The shift from one system to the other is accomplished by one of two (normal and emergency) switches. An absolute stabilizer position indicator provides a means of checking stabilizer movement and position at all times.

FLYING TAIL (HYDRAULIC POWER OPERATED ALL MOVABLE HORIZONTAL STABILIZER) CONTROL SYSTEM.

The hydraulic pressure to operate the powered longitudinal control system comes from an engine driven pump. (See Hydraulic Power Supply System paragraph.) The d-c power necessary to shift from one longitudinal control system to the other comes from the essential bus. The flying tail shift circuit breaker (42, figure 1-3A), mounted on the air conditioning panel, protects the longitudinal control system selector circuit. The powered longitudinal control system may be activated in one of two ways: by moving the longitudinal control system selector switch to HYDRAULIC when the wing flaps are up (clean configuration); or by raising the wing flaps when the longitudinal control system selector switch has already been set to HYDRAULIC. In both cases, longitudinal control is transferred from a trimming stabilizer and movable elevator to a hydraulically operated flying tail. The flying tail moves up or down as the control stick operates a valve which controls extension or retraction of an irreversible screw jack attached to the stabilizer. Artificial feel is incorporated because there is no aerodynamic feedback in an irreversible control system. On the powered longitudinal control system, the elevators are geared to move slightly at a fixed ratio with the stabilizer. Their rigging is such that under all level flight conditions the elevators trail up.

The travel of the stabilizer on powered longitudinal control is 6-1/2 degrees airplane nose-up and 4-1/2 degrees airplane nose-down. Stabilizer travel in either direction (nose up or down) in response to control stick movement will be decreased by an amount equal to stabilizer trim position in the opposite direction. Thus, if the stabilizer is positioned electrically to 2-1/2 degrees airplane nose-up trim, the limit of stabilizer travel hydraulically for full forward stick will be 2 degrees airplane nose-down.

MANUAL ELEVATOR CONTROL SYSTEM.

The manual control system consists of the electrically operated stabilizer and standard mechanically controlled elevators. The airplane may, under normal conditions, be taken out of the powered longitudinal control system by moving the longitudinal control system selector switch to MANUAL, while remaining in the clean configuration (flaps up), or by lowering the flaps even though the longitudinal control system selector switch is at HYDRAULIC.

The longitudinal control system selector switch controls the shift by actuating the shift valve which controls the hydraulic pressure acting upon the shift mechanism. Actuating the flaps controls the same valve through mechanical linkage.

[1]Airplanes ser No. 130882 and Subsequent.

Note

At airspeeds over 150 knots, if the speed brakes are kept extended when the flaps are lowered (by placing the speed brakes emergency landing override switch in its emergency position), automatic shifting from powered longitudinal to manual elevator control will not occur. Shifting will not occur, because the increased air loads upon the flaps with speed brakes extended, prevent the flaps from lowering sufficiently to actuate the shift valve.

LONGITUDINAL CONTROL SYSTEM SHIFT.

The shift from one system to the other is accomplished by the shift mechanism on the aft control sector. Hydraulic pressure holds the shift mechanism in the powered longitudinal control position by overcoming a fail-safe spring that is preloaded to force the shift mechanism to manual elevator control. Thus, when the longitudinal control system selector switch is set to MANUAL, or if there is a loss of hydraulic pressure, the spring will cause a shift to manual elevator control.

LONGITUDINAL CONTROL SYSTEM SELECTOR SWITCH.

The guarded longitudinal control system selector switch (43, figure 1-3A) is located on the inboard side of the stabilizer control selection panel on the left console. The two positions of this toggle switch enable the pilot to select either longitudinal control system; MANUAL for manual elevator control, or HYDRAULIC for powered longitudinal control (flying tail). When this switch is placed in MANUAL, hydraulic pressure to all components of the powered longitudinal control system is shut off, and control is automatically shifted to manual operation.

EMERGENCY MANUAL CONTROL.

A push-pull knob (44, figure 1-3A) labeled PUSH, is mounted on the inboard side of the stabilizer control selection panel on the left console. The emergency manual control knob provides a rapid means of shifting from the powered longitudinal control system to the manual elevator control system and attaining full electrical movement of the stabilizer. This knob normally remains in the up position, and must remain up for the powered longitudinal control system to be operable. The actual reversion to manual control is accomplished in the same manner as mentioned above; i.e., by shutting off hydraulic pressure to all the components of the powered longitudinal control system.

Note

The control stick should be near neutral when shifting from powered to manual control. If the control stick is held aft when reverting to manual control, the stabilizer cannot return to its hydraulic neutral position before pressure is shut off. This will result in a brief out-of-trim condition if the powered control system is again selected.

ABSOLUTE STABILIZER POSITION INDICATOR.

This indicator (12, figure 1-4A) is mounted on the upper left side of the instrument panel. It is calibrated in degrees to indicate absolute stabilizer position. The range of the indicator is 0 to 4-1/2 degrees airplane nose-down, and 0 to 6-1/2 degrees airplane nose-up. On the manual control system, the indicator always denotes the trim position of the stabilizer and will move only when the stabilizer trim setting is changed. When operating on the powered longitudinal control system, the indicator continuously denotes the true stabilizer position and moves not only when the stabilizer trim adjustment is changed, but also whenever the control stick is displaced from neutral. Thus, when operating on the powered longitudinal control system, IT IS IMPORTANT TO REALIZE THAT THE ABSOLUTE STABILIZER POSITION INDICATOR DENOTES TRIM POSITION ONLY WHEN THE CONTROL STICK IS IN NEUTRAL AND NO FORE OR AFT CONTROL STICK FORCE IS BEING APPLIED.

ADJUSTABLE STABILIZER.

Longitudinal trim is controlled by switches through which the electric motor of the stabilizer actuator is energized. Trim is obtained through movement of the horizontal stabilizer by the electrically operated component of the actuator. The electric motor operates on d-c power from the essential bus. Limit switches in the stabilizer actuator restrict the stabilizer movement within the limits of its electrical adjustment range. The normal range is 2-1/2 degrees airplane nose-up and 1-3/4 degrees airplane nose-down with flaps up, and 6 degrees airplane nose-up and 1-3/4 degrees airplane nose-down with flaps down.

Note

The 6 degrees airplane nose-up and 1-3/4 degrees airplane nose-down limits are established by actual or absolute stabilizer position. Therefore, if the stabilizer is held away from these limits hydraulically while it is trimmed towards them electrically (pulling aft on the control stick while trimming nose-down or vice-versa), the limits can be exceeded and the trim can be run to the limit of actuator travel (6-1/2 degrees airplane nose-up or 4 degrees airplane nose-down).

AUTOMATIC RETRIM SYSTEM.

The purpose of automatic retrim is to eliminate excessive airplane nose-up trim change when the flaps are retracted. When the flaps are being retracted, with a trim setting of more than 2-1/2 degrees airplane nose-up, the stabilizer will automatically be repositioned to 2-1/2 degrees airplane nose-up trim. Once the flaps are up, the airplane nose-up trim is limited to 2-1/2 degrees. The operation of the automatic retrim system is dependent upon the trim and longitudinal control systems selection. Automatic retrim and the 2-1/2 airplane nose-up limit is available only when the emergency manual control knob is in the normal (up) position, the electrical trim selection switch is set to NORM., and the flaps have been retracted or are being retracted. The 2-1/2 degree limit becomes 6 degrees when the emergency manual control knob has been depressed or when the electric trim selection switch is set to EMERG.

ADJUSTABLE STABILIZER TRIM CONTROLS.

ELECTRICAL TRIM SELECTION SWITCH.

The guarded electrical trim selection switch (41, figure 1-3A) is mounted on the stabilizer control selection panel on the left console. It has three positions, NORM., OFF, and EMERG. This switch permits the selection of the normal or the emergency trim circuits. In the NORM. position, the stabilizer is adjusted by the momentary thumb switch on the control stick grip. In the OFF position, neither the normal nor emergency circuit can be operated. In the EMERG. position, the stabilizer is adjusted by the emergency trim switch on the left console.

Note

Automatic retrimming and the 2-1/2 degree airplane nose-up limit are not available if the electrical trim selection switch is set to EMERG.

NORMAL TRIM SWITCH.

The momentary thumb switch (16, figure 1-6) on top of the control stick grip is normally used to trim the adjustable stabilizer. It is moved forward for airplane nose-down trim, aft for airplane nose-up trim, and is spring loaded to return to the central (off) position.

Note

Lateral movement of this switch controls the wing trimmer.

EMERGENCY TRIM SWITCH.

In the event of an open or short circuit in the normal control circuit, the electrical trim selection switch should be set to EMERG. and the stabilizer position adjusted by using the emergency trim switch. This momentary type toggle switch (40, figure 1-3A) is mounted on the stabilizer control selection panel on the left console. It is moved forward for airplane nose-down trim, aft for airplane nose-up trim, and is spring loaded to return to the central (off) position.

RUDDER CONTROL SYSTEM.

The rudder pedals are linked to the rudder by cables and push rods. The position of the rudder is determined by conventional movement of the pedals and also by the electronic yaw damper system, if installed.

RUDDER TRIM TAB SYSTEM.[1]

An electrically operated rudder trim tab on the lower portion of the rudder is provided for directional trim. The limit of tab travel is 5 degrees to the left and 5 degrees to the right. Limit switches in the system automatically shut off electrical power when the tab reaches the limits of its travel. The tab is controlled by a rotary switch on the left console. A rudder tab position indicator mounted on the left console shows the position of the trim tab.

RUDDER TRIM TAB CONTROL SWITCH.

This five position rotary switch is marked NOSE LEFT and NOSE RIGHT and is mounted on the left console. The positions each side of neutral as well as neutral are off positions. Turning the switch to its extreme NOSE LEFT or NOSE RIGHT setting actuates the tab to obtain the desired directional trim.

RUDDER TRIM TAB POSITION INDICATOR.

This indicator is mounted on the left console. It is calibrated in degrees with a range of 0 to 5 degrees nose left and 0 to 5 degrees nose right trim.

YAW DAMPER SYSTEM.[2]

The electronic yaw damper system eliminates lateral-directional oscillations which are sometimes encountered in swept wing aircraft. These oscillations are apparent to the pilot as forms of snaking, Dutch roll, or wallowing. The yaw damper senses small yawing motions and automatically displaces the rudder to correct the disturbances before they become apparent to the pilot.

The power requirements of the yaw damper system are 115 volt, 400 cycle, 3 phase ac for the amplifier and 28 volts dc for the servo unit motor. The ac is supplied by either inverter. The dc is supplied by the main bus and is controlled by the yaw damper power switch.

The yaw damper system consists essentially of two units: an amplifier and a rudder servo unit, and the control switches. The amplifier unit detects yawing velocity by means of a rate gyro and converts the mechanical displacement of the gyro into electrical signals. These signals are sent to the rudder servo unit, where the signals energize and also control the action of two clutches in the rudder servo unit. The rudder servo unit consists of the d-c motor, reduction geared to the two clutches which are geared to a common output shaft. This shaft drives a capstan connected to the rudder through cables. The rudder is deflected to correct the yaw disturbances detected by the rate gyro.

Note

The yaw damper indirectly activates the rudder-to-pedal cable system and causes the rudder pedals to move as the rudder is deflected by the yaw damper. This movement of the pedals may seem strange to the pilot on early familiarization flights, but will become virtually unnoticeable as the pilot gains experience in an airplane equipped with this system.

The yaw damper system is controlled by two pilot operated switches: the yaw damper power switch and the sensitivity selector switch. In addition, there are two

[1]Airplanes ser No. 130756 and subsequent.

[2]Airplanes ser No. 130850 and subsequent.

automatic cut-out switch arrangements which disconnect the yaw damper whenever its action conflicts with pilot effort. The yaw damper normally operates whenever the yaw damper power switch is in the ON position, except when it is disconnected by the cut-out switches. One set of cut-out switches is associated with the rudder pedals and disconnects the yaw damper whenever the pilot applies a force greater than 45 pounds on either or both rudder pedals. This permits the pilot to yaw the airplane intentionally for control in cross-wind take-offs or landings.

Note

Pilots are cautioned not to rest their feet on the rudder pedals during straight flight so heavily that the 45 pound cut-out switches keep the yaw damper continuously disconnected.

The other set of cut-out switches is associated with lateral motion of the stick, and disconnects the yaw damper whenever the stick is displaced more than 1-1/2 inches from neutral. The yaw damper remains disconnected for two seconds after the stick has been returned to the 1-1/2 inch band on either side of neutral. This lateral cut-out feature allows a turn entry or roll reversal, permitting an intentional turn entry away from an established flight path. Since the yaw damper may be temporarily disconnected by lateral motion of the stick during a turn entry or roll reversal, appropriate rudder should be used to coordinate these maneuvers exactly as though no yaw damper was installed. The yaw damper sensitivity selector switch has two settings, LOW GAIN and HIGH GAIN, which allow the pilot to choose the sensitivity most comfortable to him under a given set of flight conditions. With the HIGH GAIN setting, the effectiveness of the yaw damper for oscillation elimination is good; however, in rough, turbulent air, particularly at low flight speeds, the motion of the rudder pedals may be annoyingly large. With the LOW GAIN setting, the effectiveness of the yaw damper is reduced, but in rough, turbulent air, particularly at low speed, the motion of the rudder pedals will be more tolerable.

YAW DAMPER POWER SWITCH.

This OFF-ON switch is mounted on the right cabin rail just below the windshield frame. The yaw damper system is made operative by setting the yaw damper power switch to ON. This completes the circuit between the main bus and the rudder servo unit d-c motor.

YAW DAMPER SENSITIVITY SELECTOR SWITCH.

The amount of yaw correction provided by the system is determined by the setting of the yaw damper sensitivity selector switch located adjacent to the yaw damper power switch. The switch may be set to LOW GAIN or HIGH GAIN, depending upon the degree of correction desired by the pilot.

SURFACE CONTROLS LOCK.

The controls are locked by utilizing the pilot's harness and a cable assembly. The harness is used to secure the control stick and the cable assembly is attached to each rudder pedal and secured to the control stick (figure 1-11).

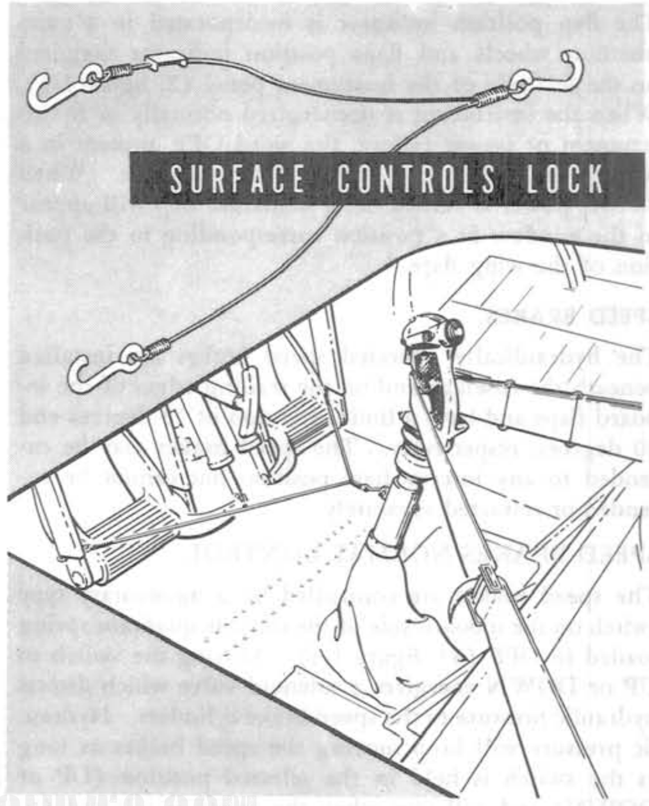


Figure 1-11. Surface Controls Lock

FLAPS.

The flaps are hydraulically operated and are controlled by a lever (11, figure 1-3) on the left console. They can assume either of two positions, up or down. The down position is used for both take-off and landing. Flap surfaces are on the trailing edge of each wing and beneath the fuselage. The wing flaps are referred to as outboard flaps and the fuselage flaps as the inboard flaps.

FLAP CONTROL LEVER.

The two flap control lever positions are marked DOWN and UP. When the lever is moved to DOWN, a valve is opened which directs hydraulic pressure to the flap actuating cylinders. The cylinders move both the inboard and outboard flaps to their full down position, which is 40 degrees for the inboard flaps and 30 degrees for the outboard flaps. No intermediate flap setting can be made. Moving the flap control to UP raises the flaps.

Note

To actuate the flaps, first move the flap control lever inboard to free it from its detent before attempting to select the DOWN position.

When the flap control lever is moved to the DOWN position, wing slats extend simultaneously with the flaps.

FLAP POSITION INDICATOR.

The flap position indicator is incorporated in a combination wheels and flaps position indicator mounted on the left side of the instrument panel (2, figure 1-4). When the instrument is deenergized normally or by instrument or power failure, the word OFF appears in a window on the upper portion of the dial face. When electric power is turned on, a miniature flap will appear in the window in a position corresponding to the position of the wing flaps.

SPEED BRAKES.

The hydraulically operated speed brakes are installed beneath the fuselage and on the trailing edges of the inboard flaps and have a limit extension of 75 degrees and 40 degrees, respectively. The speed brakes may be extended to any intermediate position but cannot be extended or retracted separately.

SPEED BRAKES NORMAL CONTROL.

The speed brakes are controlled by a momentary type switch on the inboard side of the throttle quadrant spring loaded to OFF (33, figure 1-3). Moving the switch to UP or DOWN energizes a solenoid valve which directs hydraulic pressure to the speed brake cylinders. Hydraulic pressure will keep moving the speed brakes as long as the switch is held in the selected position (UP or DOWN) and will stop when the switch is released (to OFF) or when they reach the limit of their travel.

Note

Normally, the landing flaps and speed brakes cannot be down simultaneously. If the flaps are extended while the speed brakes are down, the latter will retract automatically. However, for a wheels-up emergency landing, the speed brakes can be extended by the normal control when the landing flaps are extended by means of the speed brakes emergency landing override switch. (See Speed Brakes Emergency Landing Override Switch paragraph.)

SPEED BRAKES EMERGENCY CONTROLS.

SPEED BRAKES MANUAL OVERRIDE CONTROL.

If normal operation fails, the speed brakes manual override control (10, figure 1-6), a "T" handle on the left side of the after cabin bulkhead, may be used to retract the speed brakes. Pulling this handle will mechanically operate the solenoid valve which directs hydraulic pressure to raise the speed brakes.

Note

A special speed brakes reset type circuit breaker is mounted on the left console (32, figure 1-3) outboard of the normal control. If the speed brake circuit breaker will not stay set, check that speed brake switch is in the OFF position. If speed brakes are out, retract by use of the speed brakes manual override control.

SPEED BRAKES EMERGENCY LANDING OVERRIDE SWITCH.

This two position, guarded toggle switch, mounted on the aft portion of the left console (25, figure 1-3), is safety-wired in the normal position. In the normal position, the speed brakes will be raised automatically whenever the landing flaps are lowered. Breaking the safety wire, raising the guard and setting the switch to the emergency position, with landing flaps down, permits the speed brakes to be lowered using the normal speed brakes control switch. This procedure permits lowering both the flaps and speed brakes in an emergency such as a wheels-up landing.

SPEED BRAKES POSITION INDICATOR.

A speed brakes position indicator is installed on the left side of the instrument panel (6, figure 1-4). When the speed brakes are fully retracted, the word UP appears on the indicator. When the speed brakes are in any intermediate position or full down, the word DOWN appears on the indicator. A barber pole flag appears on the dial face when power to the indicator is cut off.

SLATS.

Slats are installed on the leading edge of the wing to augment the slow speed controllability of the aircraft. They are hydraulically operated and extend (forward of the leading edge) simultaneously with the flaps when the latter are lowered. The slats retract when the flaps are raised.

LANDING GEAR.

NORMAL CONTROL.

The normal control, a two position lever operating a hydraulic selector valve, is on the instrument panel bulkhead forward of the left console (36, figure 1-4). When the lever is moved to DOWN, after releasing the "T" latch, hydraulic cylinders open the wheel doors, lower and lock down the main and nose wheels and then close the main wheel doors again. The doors are operated by separate cylinders. When the lever is moved to UP, action is reversed and special locking cylinders lock the main wheels in the up position. A solenoid operated latch is installed to prevent inadvertent wheel retraction when the airplane is on the deck. When airborne, the struts extend, releasing the latch, which permits moving the control lever to UP. Extension or retraction of the landing gear may be accomplished by the normal control, using the auxiliary hydraulic pump in the vent of normal hydraulic pump failure.

Note

When the landing gear control handle is moved to DOWN, the guns are safetied.

EMERGENCY CONTROLS.

EMERGENCY EXTENSION CONTROL HANDLE.

A red "T" handle, just outboard of the normal control (1, figure 1-4), when pulled out, actuates a cable to open a compressed air bottle and direct air pressure to the cylinders to open the doors and lower and lock the wheels (and again close the main wheel doors). The handle shaft is notched to provide a lock when it is pulled out to release position. IT MUST BE LOCKED WHEN PULLED TO THE RELEASE POSITION.

Note

> Once the emergency control has been used, the gear cannot be retracted until normal operation has been restored by a deck crew by reservicing the system.

DOWN LOCK SOLENOID RELEASE.

A thumb operated release knob is located just forward of the instrument panel bulkhead on the left side, just inboard of the normal control (35, figure 1-4). If electrical failure should make the down lock solenoid inoperative, pushing the knob outboard will clear the control lever to raise the gear for a wheels-up landing.

INDICATORS.

WHEELS AND FLAPS POSITION INDICATOR.

A standard indicator which shows wheels down and locked or wheels up and locked is on the left side of the main instrument panel (2, figure 1-4).

LANDING GEAR UNLOCKED WARNING LIGHT.

A red light in the translucent handle of the landing gear control lever (36, figure 1-4) glows when the gear is not locked in the up or down position.

BRAKES.

NORMAL CONTROLS.

The brake pedals operate power assist brake valves (mounted on the pedals) to control hydraulic pressure to the disc type brakes. A special hydraulic reservoir (connected to the main system) is installed for the brakes so that brake operation is available in the event of hydraulic system failure.

EMERGENCY CONTROL.

The emergency brake red "T" handle is on the left console, aft (24, figure 1-3). The handle is pulled up to release and inboard to lock (the handle shaft is notched to provide a lock for the release and lock position). When pulled, the handle actuates a cable to open a compressed air bottle which acts on the brake cylinders.

Note

> Once the emergency "T" handle is used, the brakes are set full on. Release and normal operation must be effected by a deck crew.

ARRESTING HOOK.

NORMAL CONTROLS.

HOOK DOWN AND BARRIER GUARD CONTROL.

The hook control, on the instrument panel bulkhead forward of the right console (24, figure 1-4), operates a chain and cable assembly to the hook and a cable assembly to the barrier guard. The hook rides on a carriage and roller assembly and the control must be pulled and released repeatedly (three or four times) until the hook is fully extended and locked down. The barrier guard is a spring loaded square tube which, when the control handle is pulled, projects up from the fuselage just forward of the windshield. A switch on the release lowers the tail skid when the hook is lowered. The hook and barrier guard must be restowed by the deck crew.

CAUTION

> When test operating the system, ensure that personnel are clear of the hook and barrier guard.

HOOK UP CONTROL.

This push button switch (25, figure 1-4), is on the instrument panel bulkhead forward of the right console, adjacent to the hook down and barrier guard control. When the button is pushed, a solenoid operated hydraulic valve is actuated to direct pressure to a single action cylinder which raises the hook clear of the deck to permit taxiing forward of the barrier and arresting cables. (This cylinder action retracts the tail skid simultaneously through a cable linkage.)

Note

> The hook up push button switch will raise the hook only when the landing gear control is in the DOWN position.

INDICATORS.

HOOK POSITION WARNING LIGHT.

A red press-to-test warning light on the main instrument panel bulkhead forward of the right console (22, figure 1-4) glows when the hook is in any intermediate position between full up and full down. The light goes out when the hook is either fully extended or retracted.

APPROACH LIGHT.

When the wheels are down and locked and the hook is lowered, the approach light is lighted (steady); if the wheels are down and locked and the hook is *not* lowered the approach light flashes.

TAIL SKID CONTROLS.

The skid is interconnected mechanically with the arresting hook. The hook raising cylinder raises the skid through a cam and cable arrangement and the skid is lowered when pressure to the cylinder is released. Pressure to the cylinder is controlled by a solenoid valve operated by switches as follows:

a. A switch on the landing gear control causes the cylinder to extend and raise the skid when the gear is raised and releases pressure from the cylinder to cause the skid to lower when the gear is lowered.

b. A limit switch actuated by the throttle is utilized to raise the skid when the throttle is moved full forward to OPEN and to lower the skid when the throttle is retarded to 90 per cent power when the landing gear control is at DOWN.

c. A switch on the arresting hook release overrides both the landing gear control and the throttle switches to lower the skid when the hook is lowered.

d. The hook raising switch button, when pressed to raise the hook from the deck after landing, also raises the skid.

TAIL SKID CONTROL SWITCH.

A tail skid control switch equipped with a guard (5, figure 1-5), is provided for catapult take-off. When set to DOWN, after clearing the guard, the throttle actuated skid raising switch is overridden and the skid remains down until the landing gear is raised.

WING FOLDING.

NORMAL CONTROLS.

The folding and locking control levers assembly is on the aft end of the right console (16, figure 1-5). The levers lie flush with the console when the wings are spread and locked. The control is operated by pushing down on the plate marked PUSH with the index or second finger and lifting the outer lever up to disengage the safety locks on the wing lock cylinders. A detent on this outer lever then clears the inner lever so it can be lifted up to unlock the wing lock cylinders and to fold the wings. The inner lever is pushed down into the console to spread and lock the wings and the outer lever is pushed down flush with the console to engage safety locks on the lock cylinders.

WARNING

Do NOT force the outer lever into the locked position if the normal amount of force does not permit the lever to go down. This may be an indication that the wing fold hinge lock pin is not in the locked position.

The inner lever operates a hydraulic selector valve to actuate folding and locking cylinders (one each—left and right). When pushed down (spread), timer check valves open after the folding cylinders are fully retracted to permit pressure to actuate the lock cylinders. In the folding action (levers lifted), timer check valves permit pressure to flow to the folding cylinders after the locking cylinder pistons have been withdrawn.

CAUTION

Make certain the wing lock lock (outer), control lever is moved through its limit of travel before operating wing folding (inner) control lever.

Never leave the wing folding control lever in an intermediate position between its wing folded and wing spread positon.

The wing folding or spreading cycle must be completed before reversing the direction of wing movement.

After wings are folded, it is recommended that wing fold jury struts be inserted before the engine is shut down.

Before spreading wings, ensure that dump valves are closed.

The outer control lever of the assembly, when pushed down, actuates a cable and bellcrank linkage which rotates notched pins to block the locking cylinder pistons in the locked position and pulls the red signal vanes out of sight when the pins are in place. When the control is lifted up, the pins are rotated to clear the lock cylinder pistons for withdrawal (unlock) and the signal vanes appear.

INDICATORS.

Red signal vanes are installed on the upper surface of the wing stub leading edges just inboard of the folding axes. When the wings are spread and locked, the vanes are drawn out of sight of the pilot and into the wings by mechanical action, through cables and bellcranks from the locking control. When the wings are unlocked, the vanes protrude from the wings and are visible to the pilot.

INSTRUMENTS.

The majority of the instruments are installed on the main instrument panel (figure 1-4). They can be classified into three groups; flight instruments, engine instruments and miscellaneous instruments. In the flight instrument group, the altimeter, rate of climb indicator and airspeed indicator operate from the pitot static system; the turn and bank indicator, from engine compressor bleed air. The G-2 remote compass and gyro horizon indicator are powered by ac supplied by the inverter system. The radio compass is d-c powered from the main bus. In the engine instrument group, the tailpipe temperature indicator is d-c powered from the main bus. The fuel quantity indicator is powered by dc from the main bus and ac from the inverter system. The fuel flowmeter and oil pressure indicator are powered by ac from the inverter system. The tachometer indicator is powered by ac from a self-contained source (tachometer generator). The miscellaneous group of instruments comprises the wheels and flaps position indicator, the speed brakes position indicator, the stabilizer position indicator, and the rudder trim tab position indicator, which are powered by dc from the essential bus. Included in this group are the accelerometer, which is internally mechanical, and the Bourdon tube type hydraulic pressure gages.

G-2 REMOTE COMPASS.

The G-2 compass combines the advantages of the remote indicating compass and the gyro compass into one instrument, thus providing a stabilized gyro compass reading (31, figure 1-4). It also corrects automatically for drift, and eliminates oscillation and northerly turning error. A correspondence dial, located in the center of the master compass indicator, gives an unstabilized remote compass reading, and the outer dial gives a stabilized gyro compass heading, free from drift. A selector switch, located on the electrical control panel on the right console (41, figure 1-5) provides compass slaving of the instrument or permits its use as a free directional gyro. (See Navigation Equipment paragraph, Section IV, for operation.)

MAXIMUM ALLOWABLE AIRSPEED INDICATOR.

The maximum allowable airspeed indicator is located on the upper row of instruments to the left of the center line and has a range from 0 to 650 knots in increments of ten (33, figure 1-4). It is connected to both static and pressure lines. The indicator is a combination instrument consisting of two entirely different mechanisms, the pointers of which indicate on the same dial. One of these instruments is a conventional airspeed indicator and the other, usually called a Mach mechanism, is an altimeter calibrated to show maximum allowable airspeed for a given Mach number. The Mach mechanism is preset to the highest flight Mach number for the airplane. This number appears in the small window of the dial. The indicated airspeed corresponding to the safe Mach number is then indicated by a warning pointer which is wider than the airspeed pointer and is painted with red and yellow stripes. As the airplane ascends, the warning pointer indicates lower and lower airspeeds, because the indicated airspeed for a given Mach number diminishes with altitude, since the value of the speed of sound decreases with the increases in altitude. The maximum airspeed pointer is used by the pilot to determine the airspeed corresponding to the limiting Mach number of the airplane in unaccelerated flight. As long as the pointers do not cross, he is flying safely. Adjustment screws on the indicator are used to set stops for the maximum allowable airspeed and critical Mach number. An airspeed correction card holder and an airspeed correction card are located on the right windshield frame.

AIRSPEED AND MACH NUMBER INDICATOR.

Note

The airspeed and Mach number indicator will, when available, replace the maximum allowable airspeed indicator.

The airspeed and Mach number indicator is located on the instrument panel in the upper row of instruments to the left of the center line. The indicator is a combination instrument, connected to both static and pitot pressure lines, consisting of an airspeed mechanism and an altitude mechanism. The indicated airspeed mechanism drives a pointer to indicate airspeed on a fixed dial. The pointer also indicates the Mach number on a movable Mach number scale which is driven by the altitude mechanism.

The gearing between the moving scale and the altitude mechanism is such that the Mach number will be indicated by the pointer on the moving scale at any combination of indicated airspeed and altitude within the range of the instrument. The airspeed indicator has a range of 80 to 650 knots and the Mach number scale has a range of 0.50 to 2.0. The indicator has two triangular indexes, a Mach number setting index and an airspeed setting index. The setting of the Mach number index and the airspeed index is made by the adjustment knob located in the lower left corner of the bezel. The Mach number index is set by depressing and turning the knob and setting the index to the desired Mach number. The Mach number index is not necessarily set at the limit Mach number of the airplane. It is for the pilot's convenience in flying any constant Mach number within the airplane limitations. The airspeed indicator index is set by turning the knob without depressing it and setting the index to any desired airspeed within its range of 80 to 145 knots.

Note

Either index can be set without changing the setting of the other index.

The following two conditions are given as examples of the operation of the indicator. As the airplane ascends at a constant airspeed, the pointer will remain stationary and the Mach number scale will rotate, indicating an increasing Mach number. As the airplane ascends at a constant Mach number, the Mach number scale and the pointer rotate, with the pointer maintaining its position on the Mach number scale, indicating a constant Mach number and decreasing airspeed. This is due to the fact that the speed of sound decreases with increasing altitude.

FAST ERECTING GYRO HORIZON INDICATOR.[1]

A fast erecting gyro horizon indicator is located on the upper row of the main instrument panel to the right of the center line (28, figure 1-4). A warning light and control switch are located outboard on the electrical

[1]Airplanes ser No. 130752 through 130771.

control panel on the right console (42, 44, figure 1-5). The power unit is installed in the fuselage. This installation provides an immediate indication of the airplane's attitude.

OPERATION.

Normal operation of the installation is automatic upon setting the battery switch to BAT. & GEN. When power is turned on, the indicator gyro is energized from a transformer and the electromagnet is energized from a rectifier at the same time. This combined action erects the gyro and brings the motor up to speed in less than one minute. At the end of this time the electromagnet is deenergized and the gyro rotor circuit is switched to the normal operating voltage. When the power unit is first energized, the red warning light glows and will go out when the magnet is deenergized. If the light glows for longer than one minute, indicating power unit malfunction, the switch must be set to OFF; this is done to prevent the electromagnet from remaining energized unnecessarily.

GYRO HORIZON INDICATOR.[1]

A gyro horizon indicator is located on the upper row of the main instrument panel to the right of the center line. This instrument provides an immediate indication of the airplane's attitude when properly erected.

The indicator has a pitch scale visible through a rectangular window located in the center of the instrument. The pitch scale has a range of 0 to 80 degrees for indicating both positive and negative airplane pitch attitudes.

OPERATION.

Quick erection of the gyro horizon indicator is accomplished by means of a mechanical device which is actuated by the knob, labeled PULL TO CAGE, on the instrument bezel. This knob must be pulled out to its mechanical stop immediately after the battery switch is set to BAT. & GEN. and held in that position until the horizontal and banking index bars cease to oscillate, at which time they should indicate 0 pitch and 0 roll within approximately 3 degrees. The time required to hold the PULL TO CAGE knob out before the index bars stabilize depends upon the position of the gyro; however, the longest time will be approximately 10 seconds. By means of the small knob on the left side of the bezel the miniature airplane may be raised or lowered for any desired fore-and-aft attitude of the airplane. When the battery switch is set to OFF, or if there is a partial or complete power failure, an OFF flag will appear on the dial face.

CAUTION

Do not erect the gyro horizon indicator in flight unless the airplane is flying straight and level, or the gyro will give an incorrect indication.

STAND-BY COMPASS.

The stand-by compass is mounted above the instrument panel to the right of the sight unit (12, figure 1-4). Two correction cards are mounted below the instrument panel to the right of the center line. One card shows compass calibration for normal operating condition with all equipment in operation; the second card gives the calibration with the battery and generator switch in the OFF position.

CANOPY.

NORMAL CONTROLS.

CANOPY CONTROL—NORMAL HYDRAULIC.

This handle is on the left side of the cabin, just forward of the canopy track. The handle is moved forward to CLOSE and aft to OPEN. The control handle operates a selector valve to actuate a hydraulic cylinder on the fuselage deck to move the canopy forward and aft (14, figure 1-3).

CAUTION

Do not return canopy control handle to neutral when canopy is selected to full OPEN or CLOSED.

Keep head and hands inside canopy during operation. If canopy does not close fully, it indicates faulty latching. Do not open in flight above limiting airspeed except in an emergency, as it may be lost.

CANOPY CONTROL—GROUND OPERATION.

This lever is on the left side of the fuselage aft of the line of the seat armor plate, just below the edge of the canopy. The control is operated by pressing in the forward end with the thumb and then rotating the handle up to OPEN or down to CLOSED. The lever actuates a switch to start the auxiliary hydraulic pump and operates the selector valve to direct pressure to canopy cylinder.

[1]Airplanes ser No. 130772 and subsequent.

WARNING

See that personnel are clear of flaps and speed brakes when operating canopy ground operation control.

EMERGENCY CONTROL.

The normal canopy control described above incorporates an emergency canopy control lever labeled EMERGENCY OPEN. Folding this handle into a slot in the normal control handle permits the entire control assembly to be moved beyond OPEN and into the EMERG OPEN position. This releases air pressure from an air bottle system into the canopy control hydraulic cylinder to open the canopy (13, figure 1-3).

CANOPY GROUND RELEASE.

The canopy may be removed by using the handgrip on the aft end. Pressing down the handgrip unlatches the canopy from the actuating cylinder.

PILOT'S EJECTION SEAT.

NORMAL CONTROLS.

SEAT HEIGHT CONTROL.[1]

This lever is mounted on the right console above the main circuit breaker panel. It is moved aft to DOWN to lower the seat and forward to UP to raise it. The lever operates a selector valve controlling pressure to the height adjusting hydraulic cylinders behind the seat. The control is spring loaded and when released, locks the seat at the selected position (29, figure 1-5).

SEAT HEIGHT CONTROL.[2]

Seat height is adjusted by an electrical actuator controlled by a three position momentary switch, with a center (off) position, mounted on the right of the seat. The two momentary positions are DOWN and UP (1, figure 1-6).

HARNESS LOCK.

The harness inertia reel lock control handle is mounted on the left side of the seat. The lever is moved AFT TO SLACK OFF the harness in order to lean forward, etc; the lever is moved FORWARD TO LOCK the harness (11, figure 1-6).

EMERGENCY CONTROLS.

PRE-EJECTION LEVER.

This lever is on the left side of the cabin below the canopy track (9, figure 1-3). It is PULLED INBOARD AND PUSHED DOWN to operate and then PUSHED OUTBOARD TO LOCK. When the lever is operated, the canopy is jettisoned (by pressure from an air bottle), the knee braces on the seat sides are moved up into position and the firing charge safety is pulled.

WARNING

The lever MUST BE PUSHED OUTBOARD TO LOCK DOWN.

EMERGENCY EJECTION SEAT ARMING CONTROL.

An emergency ejection seat arming control is provided. Under certain extreme flight conditions, such as high negative "g's", it may be difficult to reach and actuate the pre-ejection lever. For this condition, or one where the canopy fails to jettison, using the emergency ejection seat arming control will permit ejection through the canopy. This control is a red handle on the left side of the headrest and is attached to the cable which normally pulls the safety pin in the seat catapult firing mechanism. Pulling the control forward past the pilot's left ear pulls the safety pin and arms the seat. It does not lower the seat, nor does it release the knee braces. For this type of ejection, hold knees together to prevent injury.

WARNING

Ejection through the canopy is feasible only with the canopy in the fully closed position. If the canopy has been opened (partially or fully) during the attempt to jettison, it is not safe to attempt an ejection before first closing the canopy.

SEAT CATAPULT FIRING CONTROL. (FACE COVER HANDLE).

This handle (4, figure 1-6) is just above the pilot's headrest and is attached to the face cover which is stowed on a roller behind the headrest. After operating the pre-ejection lever, the pilot slides his feet aft onto the stirrups, sets his knees against the braces and pulls the handle forward and down to pull the face curtain over his face. This action locks the inertia reel and fires the charge to eject the seat from the airplane. The seat is ejected from the airplane by the catapult unit which consists of two mated tubes and an explosive charge. The inside tube is attached to cabin floor. The outside tube, which carries the charge, is attached to seat back.

AUXILIARY EQUIPMENT.

The following systems are discussed in Section IV:

Cabin Air Conditioning System
Communication and Associated Electronic Equipment
Lighting Equipment
Oxygen System
Navigation Equipment
Armament
Armament Control System
Gun Camera
Anti-"G" Suit Equipment

[1]Airplanes ser No. 130752 through 130842.
[2]Airplanes ser No. 130843 and subsequent.

SECTION II

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Section II NORMAL PROCEDURES

BEFORE ENTERING THE AIRPLANE.

a. See Section V for limitations imposed on this airplane.

b. Use the operating data contained in the Appendix to determine the required airspeed and power settings necessary to complete a mission.

c. Determine weight and balance status of airplane:— Obtain take-off and anticipated landing gross weights. Have useful load checked. Be sure proper ammunition load or ballast is aboard.

Note

Refer to the Handbook of Weight and Balance, AN 01-1B-40, for loading information.

EXTERIOR INSPECTION.

Consult Yellow Sheet for status of airplane and make sure airplane has been properly serviced. For complete exterior inspection, see figure 2-1.

ENTRANCE.

For instructions on entering the airplane, see figure 2-2.

CAUTION

The boarding ladder cannot be stowed from the cabin. Before flight, ensure that it is properly stowed by the ground crew.

CANOPY AND EJECTION SEAT CHECK.

Before becoming seated in the airplane, check canopy for normal position (not jettison position). Check ejection seat for proper attachment of arming pin cable.

ON ENTERING AIRPLANE.

INTERIOR CHECKS—ALL FLIGHTS.

a. All switches off or safe (gun switches).

b. Remove controls lock (bridle) and stow.

c. Control stick and pedals for free movement and for full throw.

d. Oxygen ON (oxygen supply control at regulator). Check equipment.

e. External power sources connected (check with ground crew).

Note

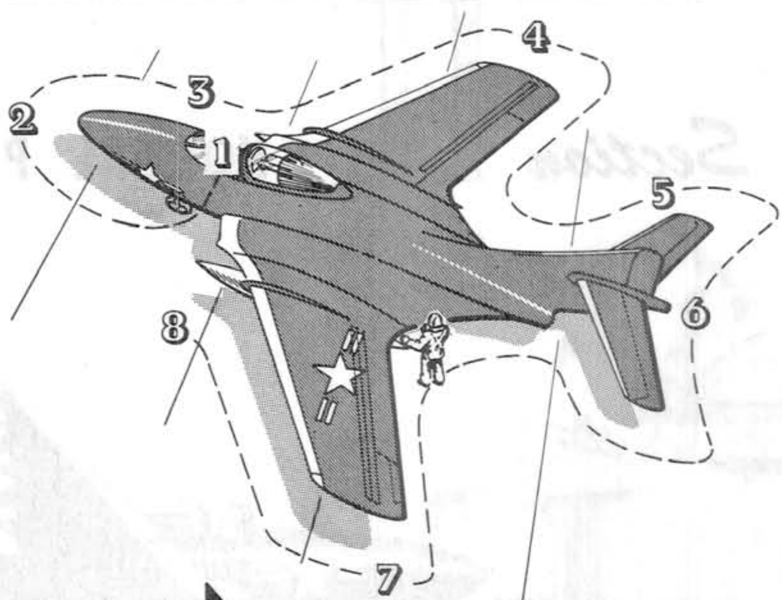
There are three external power receptacles; engine starting, general equipment and electronic testing.

f. Clock set.

g. Altimeter set.

h. Cabin clear, everything stowed; seat belt and shoulder harness fastened; oxygen, "G" suit and radio leads attached.

EXTERIOR INSPECTION



1 CABIN

a. Ejection seat arming pin cable attached.
b. All switches off.
c. Controls unlocked.
d. Control bridle stowed.

2 NOSE

a. Overall view of airplane.
b. Landing gear chocked.
c. Overall view of nose gear indicates no obvious defects.
d. Nose gear tire and shock strut properly inflated.
e. Check nose for positive lock and air bottles in nose wheel well for proper pressure.
f. Left and right gun barrels unplugged

3 FUSELAGE - RIGHT SIDE

a. Access doors closed.
b. Intake duct unplugged.
c. Overall view of main landing gear indicates no obvious defects.
d. Main gear tire and shock strut properly inflated.
e. Speed brakes full up.
f. Inboard flaps and speed brakes hinge points and contour flush with fuselage and wing stub.

4 RIGHT WING

a. Overall view of wing upper and lower surfaces indicated no washboarding, wrinkles or cracks.
b. Wing fuel tank filler cap and door secure.
c. External stores secure. Filler cap on droppable fuel tank secure
d. Navigation lights undamaged.
e. Slat completely retracted-maximum gap 1/16 inch.
f. Flaperon full flush.
g. Flaperon hinge points secured and safetied.
h. Flap full up (no trail). Hinge points secured and safetied.
i. Wing fairings in place.
j. Wing tank dump port unplugged.

5 STABILIZER

a. Overall view indicates no wrinkle or cracking.
b. Elevators move freely. Hinge points secured and safetied.
c. Elevator tab hinge points secured and safetied.
d. Elevator tab play - no noticeable play permissible.
e. Stabilizer fairings intact, screws in place and no deformation of fairing itself.

6 TAIL SECTION

a. Overall view of fin and rudder indicate no wrinkle or crack.
b. Rudder moves freely. Hinge points secured and safetied.
c. Rudder trim tab (if installed) - no noticeable play permissible.
d. Navigation lights undamaged.
e. Look up tailpipe to check condition of turbine blades and check shroud to see that there is no evidence of turbine blades rubbing.
f. Auxiliary air doors uncovered.

7 LEFT WING

a. Reverse procedure given for right wing.
b. Wing trimmer hinge points secured and safetied with cotter pin.
c. Play in trimmer not to exceed 1/8 inch.
d. Flaperon full flush with wing surface.
e. Wing fuel tank filler cap and cover in place.

8 FUSELAGE - LEFT SIDE

a. Inboard flaps and speed brakes hinge points secured and safetied and contour flush with fuselage and wing stub.
b. Speed brakes full up.
c. Overall view of main landing gear indicates no obvious defects.
d. Main gear tire and shock strut properly inflated.
e. Intake duct unplugged.
f. Access doors closed.
g. Fuselage fuel tanks filler caps and doors secure.

Figure 2-1. Exterior Inspection

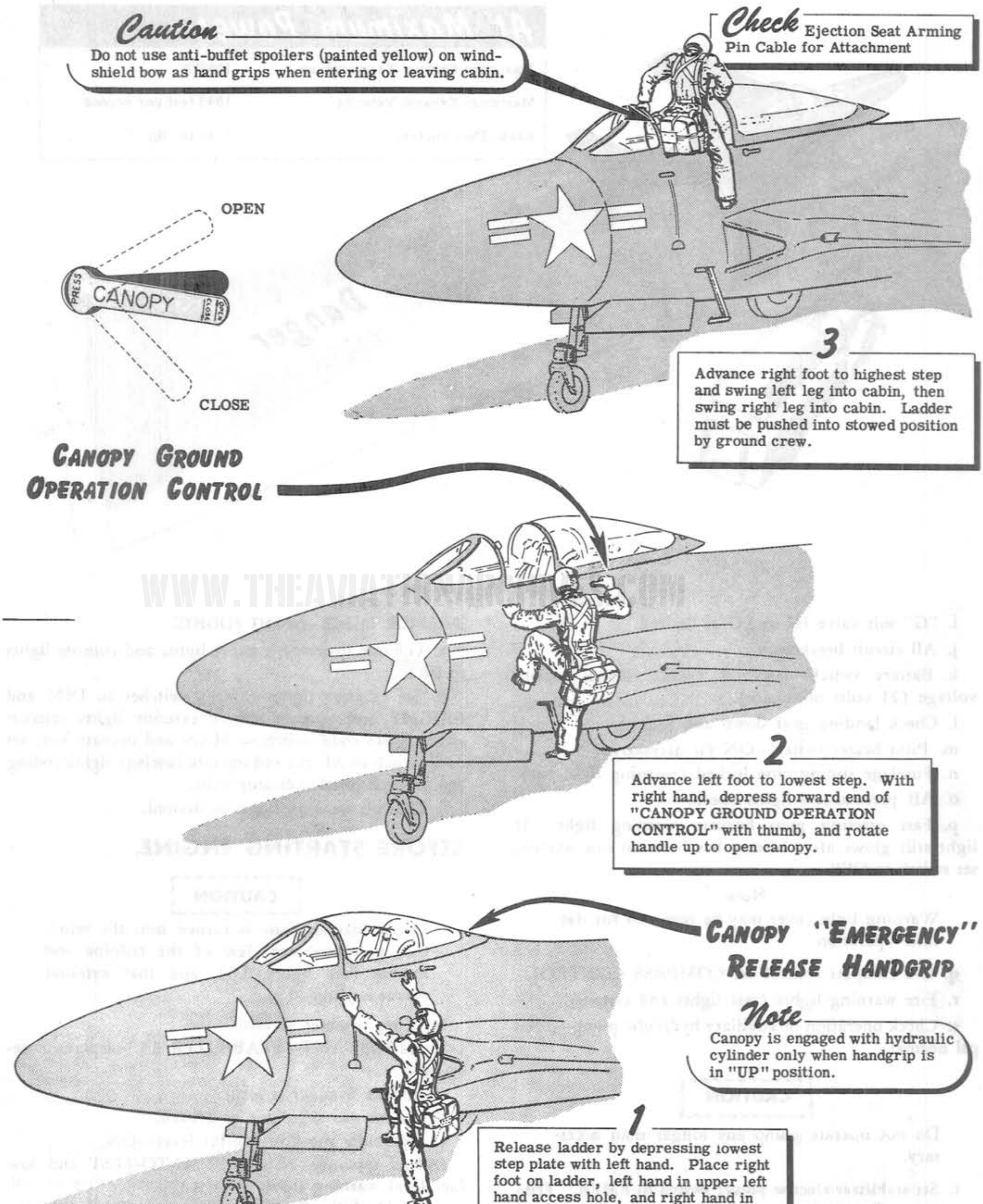
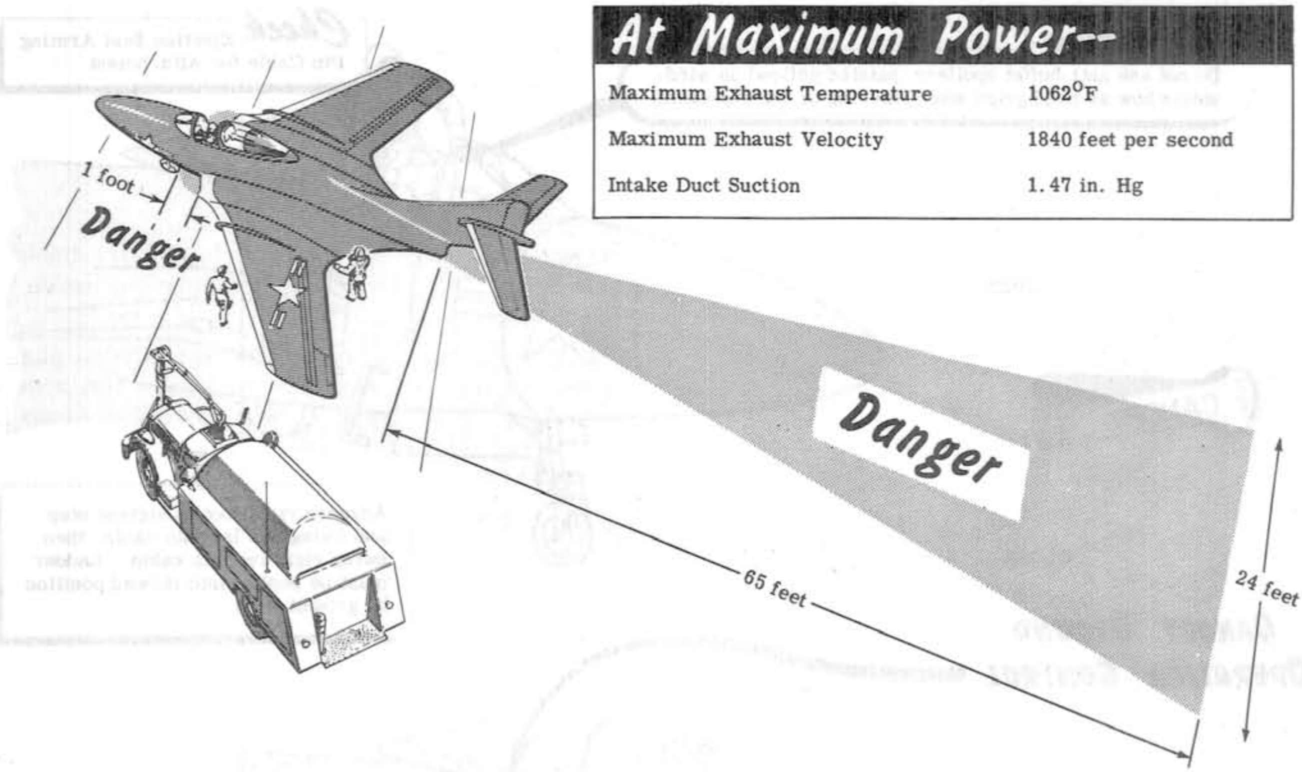


Figure 2-2. Entrance to Airplane



At Maximum Power--

Maximum Exhaust Temperature	1062°F
Maximum Exhaust Velocity	1840 feet per second
Intake Duct Suction	1.47 in. Hg

Figure 2-3. Danger Areas

i. "G" suit valve HI or LO as desired.

j. All circuit breakers in.

k. Battery switch—BAT. & GEN. Check battery voltage (21 volts minimum).

l. Check landing gear down and locked.

m. Pitot heater switch—ON (if necessary).

n. Fuselage sliding nose locked (warning light out).

o. All press-to-test lights check.

p. Fast erecting gyro horizon warning light. If light still glows after battery has been on one minute, set switch to OFF.

Note

Warning light cover may be removed for daytime operation.

q. G-2 compass control set COMPASS CONTROL.

r. Fire warning lights (test lights and system).

s. Check operation of auxiliary hydraulic pump—1700 psi normal.

CAUTION

Do not operate pump any longer than necessary.

t. Set stabilizer electric power switch to EMER. Trim nose-up and nose-down while checking indicator and visually check movement of stabilizer in rear view mirror. IMPORTANT—RESET STABILIZER POWER SWITCH TO NORM. AND REPEAT CHECK.

INTERIOR CHECK—NIGHT FLIGHTS.

a. Operate instrument panel lights and console lights to BRT.

b. Set exterior lights control switches to DIM and BRIGHT and operate master exterior lights selector switch. Set code switch to MAN and operate key; set code switch to AUTO and operate fuselage lights coding key. Check jewel indicator light.

c. Dim all warning lights as desired.

BEFORE STARTING ENGINE.

CAUTION

Check that airplane is turned into the wind, that personnel are clear of the tailpipe and intakes (see figure 2-3), and that external power is plugged in.

a. Wing trimmer at zero.

b. IMPORTANT—STABILIZER 3.5° airplane nose-up trim.

c. Rudder trimmer at zero.

d. Set oxygen regulator as desired.

e. Hydraulic pressure control lever—ON.

f. Fuel quantity. Check PUSH-TO-TEST and low fuel level warning light.

g. Check that reference pointer on tailpipe temperature indicator is set at 980°C.

h. Check that flaperette emergency system air pressure gage indicates 1900—2000 psi.

STARTING ENGINE.

CAUTION

Use only the following procedure to start the engine. Any divergence might result in a hot start, a condition which is seriously detrimental to the engine and which will abnormally shorten its life. See Hot Starts paragraph for procedure when a hot start occurs.

Note

Tachometer indicator shows per cent of rated rpm (100% = 11800 rpm).

a. Check that throttle is at CLOSED.

b. Battery switch at BAT. & GEN.

c. Set fuel master switch to ON—after a few seconds check that the fuel boost pressure warning light goes out, indicating that sufficient fuel pressure (6 psi min) has been built up.

Note

This is not a positive check of the boost pump. A malfunctioning pump may build up 6 psi pressure with a closed system and still not provide sufficient pressure under flow conditions.

d. Set engine start master switch to ON.

e. Set cranking switch to START, hold for two seconds and release.

f. When tachometer stabilizes at 10% rpm or over, move throttle outboard to START, then forward to IDLE detent. Light-up should take place, as indicated by tailpipe temperature rise—913°C is the limit for starting and acceleration. The engine should reach an idling speed of 31-32% rpm.

Note

If engine fails to accelerate after light-up during starting, operate engine primer switch momentarily to provide additional fuel flow.

g. With engine idling, check instruments:

Oil pressure gage—2 psi min.

Tailpipe temperature gage—657°C max.

CAUTION

Prolonged idling may result in excessive tailpipe temperatures; if this occurs, operate at 70% rpm approximately for a short time.

h. Advance throttle to full OPEN and check instruments. Tachometer—100% rpm.

WARNING

If engine speed surges to 105% rpm, even momentarily, shut down immediately, record in engine log book and order engine removed for overhaul.

Note

In normal operation, 100% rated thrust will not be obtainable when ambient air temperature is above 15°C (59°F); 100% rpm is not necessary to obtain 100% rated thrust when the ambient air temperature is below 15°C (59°F).

Oil pressure gage—7-55 psi.

Tailpipe temperature gage—Limit varies with ambient temperature; see Engine Operating Limitation, Section V.

i. Retard throttle to IDLE—31-32%.

j. Check operation of engine driven fuel boost pump. Operate engine at 50-60% rpm and press fuel system boost pump cut-off button on left console; if pump is not operating, fuel pressure warning light will glow. If light glows, shut down and investigate.

FALSE STARTS.

If light-up does not occur within 15 seconds after advancing throttle to IDLE, or if engine fails to accelerate to idle rpm within approximately one minute after light-up, proceed as follows:

a. Set throttle to CLOSED.

b. Set engine start master switch to OFF.

c. When engine stops rotating, set fuel master switch to OFF and investigate.

CAUTION

Never set fuel master switch to OFF until engine stops rotating.

CLEARING ENGINE.

a. Set engine start master switch to ON, and fuel master switch to ON.

b. Set cranking switch to START and release.

c. Operate engine at 8-10% rpm for 30 seconds to clear engine.

d. Set engine start master switch to OFF to discontinue clearing procedure.

CAUTION

Do not set cranking switch to START until engine has stopped rotating.

WARNING

If the throttle is closed inadvertently during engine operation, there will be an immediate flame-out which will be impossible to catch, regardless of how quickly the throttle is reopened. DO NOT TRY TO REGAIN IGNITION BY REOPENING THE THROTTLE, since raw fuel will be sprayed out of the tailpipe and create a dangerous condition. A standard start or relight procedure will be necessary to restart the engine.

idle is sufficient to maintain taxi speed. The nose wheel is self-centering and is not steerable. Use the brakes to steer the airplane. To stop, retard throttle and apply brakes evenly. Restrict taxi time to an absolute minimum, as fuel consumption during ground operation is exceedingly high. Fuel flow while taxiing is approximately 20-25 pounds per minute. Each minute of taxiing time reduces range by five miles.

BEFORE TAKE-OFF.

PREFLIGHT AIRCRAFT CHECK.

a. Controls unlocked and surfaces move freely.

b. Attitude and directional gyros set as desired and check operation.

c. Longitudinal control system selector switch set to MANUAL.

d. Stabilizer trim electric power switch set to NORM.

e. Speed brakes up.

f. Yaw damper on.

g. Cabin pressurization on. Temperature control set as desired.

Note

On humid days, use ram air ventilation for take-off and climb to 5000 feet. This will prevent fog formation in the cabin.

h. Set cabin air vent controls as desired.

Note

The following items (steps i. through t.) are those of the take-off check list.

i. Check flying tail.

j. Stabilizer (trim airplane)—nose-up 3.5°.

WARNING

Set stabilizer trim with the longitudinal control system selector switch at MANUAL. When operating with this switch set at HYDRAULIC, the absolute stabilizer position indicator denotes trim position only when the control stick is in neutral and no fore or aft stick force is being applied.

k. Wing and rudder trim—neutral.

l. Hydraulic system valve (control lever)—ON.

m. Wings locked.

n. Flaps down.

o. Fuel.

p. Sliding nose—lock.

q. Oxygen—ON.

r. Shoulder harness (tight and locked).

s. Seat cycled and locked (positioned as desired).[1]

t. Canopy (open).

u. Taxi out into take-off position, heading airplane straight down runway with nose wheel straight.

PREFLIGHT ENGINE CHECK.

With engine operating normally and brakes on, advance throttle to 100% and check instruments.

a. Oil pressure:

Ambient Air Temperature	*Oil Pressure*
—17°C	7-50 psi
— 1°C	7-45 psi
Above 15°C	7-40 psi

b. Tailpipe temperature—Limit varies with ambient temperature; see Engine Operating Limitations, Section V.

TAKE-OFF.

a. Take-off check list completed.

b. Hold brakes and advance throttle.

c. With engine at take-off rpm, release brakes and begin take-off run.

d. Maintain direction with brakes and flaperons until rudder control becomes effective (60-70 knots). A raised flaperon adds drag to assist brakes.

e. At approximately 80 knots, lift the nose wheel slightly off the runway and fly the airplane off at 120 knots.

Note

A very high angle of attack at too low a speed will increase the drag and lengthen take-off run.

f. Landing gear up when definitely airborne (retraction time about 10 seconds).

g. Close canopy.

h. Flaps up above 150 knots IAS.

WARNING

Only on airplanes equipped with the interim longitudinal control system modification, marginal longitudinal nose-down control will be experienced if flaps are retracted and control system is allowed to shift from manual control to hydraulic power operation at large airplane nose-up stabilizer settings or at a very low airspeed. Therefore, DO NOT RETRACT FLAPS AT STABILIZER SETTINGS GREATER THAN 3.5 DEGREES AIRPLANE NOSE-UP TRIM, OR AT TRIMMED AIRSPEEDS LESS THAN 150 KNOTS IAS.

i. Accelerate to best climbing speed (390 knots approximately); see Climb Curves in Appendix I.

[1] Airplanes ser No. 130752 through 130842.

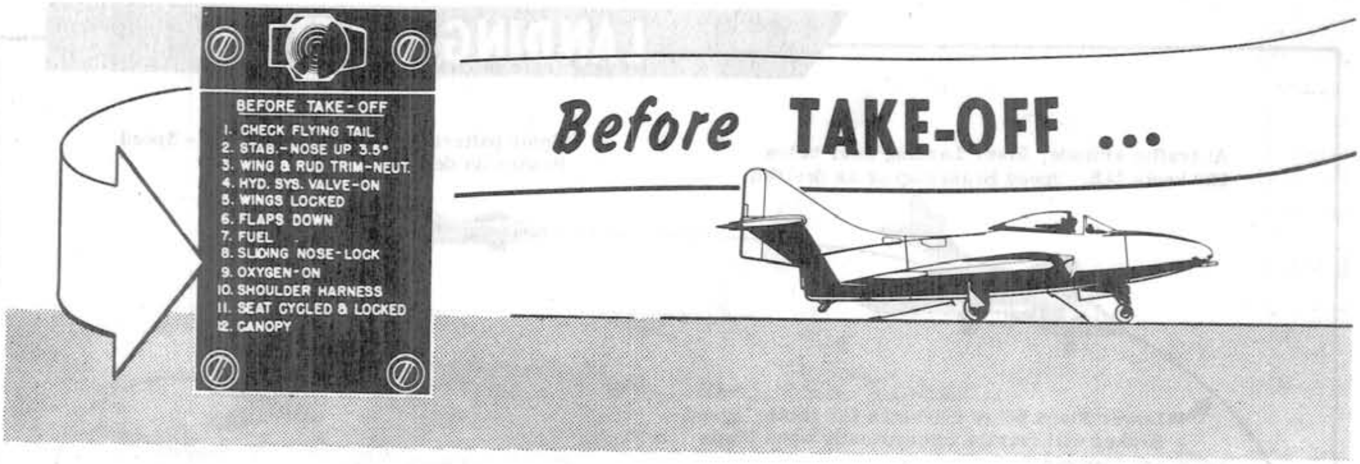


Figure 2-4. Take-off Check List

j. When at a safe altitude, shift longitudinal control system to HYDRAULIC (5000 feet recommended).

Note

There may be a small trim change when shifting from one system to the other. This is at a minimum at speeds of 250 to 350 knots. For familiarization flights, it is recommended that the shift be made within this speed range.

k. The take-off distances to clear a 50 foot obstacle are given in the Take-off Distance to Clear 50 Foot Obstacle Curves in Appendix I. Immediately after lift-off, level off and accelerate to speeds (shown on the above curves) to clear 50 foot obstacle. Do not exceed these speeds, as they result in an optimum climb angle. Gear should be retracted as soon as airborne. After clearing the obstacle, retract the flaps above 150 knots IAS and accelerate to best climb speed.

l. Emergencies—see Section III.

CLIMB.

Climb at take-off rpm, or the rpm for tailpipe temperature limits. (See Section V, figure 5-3, for engine operating limits.) See figure A-7 in Appendix I for recommended climb airspeeds and other pertinent climb data. After reaching a safe altitude, set longitudinal control system selector switch to HYDRAULIC.

FLIGHT CHARACTERISTICS.

See Section VI.

SYSTEMS OPERATION.

See Section VII.

DESCENT.

Utilize speed brakes to decelerate. Use of idle rpm (throttle at IDLE setting) during descent will conserve fuel.

Note

During descent, maintain tailpipe temperature above 260°C (500°F) to prevent flame-out.

Two standardized descent schedules are given in Appendix I in figures A-8 and A-9. Descents with the fuel low level warning light on must be made in accordance with the procedure given in Appendix I, Description of Charts and Tables paragraph, step h.

PRE-TRAFFIC PATTERN CHECK LIST.

a. Armament master switch—OFF; gun switches—SAFE.

b. Hydraulic pressure control lever—ON.

c. Wing tanks—empty.

d. Check communication equipment.

e. Yaw damper—ON.

f. Change to manual longitudinal control (set longitudinal control system selector switch to MANUAL). For familiarization flight, 5000 feet altitude is recommended.

g. Wing tank dump switch—NORMAL.

TRAFFIC PATTERN CHECK LIST.

a. Lower landing gear when below 220 knots.

b. Arresting hook—extend for carrier landing.

c. Flaps down when below 200 knots.

Note

If speed brakes have been used to decelerate, they will retract automatically before the flaps will extend.

d. Depress brake pedals—check "feel".

e. Check fuel quantity.

f. Shoulder harness and seat belt—locked and tightened.

g. Canopy—open.

LANDING.

For field landings, make final approach at 120 to 130% of power-off stall speed with wheels and flaps extended (see figure 6-1, Stall Speeds Chart). Avoid high rates

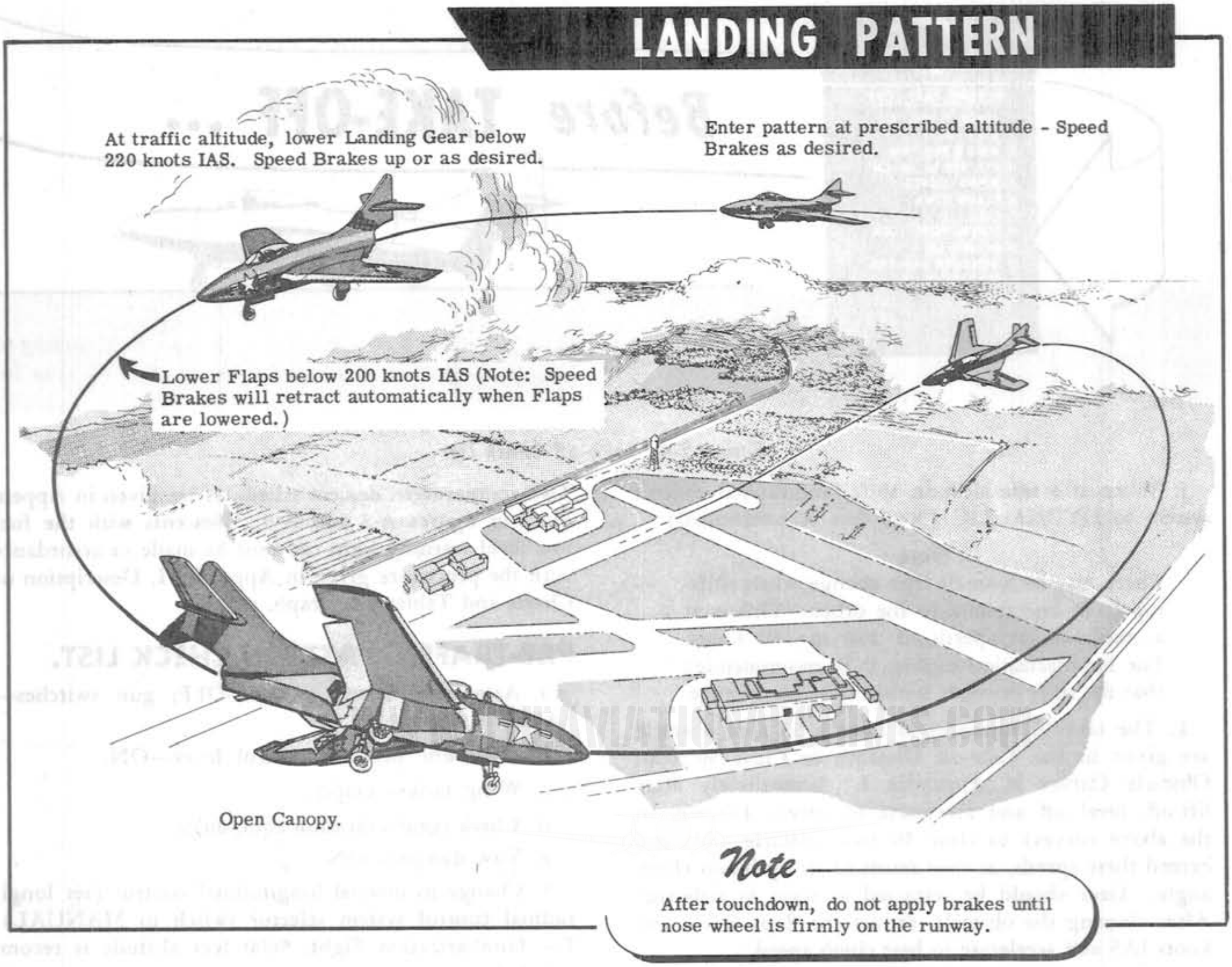


Figure 2-5. Landing Pattern Diagram

Figure 2-6. Landing Check List

of descent on final approach, as airplane's response to landing flare-out is slower than that of a straight wing airplane. For Landing Pattern Diagram, see figure 2-5; for emergency procedure, see Section III.

CAUTION

Because of the slower accelerating characteristics of the jet engine, the landing traffic pattern should be planned to permit engine operation above 65% rpm.

Brakes should be applied after the nose wheel has contacted the runway. For extended tire life, use only as much braking as necessary.

Note

During initial roll-out, the flaps are particularly effective for deceleration if the nose of the airplane is held high.

CROSS-WIND LANDING.

Cross-wind approach and touch-down techniques used for straight wing airplanes are applicable. Satisfactory control during roll-out can be obtained in cross-winds greater than 25 knots by using the flaperons (for drag) to supplement rudder control after placing the nose wheel on the runway.

WAVE-OFF.

Remember that the jet engine will not respond as quickly as a reciprocating engine. Maintaining at least 65% rpm while in the landing pattern will assist in making a rapid wave-off.

a. Throttle—full forward.

b. Landing gear up—when climbing.

c. Flaps up—above 150 knots.

WARNING

Only on airplanes equipped with the interim longitudinal control system modification, marginal longitudinal nose-down control will be experienced if flaps are retracted and control system is allowed to shift from manual control to hydraulic power operation at large airplane nose-up stabilizer settings or at a very low airspeed. Therefore, DO NOT RETRACT FLAPS AT STABILIZER SETTINGS GREATER THAN 3.5 DEGREES AIRPLANE NOSE-UP TRIM, OR AT TRIMMED AIRSPEEDS LESS THAN 150 KNOTS IAS.

Note

Approximately 220 pounds of fuel will be required to go around again in a tight pattern.

AFTER LANDING.

a. At end of taxi run raise flaps.

b. If tailpipe temperature is high from hard taxiing or stationary ground running, operate at 55-65% rpm for one minute.

CAUTION

After wings are folded it is recommended that wing fold jury struts be inserted before the engine is shut down.

STOPPING ENGINE.

Note

Normal shut-down should be made from approximately 70% rpm engine speed.

a. Retard throttle to CLOSED from a stabilized rpm.

Note

Check that engine runs down freely. Engine driven accessories will slow down the engine. Any undue friction should be noticeable.

b. After engine stops rotating, set fuel master switch to OFF.

c. After 10 seconds, set engine start master and battery switches to OFF.

BEFORE LEAVING THE AIRPLANE.

Proceed as follows:

a. Set all switches to OFF.

b. Install surface controls lock (bridle) and make up safety belt over front of stick.

c. Close canopy, using handle on left side after leaving cabin.

d. Be sure airplane is properly chocked.

SECTION III

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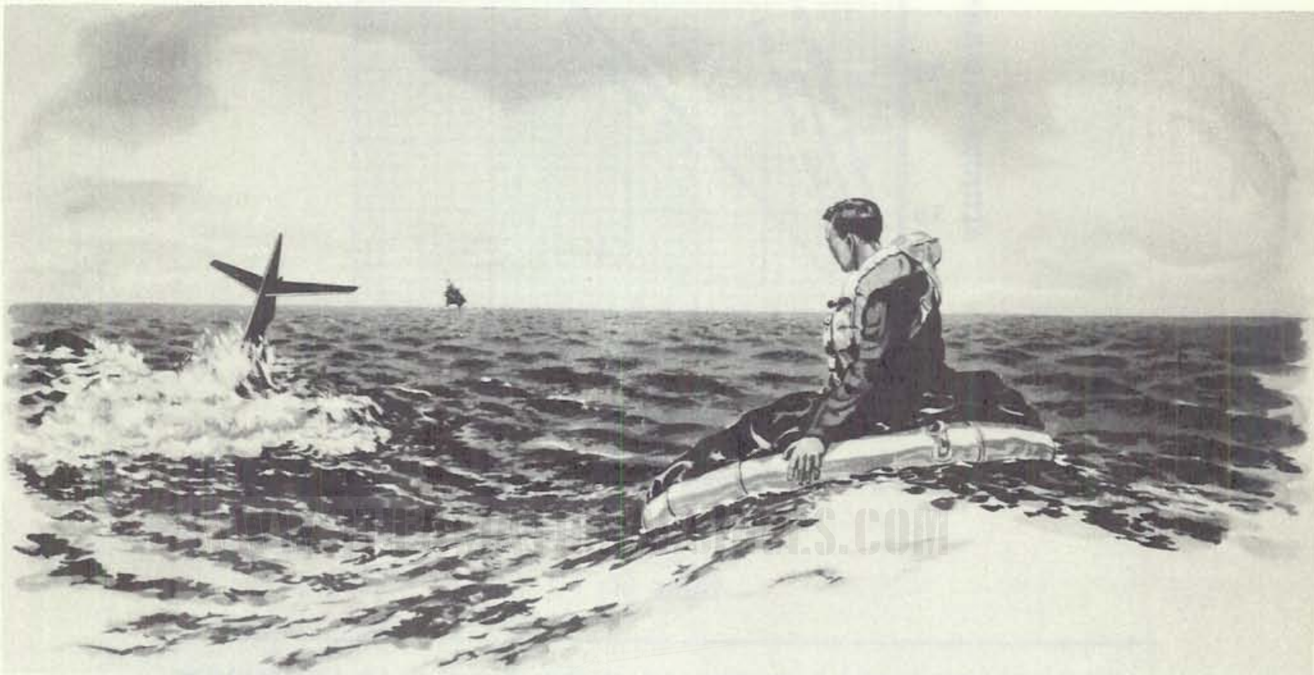
Section III EMERGENCY PROCEDURES



ENGINE FAILURE.

DURING TAKE-OFF.

a. If power fails before leaving ground, retard throttle to CLOSED and use brakes.

b. If power fails after becoming airborne, but while there is still runway left, retard throttle to CLOSED, land, and use brakes. For minimum stopping distance, fly the airplane onto the ground, force the nose wheel on the ground with full forward stick, and begin using brakes. Apply the brakes gently at first, increasing pedal pressure as they take effect. Be careful in applying brakes to avoid blowing a tire, because braking effectiveness with blown tires is poor. For this same reason, the emergency air brake should not be used until speed is below at least 50 knots, since the air brake will blow both main tires if applied at too great a speed.

c. If power fails after becoming airborne, and there is no runway left, retard throttle to CLOSED, move landing gear control lever to UP, move wing flap lever to DOWN, and land straight ahead.

d. If the failure occurs above several hundred feet, push over, hold 160 knots, and follow procedure in step c., above. If time permits, an engine relight procedure may be attempted (see Airstarts paragraph).

ENGINE FAILURE IN FLIGHT.

Note

The information and procedures presented in this section are based on actual flight tests.

GENERAL.

Although sudden failure of the engine in flight may be an alarming surprise to the pilot, the situation will probably not be critical immediately . There will be no change in the controllability of the airplane. If the engine has flamed out because of extremely fast engine acceleration or deceleration at high altitude, the chances of obtaining a relight are excellent. If the engine failure is more serious and cannot be restarted, a controlled letdown and satisfactory dead stick landing or ditching can probably be made without unusual difficulty. Immediately after an engine failure, the following conditions will be apparent to the pilot:

a. Loss of thrust, rapid dropping of engine rpm and tailpipe temperature.

b. Failure of the cabin pressurization system. The noise level in the cabin will become quieter and cabin altitude will increase to the airplane altitude.

c. Failure of the electrical circuits on the main bus of the electrical system as the engine windmill rpm

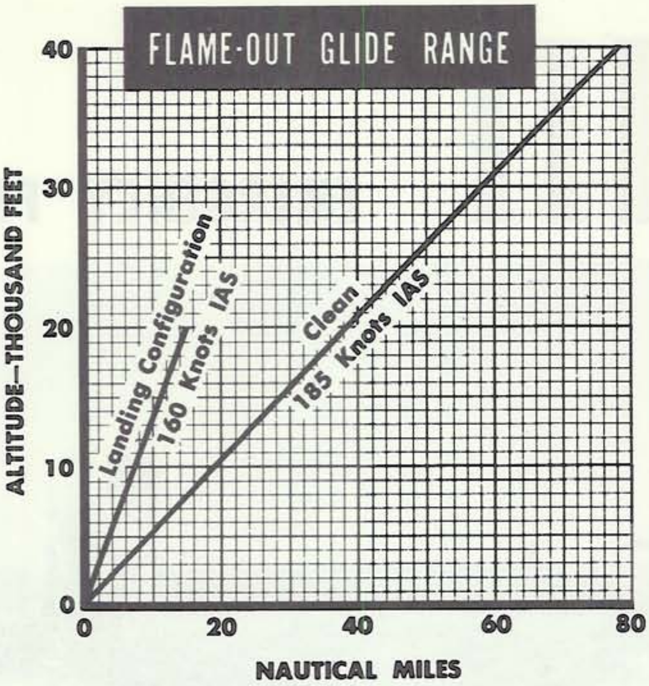


Figure 3-1. Flame-out Glide Range Curves

TABLE III-I

TIMES REQUIRED FOR LANDING GEAR AND WING FLAP ACTUATION WITH AUXILIARY HYDRAULIC PUMP OFF—ENGINE WINDMILLING

To Extend Landing Gear 185 knots 10000—12000 ft	10-12 sec
To Extend Wing Flaps 160 knots 8500 ft	30 sec

Note

At higher altitudes, landing gear and wing flaps extend at faster rates because of increased engine windmill speed at same IAS.

Landing gear and wing flap actuation times are increased if the power operated longitudinal control system is being used; therefore, this system should be turned off when making an engine-off descent.

The landing gear may be extended by using the emergency air bottle. Extension time is 5-6 seconds. However, if landing gear is extended by use of the air bottle, it cannot be retracted.

drops below the generator cut-in speed (provided the battery switch is in the BAT. & GEN. position).

A procedure of steps to be taken after an engine failure is included in this section; however, the following general information should be kept in mind:

a. For maximum gliding range, the airplane should be as clean and light as possible.

b. For maximum range in the clean configuration, maintain 185 knots IAS.

An indicated airspeed 10 knots higher or lower than 185 knots reduces gliding distance only two per cent, so strict adherence to this airspeed is not necessary.

The best approach speed in the landing configuration is 160 knots IAS. The use of an approach speed less than this will very likely result in a hard landing due to insufficient airspeed for flaring out.

The gliding distance in the clean and landing configuration is shown in figure 3-1. The rate of descent at various altitudes is shown in figure 3-2.

c. The windmilling engine will provide 1500 pounds of hydraulic pressure and sufficient capacity to operate the flying tail, flaperons, speed brakes, landing gear, and flaps. Times required to extend the landing gear and wing flaps are shown in Table III-I.

d. Lateral control is satisfactory in an engine-off descent and landing for all airplane configurations. The windmilling engine will maintain adequate hydraulic pressure for normal flaperon control until the airspeed drops below 70 knots after touch-down.

Note

For complete information on the emergency flaperette control system, see Emergency Flaperette Operation paragraph in this section.

e. With the engine windmilling at less than generator cut-in speed, all electrical circuits except those connected to the essential bus are automatically disconnected when the battery switch is in the BAT. & GEN. position and the landing gear control handle is UP. (For circuits connected to the essential bus, see figure 1-9.) If it is desired to operate a circuit on the main bus, such as the radio, auxiliary hydraulic pump, or exterior lights, the battery switch may be placed in the BAT. position. Placing the landing gear control handle in the DOWN position also energizes the main bus. With the battery switch in BAT., a perfect battery will last approximately 13 minutes. If the battery is conserved by pulling unnecessary circuit breakers, it will last approximately 25 minutes. If an airstart is to be attempted, it is best to use as little electrical power as possible to ensure that the battery power will be sufficient for the airstart. If an airstart is to be attempted, never set the battery switch to OFF as this cuts off the electric fuel boost pump.

f. Canopy frosting may occur during engine-off descents. It will be the most severe when descending from high altitudes into an atmosphere of high humidity. The frosting can be kept to a minimum by opening the canopy slightly.

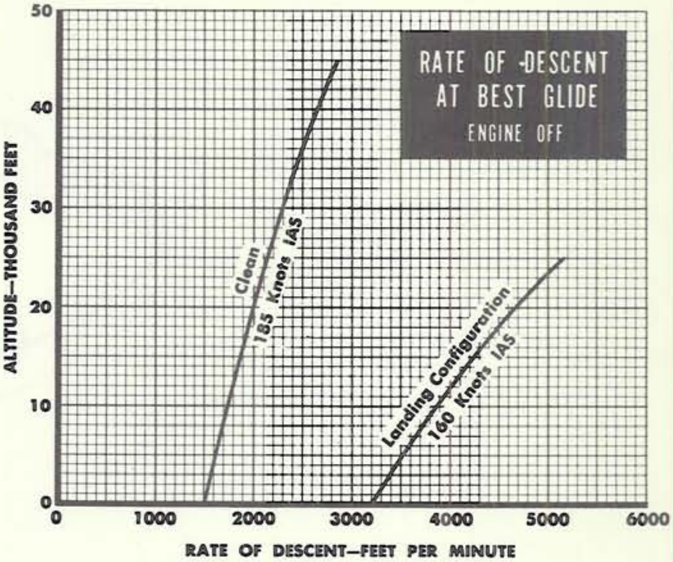


Figure 3-2. Rate of Descent at Best Glide Curves

PROCEDURE.

The following procedure applies to the situation where landing gear, wing flaps, and speed brakes are up when the engine fails and the airplane has at least several thousand feet of altitude over the terrain.

a. Retard throttle to CLOSED.

b. Establish 185 knots IAS as soon as possible for maximum range glide. If speed is above 185 knots, pull up and climb until speed drops to 185 knots.

c. If at high altitude, check oxygen mask for tight fit after pressure surge following loss of cabin pressurization.

d. Dump wing tank fuel and jettison external stores if carried.

Note

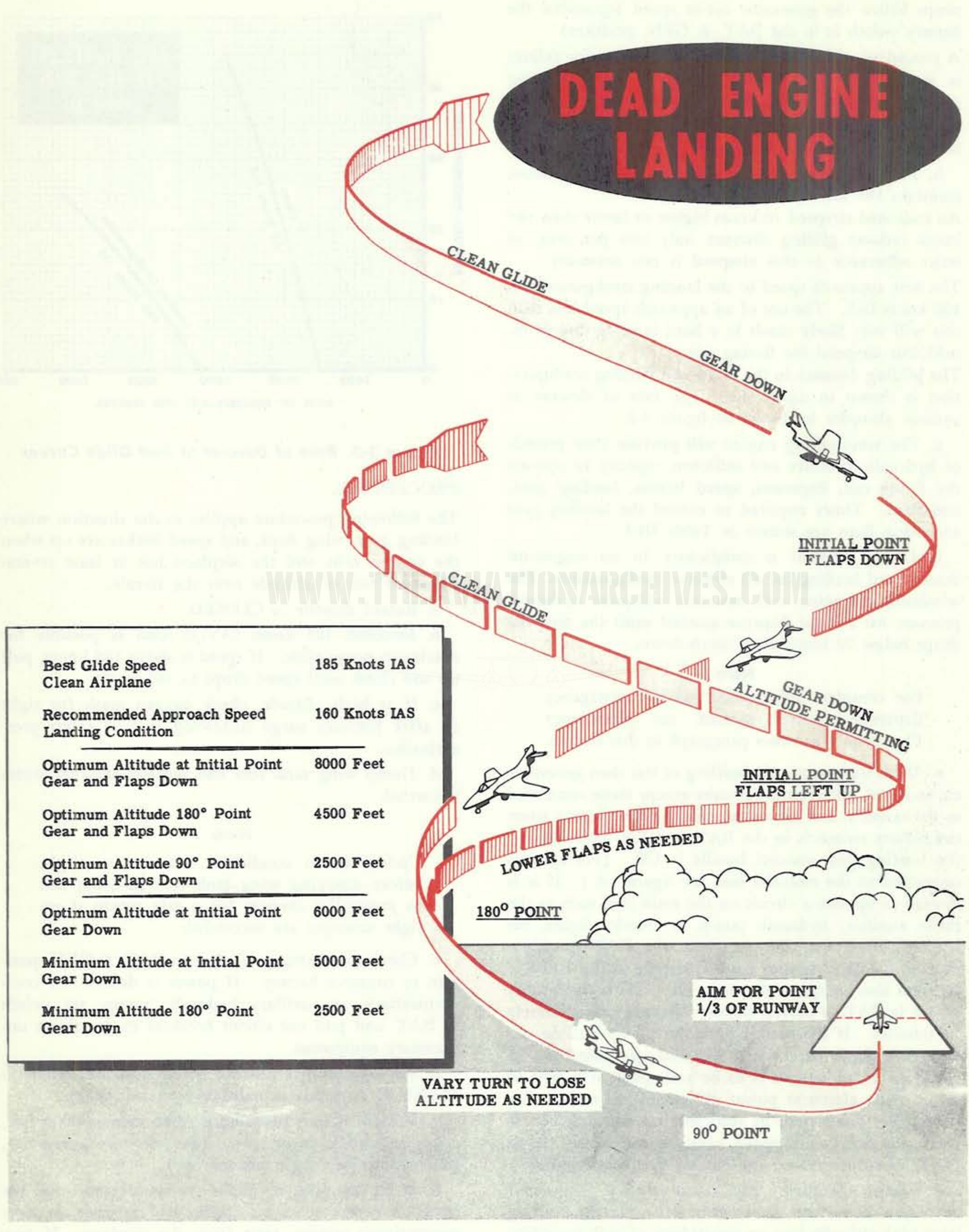
Under certain conditions, attempt a relight before dumping wing tank fuel in order not to jeopardize chances for a safe return if relight attempts are successful.

e. Check that battery switch is in BAT. & GEN. position to conserve battery. If power is desired for communications or auxiliary hydraulic pump, set switch to BAT. and pull out circuit breakers to deactivate unnecessary equipment.

f. Set longitudinal control system selector switch to MANUAL to reduce demand on hydraulic system.

g. Initiate airstart procedures when below 30000 feet, using relighting procedure. (See Airstart paragraph, this section, for relight procedures.)

h. If all attempts to relight are unsuccessful and the situation occurs at night, during bad weather, or over mountainous terrain, eject from the airplane. If possible, eject above 5000 feet altitude. (See Bail-out paragraph, this section, for ejection procedure.)



Best Glide Speed Clean Airplane	185 Knots IAS
Recommended Approach Speed Landing Condition	160 Knots IAS
Optimum Altitude at Initial Point Gear and Flaps Down	8000 Feet
Optimum Altitude 180° Point Gear and Flaps Down	4500 Feet
Optimum Altitude 90° Point Gear and Flaps Down	2500 Feet
Optimum Altitude at Initial Point Gear Down	6000 Feet
Minimum Altitude at Initial Point Gear Down	5000 Feet
Minimum Altitude 180° Point Gear Down	2500 Feet

Figure 3-3. Dead Engine Landing Pattern

i. If an airstart has not been achieved after repeated attempts, or by the time 10000 feet is reached, and the situation occurs during daylight hours under favorable conditions, all efforts should be turned toward making a successful landing.

j. If engine failure occurs below 10000 feet, primary emphasis should be on making a successful landing. Do not jeopardize chances of making a successful landing by overconcentration on relight attempts.

EMERGENCY LANDINGS.

FORCED LANDING—DEAD ENGINE.

PATTERN.

The recommended pattern for dead stick landings and simulated flame-out landings is shown in figure 3-3. The pattern consists of a 360 degree approach with two fixed check points. The initial point is defined as a position above and slightly to starboard of the intended landing point, with the airplane headed in the direction of the landing runway. The 180 degree point is the down-wind position abeam of the intended landing point from which the turn onto the base leg is made. Two possible patterns are presented, because it is possible to make the approach with landing gear and flaps down all the way from the initial point, or to lower only the gear at the initial point and lower the flaps when needed later in the approach. If sufficient altitude is available, it is better to lower the flaps at, or before, the initial point, so that the flaps will fully extend and the rate of descent stabilize early in the approach. A constant rate of descent will make it easier for the pilot to judge his gliding angle and plan his approach. However, if insufficient altitude is possessed to make this type of approach, it is possible to make the approach with the flaps up and extend them when needed to hit the desired landing point. This type of approach is not unduly difficult, but more judgement must be exercised by the pilot during the approach. By following one of these patterns and using the pattern altitudes and airspeeds in figure 3-3, a pilot should be able to hit the desired landing point with relative ease. When using the recommended procedure for a dead stick landing, the pilot is required to exercise a minimum amount of judgment. This is beneficial in the event of a dead stick landing, because a pilot's judgment is likely to be impaired by the tenseness of the situation.

GENERAL PROCEDURE.

When a pilot is committed to a dead engine landing, either because of fuel exhaustion or failure to get an airstart after a flame-out, he should execute the following general procedure:

Establish the recommended clean gliding speed of 185 knots and plan the let-down pattern so as to arrive over the initial point at the correct altitude for the type of approach to be made. The following steps should be started at sufficient altitude so as to be completed upon arriving over the initial point:

a. Retard throttle to CLOSED.

b. Set fuel master switch OFF.

c. Set battery switch to BAT.

d. Move longitudinal control system selector switch to MANUAL.

e. Auxiliary hydraulic pump ON.

f. Move landing gear control lever to DOWN if a safe landing is probable.

Note

> If there is insufficient altitude to make the field with landing gear down, the landing gear should be left up and extended only when the field is definitely within reach.
>
> The landing gear may be extended quickest by using the emergency landing gear air bottle. The extension time will be five to six seconds. Once extended by use of the air bottle, the landing gear CANNOT be retracted.

g. Speed brake landing override switch to emergency position.

h. Lock and tighten shoulder harness. Remove personal conneetions (oxygen, "g" suit, radio leads).

i. Open canopy.

Extend flaps upon reaching the initial point, altitude permitting, and reduce speed to 160 knots IAS. Commence a left turn, banked 25 to 30 degrees. If the altitude over the initial point is higher than recommended, delay the turn slightly or decrease the bank so the airplane will arrive at the 180 degree position at the correct altitude. If the initial point is reached with less altitude than the 8000 feet recommended for the high 360 degree patterns, continue the approach with flaps up, and lower the flaps as needed to reach the 180 degree position at the recommended 4500 feet, or to intercept the flaps-down landing path. When a cross wind prevails, shallow or steepen the turn from the initial point to the 180 degree position if the cross wind is from the port or starboard, respectively, in order to have the correct distance at the 180 degree position. At the 180 degree position, check the altitude, angle of descent and position to determine if the same turn may be continued, or if a shallower or steeper bank should be used. At the 90 degree position, the airplane should be approximately 5000 feet down-wind of the landing point, and the altitude should be approximately 2500 feet with the flaps down. Plan the final turn in order to reach the straightaway with about 1000 feet of altitude. If the airplane is high, nose over and pick up additional speed to steepen the glide path. The speed brakes may be opened to further steepen the glide path.

Note

> The longitudinal control system selector switch should be set at MANUAL and the speed brake landing override switch must be set to its emergency position before lowering speed brakes.

It is also possible to use a forward slip in order to lose some altitude, but this should not be carried any lower than about 600 feet, because of the high rate of descent it will cause, and the resultant increased time and altitude required to flare out for landing. Normally, commence the flare-out at about 200 feet above the runway. In the event of a steeper glide path, brought about by the use of speed brakes, slips or nosing over, commence the flare-out as high as 400 feet above the runway. When beginning the flare-out at altitudes above 200 feet, exercise care not to flare out too abruptly, causing the airplane to run out of airspeed at too high an altitude. If, at any time in the approach up to the last 500 feet of altitude, it is seen that the airplane is undershooting, maintain airspeed at 160 knots and partially or fully retract the flaps until the final approach or enough altitude is possessed so that they may again be lowered. If the airspeed is maintained, no noticeable sinking will result from the flaps retraction and the glide range will be extended considerably. If enough altitude is still not possessed to make the field with gear down, retract the landing gear and effect a wheels-up landing. THE MOST IMPORTANT SINGLE THING TO REMEMBER ABOUT THE DEAD ENGINE LANDING APPROACH IS THAT UNDER NO CIRCUMSTANCES SHOULD THE AIRSPEED FALL BELOW 160 KNOTS. Because of the higher than normal altitudes used on the flame-out landing, there is a strong illusion that the landing will be overshot. This is likely to cause the pilot to lengthen out his pattern and undershoot. For this reason, a point one-third the way down the runway should be the intended landing point. Make a normal landing and roll-out. If the airplane is high and fast over the end of the runway and it appears that insufficient runway remains for a normal landing and roll-out, fly the airplane onto the ground fast, force the nose wheel on the ground with full forward stick and begin using brakes. Apply the brakes gently at first, increasing pressure as they take effect. Be careful in applying brakes to avoid blowing a tire, because braking effectiveness with blown tires is poor. For this same reason, the emergency air brake should not be used until speed is below at least 50 knots, since the air brake will blow both main tires if applied at too high a speed.

SIMULATED DEAD ENGINE FORCED LANDINGS.

By practicing simulated dead engine forced landings, a pilot will develop sufficient skill and confidence in the maneuver so that an actual power-off landing will present no undue hazard.

To simulate a flame-out, the following rpm, with speed brakes extended, is the equivalent of a dead engine:

Altitude	*RPM*
30000—20000 feet	85%
20000—10000 feet	80%
Below 10000 feet, with landing gear and flaps down	65%

Note

> The longitudinal control system selector switch should be set at MANUAL when performing simulated dead engine forced landings.
>
> To keep speed brakes extended when flaps are down, the speed brakes landing override switch must be set to its emergency position.

When practicing simulated dead engine landings, the landing patterns of figure 3-3 should be followed. The pilot may vary his altitudes from those recommended in figure 3-3 to determine the easiest flame-out approach for him. In practicing simulated flame-out landings, the following precautions should be observed:

a. Normal field landing weight restrictions should be observed when making simulated flame-out landings.

b. Before a pilot carries a simulated flame-out approach to a landing, he should make at least three approaches, taking a wave-off upon reaching 500 feet of altitude.

c. Until pilots become thoroughly skilled in the maneuver, simulated flame-out landings should be made touch-and-go.

d. Simulated flame-out landings on runways shorter than 6000 feet should be done with extra caution.

e. The 160 knots approach speed for flame-out and simulated flame-out landings should be regarded as a minimum.

f. Slips should not be carried any closer to the ground than 600 feet.

g. Care should be taken to commence the flare-out at sufficient altitude to ensure a smooth landing.

h. When it appears that a hard landing is impending, the speed brakes should be retracted to prevent damage to the forward speed brake section.

After skill is once gained in the simulated flame-out landing, a pilot should refresh himself periodically to maintain a high level of proficiency in the maneuver. One or two simulated flame-out practices a month should be sufficient.

Important

> A simulated flame-out approach presents a good way to make an emergency landing when the reliability of the engine is questionable. Set up the standard simulated flame-out pattern. If at any time in the approach the engine stops, retract the speed brakes and continue the same approach pattern to a safe landing.

BELLY LANDING—ENGINE OPERATING.

If a normal landing cannot be made on a suitable airfield, a wheels-up landing in accordance with the following procedure is recommended:

a. Dump wing tank fuel. Jettison external stores if carried.

b. Use up excess fuel to establish an aft cg condition and minimize possible fire hazard.

c. Move longitudinal control system selector switch to MANUAL.

d. Wing flaps—down. Reduce airspeed to approach speed.

e. Speed brakes—down. Extended speed brakes will cushion touch-down and minimize damage. Note that to extend speed brakes when the wing flaps are down, the speed brake landing override switch must be in its emergency position.

f. Lock and tighten shoulder harness. Remove personal connections (oxygen, "g" suit, radio leads).

g. Open canopy.

h. Just before contact, retard throttle to CLOSED, set fuel master switch to OFF, and battery switch to OFF.

i. Make a normal landing, touching down as slowly as possible.

j. Abandon airplane immediately after it stops.

DITCHING—ENGINE OPERATING.

a. Dump wing tank fuel. Jettison external stores if carried.

b. Use up excess fuel to establish an aft cg condition and increase buoyancy in water.

c. Move longitudinal control system selector switch to MANUAL.

d. Landing gear control lever—UP.

e. Wing flaps—down. Reduce airspeed to approach speed.

f. Lock and tighten shoulder harness. Remove personal connections (oxygen, "g" suit, radio leads).

g. Open canopy.

h. The arresting hook may be extended, if desired, to give slight warning just before touch-down.

i. If sea conditions are favorable, land into the wind. If swells are running, land along a swell.

j. Just before contact, retard throttle to CLOSED, set fuel master switch to OFF, and battery switch to OFF.

k. Make a normal landing, touching down as slowly as possible in a nose-high attitude. Avoid high rates of descent in the final approach, since the airplane may not respond to flare-out immediately and may touch down hard.

l. Leave the airplane as soon as forward motion definitely stops.

LANDING EMERGENCIES.

NOSE WHEEL UP OR UNLOCKED.

If the main landing gear is down, but the nose wheel is either up or down, but not locked, use up as much fuel as possible, drop external stores, if carried, and expend ammunition to get the airplane to an aft cg, as light as possible, and reduce fire hazard.

a. Emergency landing gear extension air bottle actuated.

b. Shoulder harness tight and locked.

c. Oxygen, radio and "g" suit disconnected.

d. Canopy open.

e. Speed brakes extended to minimize nose damage.

f. Accomplish a power-on, flaps-down approach, landing nose-high with as little sink speed as possible.

g. Throttle closed just before touch-down.

h. Fuel master switch OFF.

i. Battery switch OFF.

j. Hold nose off until speed is reduced, but let nose down onto runway before elevator effectiveness is lost.

k. Use brakes only if absolutely necessary.

l. Abandon airplane as soon as it stops.

Note

If nose wheel is down but not locked, it will sometimes lock on landing. Caution should be used not to drop in hard enough to rotate onto the nose gear.

MAIN GEAR UP OR UNLOCKED.

If one or both main wheels are not down and locked, use up as much fuel as possible, drop external stores, if carried, and expend ammunition to get the airplane as light as possible and minimize fire hazard.

a. Emergency landing gear extension air bottle actuated.

b. Shoulder harness tight and locked.

c. Oxygen, radio and "g" suit disconnected.

d. Canopy open.

e. Speed brakes extended to minimize nose damage.

f. Accomplish a power-on, flaps-down approach, landing nose-high with as little sink speed as possible.

g. Throttle closed just before touch-down.

h. Fuel master switch OFF.

i. Battery switch OFF.

j. Hold airplane off as long as possible and, if one landing gear is down, land on the side of the runway next to the extended landing gear.

Note

If one main landing gear is down but not locked, it will sometimes be locked if the landing is made in a skid in the direction that will force the questionable landing gear outboard.

BARRICADE ENGAGEMENT.

WARNING

Under unusual wing retardation barricade engagement conditions, such as free flight or severely yawed airplane attitudes, it is possible for the upper loading strap to enter the open cabin. IT IS THEREFORE MANDATORY FOR PILOT SAFETY THAT THE PILOTS KEEP THEIR HEADS DOWN AND FORWARD IN THE CABIN WHEN BARRIER AND/OR BARRICADE ENGAGEMENT IS IMMINENT. Such action can aid substantially in keeping the pilot's head and shoulders away from the back of the seat and headrest where a barricade strap is most liable to lodge if it should enter the cabin.

AIRSTART.

If combustion ceases, proceed as follows:

a. Retard throttle to CLOSED and descend below 30000 feet.

Note

If indications of a flame-out appear, retarding the throttle to IDLE may prevent the flame-out from occurring.

b. Check that battery switch is at BAT. & GEN. position.

Note

When generator cuts out during flight, all circuits except those necessary for flight will be disconnected automatically. Pitot head heat, communications circuits, etc, may be energized by setting the battery switch at BAT. Airstarts may be made with the battery switch in either BAT. & GEN. or BAT. position; BAT. & GEN. position is preferred to conserve power.

c. Check that engine start master and fuel master switches are ON.

CAUTION

Do not set fuel master switch to OFF as the fuel system will become air-locked when engine is windmilling and restarting will be impossible.

d. Set airplane speed to windmill engine at 10% rpm minimum.

e. Move throttle outboard to START, then immediately advance to IDLE.

f. A light-up will be indicated by a tailpipe temperature rise. Leave throttle at IDLE until idle rpm is reached (idling speed will vary with altitude) and engine acceleration ceases.

Note

If engine fails to accelerate after light-up during starting, operate engine primer switch momentarily to provide additional fuel flow.

CAUTION

Advancing the throttle before idle rpm is reached may result in another (rich mixture) flame-out.

g. When idling rpm has stabilized, advance throttle to obtain desired rpm.

h. If the relight is unsuccessful, retard throttle to CLOSED, and cycle engine start master switch; i.e., set engine start master switch to OFF in order to reset ignition timer before each relight attempt, but be sure to set it back to ON prior to relight attempt. Wait 30 seconds (timed by clock) to clear engine, if possible, and repeat airstart procedure.

CAUTION

Avoid practice air starting.

FIRE.

ENGINE FIRE ON GROUND.

If one or both of the fire warning lights glow, indicating a fire in the engine compartment, or if there is other positive indication of fire:

a. Retard throttle to CLOSED.

b. Set fuel master switch to OFF.

c. After five seconds, set battery switch to OFF.

d. Leave cabin.

e. Use available fire extinguishers.

If a fire is detected in tailpipe after a normal shut down:

a. Call for external power.

b. Have ground crew observe fire for spreading (at a safe distance from end of tailpipe).

c. Perform a "clear engine", using procedure given in Clearing Engine paragraph, Section II.

ENGINE FIRE IN FLIGHT.

If a fire should start in the engine compartment or aft sections of the airplane, the pilot will receive indications of it in at least one of the following ways:

a. One or both of the fire warning indicator lights will glow. Each light is connected to a separate circuit of fire detectors located at various points around the engine. When a fire warning light glows, it indicates that one of these detectors has been actuated.

b. Smoke or fumes in the cabin.

c. Visual indications of smoke or flame around the airplane or smoke trail behind the airplane.

d. Unusual engine roughness or muffled explosions.

e. Excessive tailpipe temperatures.

f. Information from wingman.

Usually a fire will make its presence known with more than one of the above indications. If only one indication appears, such as one fire warning light, fumes or smoke, or engine roughness, the trouble may not necessarily be a fire. Try to get at least two good indications of fire before taking emergency action.

If a fire is present, proceed as follows:

a. Retard throttle to CLOSED.

b. Set fuel master switch to OFF.

c. Make dead engine landing or abandon the airplane.

ELECTRICAL FIRE.

The probability of electrical fires has been minimized by the provision of circuit breakers and fuses to protect the electrical circuits. However, if an electrical fire does occur, try to identify the source of the fire and pull the appropriate circuit breaker if it has not popped of its own accord. If the fire persists, set the battery switch to OFF and land as soon as possible.

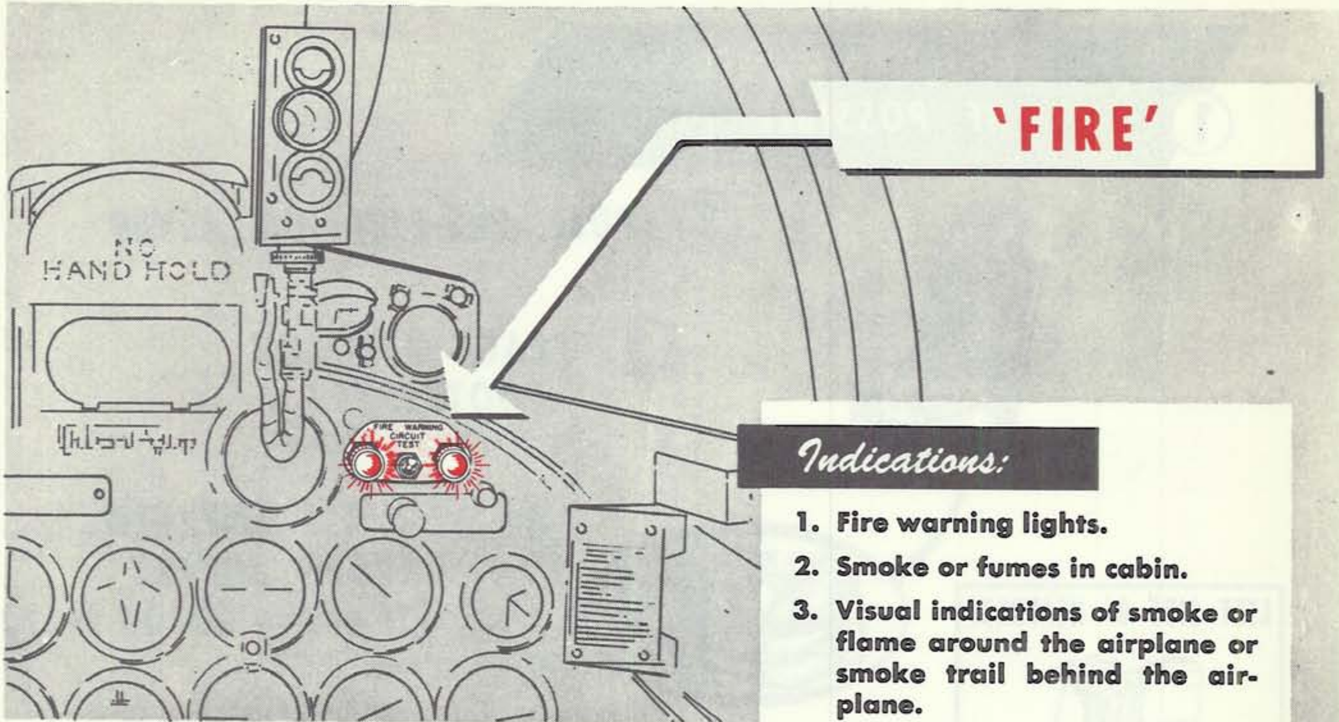
SMOKE OR FUME ELIMINATION.

If smoke or any toxic fumes are present, proceed as follows:

a. Set oxygen regulator diluter valve lever to 100% OXYGEN.

b. Set cabin pressurization system switch to OFF.

c. Hold ram air switch to INCREASE (holding the switch for 4 seconds will open the ram air valve fully).



Indications:

1. **Fire warning lights.**
2. **Smoke or fumes in cabin.**
3. **Visual indications of smoke or flame around the airplane or smoke trail behind the airplane.**
4. **Unusual engine roughness or muffled explosions.**
5. **Excess tailpipe temperature.**
6. **Information from wingman.**

Procedure:

1. **Retard throttle to CLOSED.**
2. **Set fuel master switch to OFF.**
3. **Make dead engine landing or abandon airplane.**

Figure 3-4. Fire

d. Remain on 100% oxygen until fumes or smoke have dissipated.

BAIL-OUT.

Bail-out from this airplane should be made by using the ejection seat with the following procedure:

a. REDUCE AIRSPEED IF POSSIBLE.

b. PULL PRE-EJECTION LEVER. Pull pre-ejection lever inboard, push it hard down and then push it outboard to lock. This jettisons canopy, releases knee braces and pulls safety pin in seat catapult firing mechanism, but does not lower the seat. (The radio/oxygen tube is pulled off the console nipple fitting to which it is attached and the radio lead severed by the force of ejection when the seat has traveled upward a distance of about 12 inches. The anti-"G" suit hose connection is also separated during the initial upward travel of the seat.)

WARNING

Clearance between canopy and pilot's head is critical. Make sure head is below normal operating path of canopy before actuating pre-ejection lever.

An emergency ejection seat arming control is provided. Under certain extreme flight conditions, such as high negative "g", it may be difficult to reach and actuate the pre-ejection lever. For this condition, or one where the canopy fails to jettison, using the emergency ejection seat arming control will permit ejection through the canopy. This control is a red handle on the left side of the headrest and is attached to the cable which normally pulls the safety pin in the seat catapult firing mechanism. Pulling the control forward past the pilot's left ear pulls the safety pin and arms the seat. It does not lower the seat, nor does it release the knee braces. For this type of ejection, hold knees together to prevent injury.

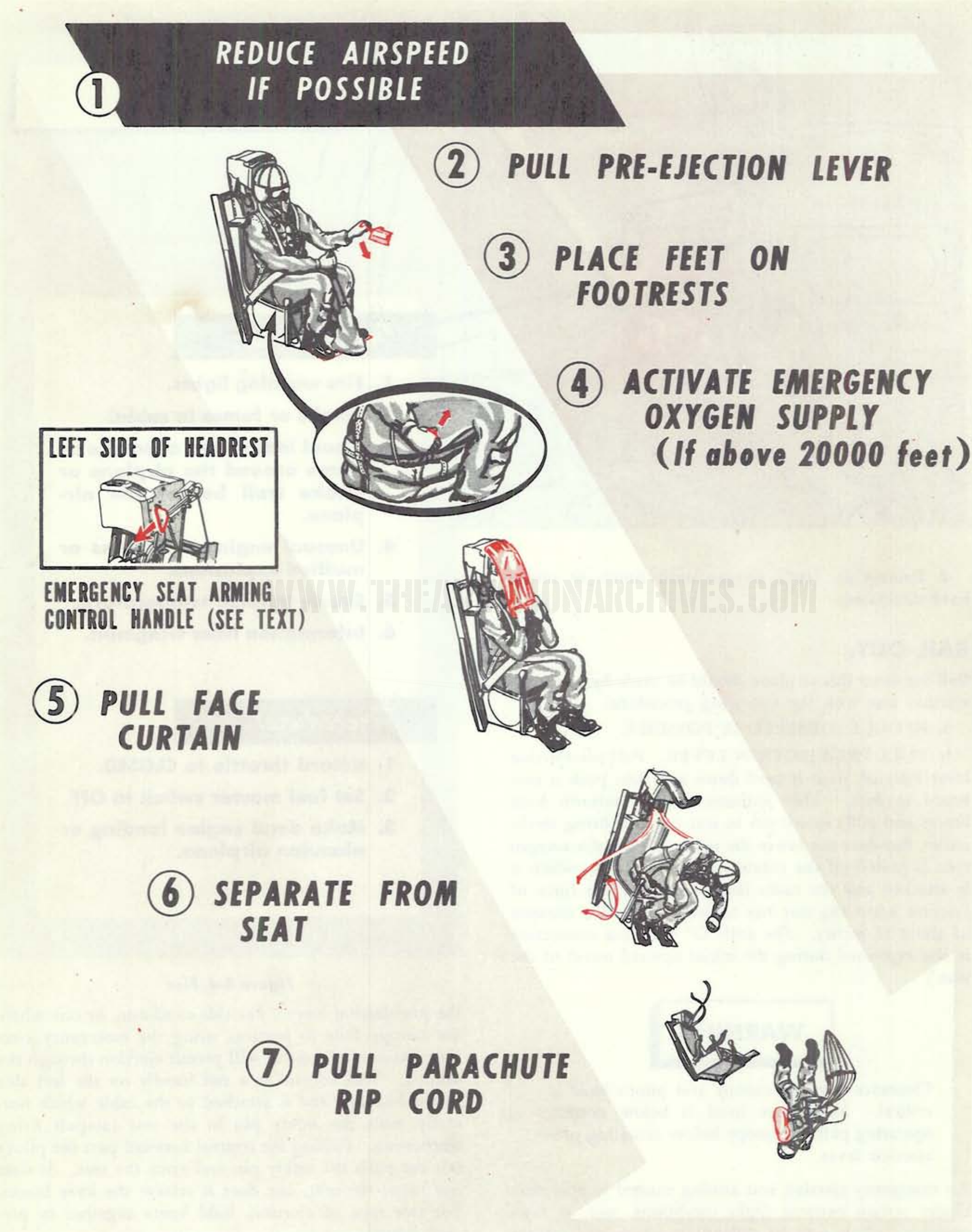


Figure 3-5. Emergency Escape

WARNING

Ejection through the canopy is feasible only with the canopy in the fully closed position. If the canopy has been opened (partially or fully) during the attempt to jettison, it is not safe to attempt an ejection before first closing canopy.

c. PLACE FEET ON FOOTRESTS.

Note

The seat does not lower, but remains in a fixed position when the pre-ejection lever is pulled. In this case, the pilot may have to lift his feet up onto the footrests if the seat is in an elevated position.

d. ACTIVATE EMERGENCY OXYGEN SUPPLY. This action is necessary only at altitudes above 20000 feet.

e. PULL FACE CURTAIN. While continuing to control airplane as much as possible, reach up with one hand and locate face curtain; then, sitting erect, with head back against headrest and muscles tensed to absorb ejection forces, reach up with the other hand and pull face curtain until fully extended. This will automatically lock the inertia reel and fire the ejection seat catapult.

Note

The face curtain is pulled by means of a red, rubber covered double handle attached to the face curtain. The pilot's headrest is fixed and is not attached to the movable portion of the seat. The position of the handles with respect to the pilot's head varies somewhat with seat position.

f. SEPARATE FROM SEAT. Immediately following ejection, release face curtain, disconnect oxygen tube and radio leads, open lap belt, and roll forward out of the seat.

Note

If time permits, the oxygen tube and radio leads should be disconnected at the alligator clip coupling prior to ejection. If disconnection is not possible prior to ejection, the tube and the leads shall be disconnected prior to opening the lap belt to ensure clean separation from the seat. When using the ejection seat for emergency escape at 2000 feet or below, it is recommended that the lap belt be opened and the oxygen tube and radio leads be disconnected prior to ejection. This procedure will shorten the time required for separation from the seat after ejection.

g. PULL PARACHUTE RIP CORD. If above 2000 feet at time of separation from seat, delay at least five seconds before pulling rip cord. This delay will preclude any possibility of collision between the seat and parachute and will also result in a lower parachute opening shock. When the escape is accomplished at high altitude, it is recommended that the pilot free fall to an altitude of approximately 18000 feet before opening his parachute in order to avoid the effects of anoxia and cold.

WARNING

Do not pull rip cord while in seat.

The firing mechanism will be armed after pulling the pre-ejection lever and care should be exercised not to pull the face curtain if ejection is not desired. The safety pin should be reinstalled after landing.

ENGINE EMERGENCIES.

Failure or malfunctioning of an element of the engine driven dual fuel pump will be indicated by the engine driven fuel pump warning light. If this light glows and no other symptoms of trouble are present, throttle back to a conservative cruise rpm, and land as soon as practicable.

AIRPLANE FUEL SYSTEM FAILURE.

If the low fuel boost pressure warning light glows, it indicates one of the following:

a. Both the submerged fuel boost pump in the forward fuel cell and the engine driven fuel boost pump have failed, or

b. The low pressure fuel filter has become clogged and is by-passing unfiltered fuel to the main pumps. The recommended procedure is to throttle back to a conservative cruise rpm and land as soon as practicable.

LOW FUEL QUANTITY.

With less than 500 pounds of fuel on board, special attention is required to maintain flight at low altitude. The maximum attainable engine speed is 96% rpm with approximately 450 pounds of fuel remaining. Engine speed decreases gradually as fuel is used, so that with approximately 200 pounds of fuel remaining, only 82% rpm is available. The engine fuel pump warning light will glow but should be ignored in this case. Fuel flow is approximately 480 to 7800 pounds per hour (80 to 130 pounds per minute) under these conditions. Obviously, the wave-off capabilities are decreased with less than 450 pounds of fuel on board. Since approximately 82% rpm is required for a carrier approach, a landing must be completed with at least 200 pounds of fuel remaining.

Note

The fuel quantities discussed above represent fuel quantity gage readings in level flight attitudes (including level coordinated turns).

During an optimum descent (figure A-8), or minimum time descent (figure A-9) and any other rapid, idle rpm descent, fuel starvation will not occur if the descent is started with sufficient fuel for the descent plus landing. (Example: Optimum descent, 40000 feet to sea level, 180 pounds fuel; one circle and landing, 250 pounds; minimum fuel on board at touch-down, 200 pounds. Total required at 40000 feet, 630 pounds.)

OIL SYSTEM MALFUNCTION.

If the oil pressure gage indicates abnormally low pressure, throttle back to lowest feasible rpm and land as soon as practicable.

If the oil pressure gage indicates zero, abnormally high pressure, or does not vary with rpm, replace the circuit fuse (right console, outboard of radio compass control panel). If trouble persists, follow procedure in preceding paragraph.

HYDRAULIC SYSTEM EMERGENCIES.

EMERGENCY HYDRAULIC SYSTEM OPERATION.

If there is insufficient pressure in the system to operate any of the units, set the selector valve control for the desired action and set auxiliary hydraulic pump switch to ON. Hydraulic fuses are installed, which will isolate and make inoperable any system (i.e., landing gear, flaps, etc) in which a line break or leak occurs.

Note

> It is possible that there may be a stoppage midway in the operation of one of the systems, caused by creeping of the fuse valves. To overcome this, set selector valve to reverse action for an instant, then return it to setting for action desired.

EMERGENCY FLAPERETTE OPERATION.

If the flaperons become inoperative due to insufficient hydraulic pressure, the switch-over to the emergency flaperette system will be automatic. The only change the pilot will notice is a reduced rate of roll, since lateral control forces are the same for both the primary and emergency systems. The rate of roll on the emergency flaperette system is approximately one-third of that attainable on normal flaperon control at approach speeds in the landing condition and 10 to 20% of that attainable on normal flaperon control at moderate to high speeds. In the event that automatic changeover to the flaperette system does not occur, changeover may be made by placing the flaperette system switch to EMER. ON & TEST.

These airplanes are equipped with an engine driven flaperette hydraulic pump and an emergency flaperette air bottle system. During final approach to a dead engine forced landing, low windmilling engine rpm may not provide sufficient hydraulic pressure for unlimited use of the flaperettes for lateral control. To supplement output of the flaperette pump in this condition and also to provide a source of pressure for the rare case of a frozen engine, causing failure of both the flaperon and flaperette hydraulic systems, the emergency flaperette air bottle system is provided. Twenty-four flaperette full deflection cycles are available when the system is turned on. To be sure that lateral control is available through the complete landing, use rudder for lateral control down to an altitude of 500 feet, depending on air turbulence, at which point, actuate the flaperette air bottle system and use the flaperettes for lateral control in the normal manner.

EMERGENCY FLYING TAIL SHIFT OPERATION.

In the event of loss of hydraulic system pressure, a safety feature is incorporated to shift longitudinal control automatically from the all-movable, hydraulically-powered flying tail to the manual elevator control system. The same shifting of control can also be selected by the pilot during any flight condition in the clean configuration by moving the longitudinal control system selector lever on the left console from HYDRAULIC to MANUAL. The time required for shift-over is 1-1/2 to 2 seconds. During shift-over, both powered and manual systems are partially effective and there is no loss of control. The two control systems are adjusted with respect to each other, so that when switching from the powered system to the manual system in straight and level flight, the nose of the airplane will rise slightly. If switch-over is made during a turn or "g" maneuver, trim change during switch-over will be small, but stick forces required to hold the same "g" will more than double. If switch-over is made at very high Mach numbers, trim change will be small, but the effectiveness of the elevator will be low and electric stabilizer trim should be used as necessary to control the flight path of the airplane in recovering to level flight.

The components of the flying tail hydraulic system have a high level of reliability; however, if malfunctioning of the flying tail is suspected, as indicated by either a lack of response to stick movement, or uncalled-for operation with no stick movement, shift immediately to the manual elevator control system. On airplanes equipped with the Interim Longitudinal Control System Modification, shut off power to the flying tail components by actuating the stabilizer hydraulic power emergency shut-off switch. On airplanes equipped with the Final Production Longitudinal Control System Modification, push down on the emergency manual control knob.

Note

> This not only shifts longitudinal control to manual elevator control, but also by-passes the 2-1/2 degrees airplane nose-up trim limit circuit and the automatic retrimming feature with flap retraction. This last fact should be remembered in case of wave-off.

On airplanes equipped with the Interim Longitudinal Control System Modification, there is a remote possibility that a malfunction of the hydraulic control system could occur when operating on the manual control system. This will be evidenced by an uncalled-for change in longitudinal trim of the airplane with corresponding motion of the absolute stabilizer position indicator. Should this situation arise, immediately shut off power to the flying tail components by actuating the stabilizer hydraulic power emergency shut-off switch.

Note

The stabilizer hydraulic power emergency shut-off valve cannot be reopened in flight but must be reset by the ground crew. If valve is closed in flight be sure to report on Yellow Sheet.

EMERGENCY LANDING GEAR OPERATION.

If wheels fail to go down and lock when the normal control is moved to DOWN:

a. Check that airspeed is below limiting airspeed and that hydraulic combat system shut-off valve control is at HYDRAULIC PRESSURE-ON (full pressure to landing gear system), and check hydraulic system pressure gage. Re-cycle gear (move control level to UP, then return to DOWN) to check hydraulic fuses.

b. Set auxiliary hydraulic pump switch to ON and wait for an interval. Extension will be slow.

c. If position indicator still does not show wheels down and locked, reduce speed to 130 knots, then pull and lock red "T" handle (handle shaft is notched to lock handle in release position) to lower the wheels by air pressure.

Note

Once this system is used, the wheels will remain down and locked until pressure is relieved by a deck crew.

EMERGENCY SPEED BRAKE RETRACTION.

If speed brakes fail to return to up from an extended position:

a. Pull out speed brakes circuit breaker (located on left console, outboard of throttle quadrant).

b. Pull emergency speed brakes up control handle (red "T" handle on left side of seat bulkhead) and hold until brakes are up. If the difficulty is due to an electrical failure in the position selector system, retraction will occur in the normal time of about five seconds. If the difficulty is due to a hydraulic failure, retraction time will be longer, since impact air pressure is being used to push the speed brakes up.

EMERGENCY BRAKE OPERATION.

The brakes are provided with a separate hydraulic reservoir and will operate after a pump failure or line failure elsewhere in the hydraulic system. The brakes are hydraulically boosted, however, and loss of hydraulic system pressure will make brake pedal forces about three times heavier.

The brakes will overheat and lose effectiveness if used excessively on landing or long taxiing. Effectiveness

can be regained temporarily by pumping the brake pedal. More than six pumping strokes may be required under extreme conditions. To regain complete effectiveness the brakes must be allowed to cool.

In the event of a brake system failure, an emergency air bottle system is provided. Pulling the red emergency "T" handle on the left console supplies air pressure to lock the brakes. (The "T" handle shaft is notched to lock handle in brakes on position.)

CAUTION

Since the air bottle pressure locks the brakes, do not use the emergency system if normal brakes will stop the airplane. If the air bottle is pulled while moving faster than 50 knots, blown tires will probably result. Braking effectiveness with blown tires is poor.

ELECTRICAL SYSTEM EMERGENCIES.

INDIVIDUAL CIRCUIT FAILURE.

If any electrical circuit fails to function, check that the appropriate circuit breaker reset button is in.

CAUTION

If button pops out repeatedly, do not attempt to hold it in, since continued use of the circuit may cause fire. Set the switch for that circuit off, if feasible.

GENERATOR FAILURE.

Generator failure will be indicated by the generator warning light and reduced voltage on the voltammeter. All circuits except those essential to flight (essential bus) will be automatically disconnected if the battery switch is in the BAT. & GEN. position and the landing gear control handle is in the UP position. Setting the battery switch to BAT., or setting the landing gear control handle to the DOWN position, will supply battery power to all circuits. Since the battery is the only source of power, it should be conserved by pulling all unnecessary circuit breakers when operating on battery power alone. (See figure 1-9 for detailed information.)

WARNING

Never set the battery switch to OFF except in case of an electrical fire.

TRIM FAILURES.

STABILIZER.

If the stabilizer electric trim malfunctions, as indicated by either a lack of response to movements of the trim button on the control stick, or by uncalled-for operation with no movement of the trim button, immediately move the stabilizer electrical power switch on the left console from NORM. to EMER. and use the stabilizer emergency control switch on the left console for trim control.

Note

On airplanes equipped with final production longitudinal control system modification, when operating with the electrical trim selection switch set at EMERG., the 2-1/2 degrees airplane nose-up limit circuit and the automatic retrimming feature with flap retraction is bypassed. The full range of trim (6 degrees airplane nose-up and 1-3/4 degrees airplane nose-down) is then available.

WING OR RUDDER TRIMMER FAILURES.

There are no emergency procedures for failures in the wing trimmer or rudder trimmer systems, since they can be overpowered with normal flight controls.

Power for the wing trimmer passes through the stabilizer primary control circuit breaker on the right side of the seat bulkhead. If this circuit breaker pops or is pulled intentionally, the trim button on the control stick will become inoperative. In this case, move the stabilizer electrical power switch from NORM. to EMER. and use the stabilizer emergency control switch for stabilizer trim.

Power for the rudder trimmer passes through the flight instruments circuit breaker. If this circuit breaker pops or is pulled intentionally, certain flight instruments (landing gear position indicator, stabilizer trim position indicator, speed brake position indicator and G-2 compass) will become inoperative.

EMERGENCY ARMAMENT CONTROL.

a. To stop runaway guns, set armament master switch to OFF or inboard and outboard gun charging switches to SAFE.

b. To jettison bombs, rocket launchers or drop tanks from MK 51 racks, move stores jettison switch up, or pull emergency hydraulic jettison "T" handle aft.

EMERGENCY OPERATION OF IFF EQUIPMENT.

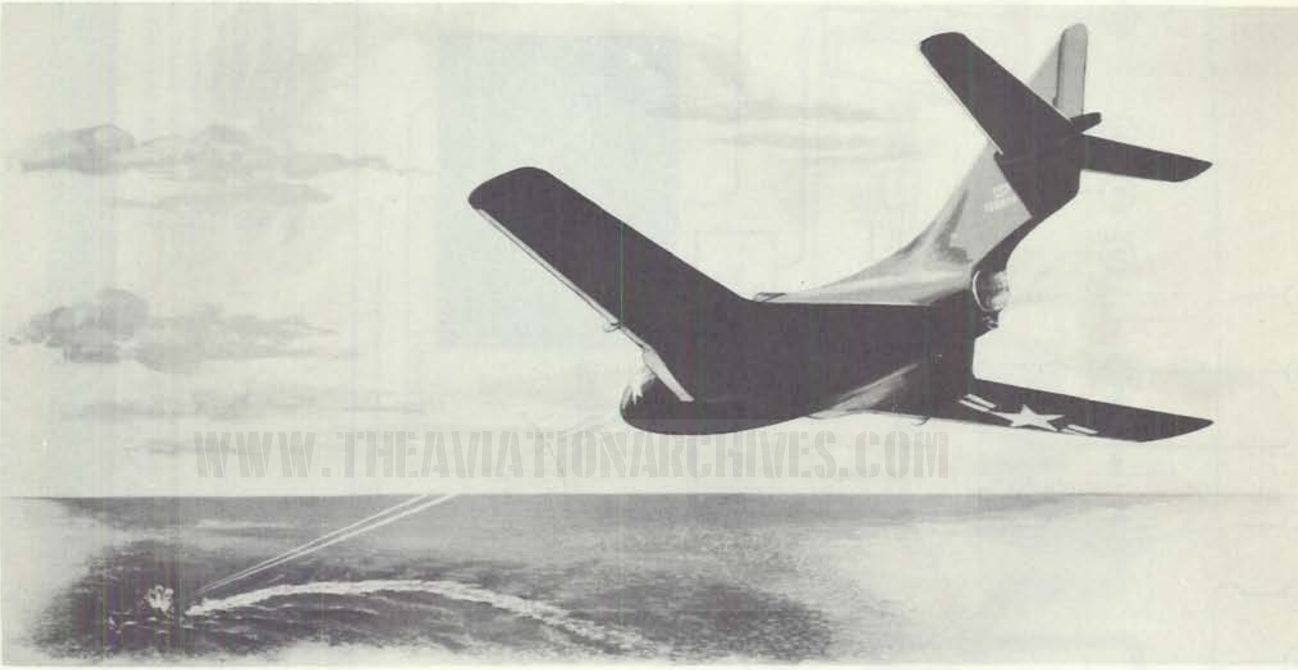
a. To indicate emergency or distress, press the dial stop and rotate the master selector to the EMERGENCY position.

b. To explode destructors within the equipment, raise red switch guard labeled DESTRUCT and set the switch to ON position. 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 DESTRUCTORS.

SECTION IV

TABLE OF CONTENTS

Section IV DESCRIPTION AND OPERATION OF AUXILIARY EQUIPMENT



CABIN AIR CONDITIONING SYSTEM.[1]

Hot, high pressure air is provided by the engine compressor. Part of this air is passed through a refrigeration unit and cooled, then mixed with the remainder and fed to the cabin. Cabin temperature is regulated by the proportion of hot air to cool air. This proportioning is controlled automatically by a selector rheostat and a thermostat, or manually with a momentary switch. The amount of air fed into the cabin remains relatively constant and a cabin pressure regulator maintains pressure control by venting the excess air. The cabin is pressurized only above 5000 feet; however, temperature control is available on the ground as well as at any altitude.

Note

> Air pressure for pressurizing the anti-"G" suit and for providing energy for rotating the turn and bank indicator gyro is supplied from the air conditioning system feed line. The pressure is supplied whenever the engine is operating.

NORMAL CONTROLS.

SYSTEM CONTROL PANEL.

This panel, located on the right console, contains the cabin pressure system on-off, stand-by temperature control, ram air vent and cabin pressure combat-normal switches and the automatic temperature control rheostat.

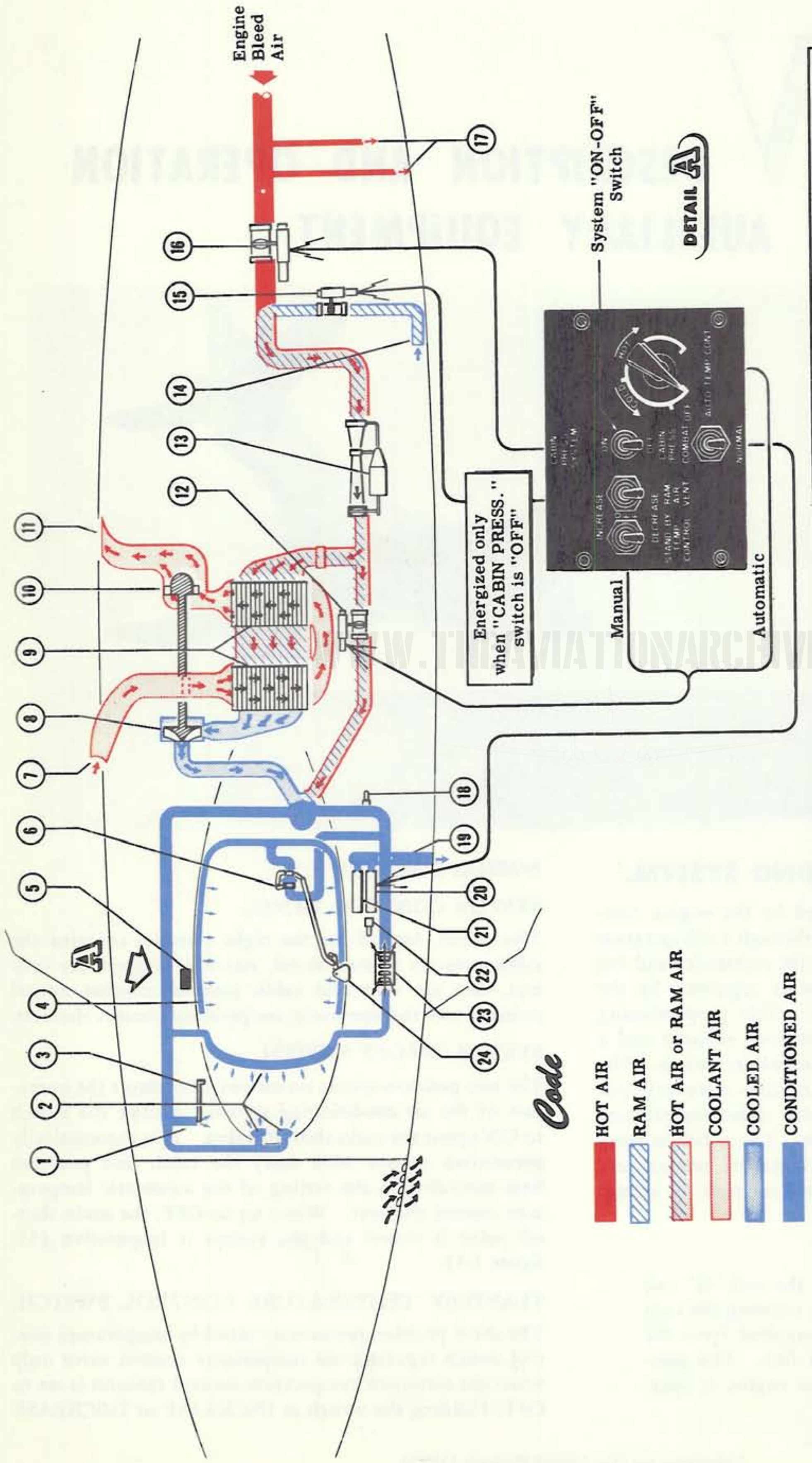
SYSTEM ON-OFF SWITCH.

The two position system on-off switch controls the operation of the air conditioning system . Setting the switch to ON opens the main shut-off valve. This automatically pressurizes (above 5000 feet) the cabin and provides heat according to the setting of the automatic temperature control rheostat. When set to OFF, the main shut-off valve is closed and the system is inoperative (33, figure 1-5).

STAND-BY TEMPERATURE CONTROL SWITCH.

The three position momentary stand-by temperature control switch regulates the temperature control valve only when the automatic temperature control rheostat is set to OFF. Holding the switch at INCREASE or DECREASE

[1]Airplanes ser No. 130752 through 130849.



1. Foot Outlet
2. Windshield Defroster Outlets
3. Foot Outlet Control
4. Canopy Defroster Outlet
5. Air Conditioning System Control Panel
6. Canopy Defroster Shut-off Valve
7. Coolant Air Scoop
8. Coolant Fan Turbine
9. Refrigeration Unit
10. Coolant Fan
11. Coolant Air Exhaust
12. By-pass Valve
13. Flow Control Valve
14. Ram Air Scoop
15. Ram Air Shut-off Valve
16. Main Shut-off Valve
17. Engine Bleed Air to Pressurize Hydraulic Tanks and Anti "G" Suit and Operate Turn and Bank Indicator
18. Anticipating Thermostat
19. Regulator and Dump Valve Exhaust
20. Cabin Pressure Regulator Valve
21. Cabin Pressure Manual Dump Valve
22. Cabin Thermostat
23. Console Outlet and Control
24. Canopy Defroster Shut-off Valve Control

Figure 4-1. Air Conditioning System

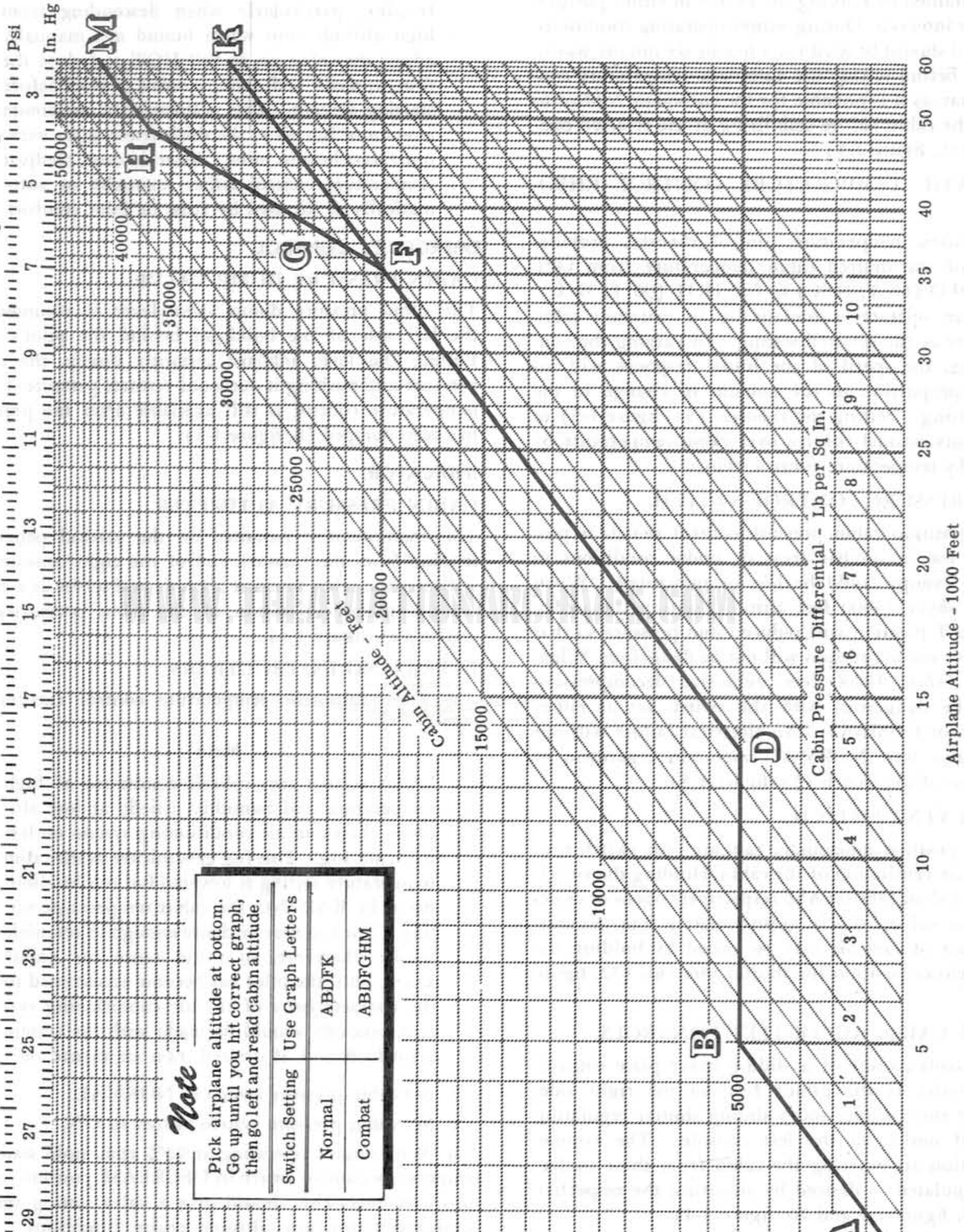


Figure 4-2. Pressurizing Schedule

respectively, opens or closes the valve fully in approximately 22 seconds. Any desired ratio of hot-to-cold air may be obtained by holding the switch in either position for shorter intervals. During winter operating conditions, this control should be used for a five or six minute warm-up period before setting the automatic temperature control rheostat, as it is possible for the automatic control to overheat the cabin before stabilizing at the selected temperature (31, figure 1-5).

AUTOMATIC TEMPERATURE CONTROL RHEOSTAT.

The automatic temperature control rheostat provides selection of the desired cabin temperature from OFF to full COLD (60°F, 16°C) to full HOT (90°F, 32°C). This system operates automatically to maintain cabin temperature at the selected setting. In varying the control setting, the speed of the initial response will increase in proportion to the amount of change in the control setting. Setting the rheostat (54, figure 1-5) to OFF permits manual control over cabin temperature by the stand-by temperature control switch.

CABIN PRESSURE CONTROL SWITCH.

The two position cabin pressure control switch is provided for use in combat areas or under conditions in which the canopy could be lost or punctured. When operating *above* 35000 feet altitude, setting the switch to COMBAT position will reduce cabin pressure so that an explosive decompression will not be dangerous. When operating *below* 35000 feet, explosive decompression will not be dangerous with the switch set at either NORMAL or COMBAT. An electrical failure will put the regulator into NORMAL operation regardless of the position of the switch (53, figure 1-5).

RAM AIR VENT SWITCH.

The three position momentary ram air vent switch provides ram air ventilation of the cabin. Holding the switch at INCREASE or DECREASE respectively opens or closes the ram air valve fully in approximately four seconds. The amount of ram air may be varied by holding the switch in either position for shorter intervals (32, figure 1-5).

MANUAL CABIN AIR OUTLET CONTROLS.

These controls consist of a sliding cover plate controlling an outlet at the pilot's feet on the right side, forward of the console, and a sliding shutter regulating a louvered outlet on the left console. The volume of ventilation air entering the cabin from these outlets may be regulated as desired by adjusting the respective control (8, figure 1-3 and 26, figure 1-4).

CANOPY DEFROSTER SHUT-OFF VALVE CONTROL.

This control consists of a lever mounted on the left side of the canopy. It is connected through a mechanical linkage to a butterfly valve in the canopy defroster duct. Pushing the lever forward to OFF closes the valve and moving it aft to ON opens the valve (6, figure 1-3).

Note

For maximum windshield defogging and defrosting, particularly when descending from high altitude into warm humid air, manually adjust the cabin air to full HOT and close the foot, console and canopy valve outlets before starting descent. This will force the maximum amount of hot air to the thick armor glass without excess heat to pilot. After descent, readjust temperature control either manually or automatically as dictated by frost or pilot comfort.

EMERGENCY CONTROL.

CABIN PRESSURE DUMP VALVE.

The cabin pressure dump valve lever is mounted on the left side of the bulkhead behind the pilot's seat. Pulling the lever inboard instantly dumps the cabin pressure and pushing it outboard restores pressure. Cabin temperature control is still available after the pressure has been dumped (8, figure 1-5).

INDICATOR.

CABIN PRESSURE ALTIMETER.

This instrument is mounted on the vertical panel extending from the forward end of the right console. It indicates the cabin pressure altitude and serves as a check for the proper operation of the cabin pressurization system (23, figure 1-4).

OPERATING INSTRUCTIONS.

a. Turn automatic temperature control rheostat to OFF.

Note

Under certain atmospheric conditions of high temperature and humidity, chiefly at low altitudes, the cabin air conditioning system outlets will emit fog. This fog gets thicker as the cabin temperature setting is lowered but can be eliminated by RAISING the cabin temperature setting. The fog may be dense enough to resemble smoke, therefore, to avoid cause for undue alarm, until the pilot has become accustomed to the characteristics of the air conditioning system, take-offs should be made with the system turned off and, if desired, ram air turned on.

b. Set cabin pressure switch to NORMAL.

c. Set cabin pressure system switch to ON.

d. With engine operating at 90% rpm, hold stand-by temperature control switch in DECREASE position for 10 or 15 seconds. This should give a valve setting that is comfortable for low altitude cruise conditions. The valve may be readjusted by holding the switch in the INCREASE or DECREASE position for two or three seconds at a time. Full valve adjustment will be reached in 22 seconds.

e. Under winter operating conditions, if the automatic temperature control does not pick up control of the cabin heat without at first creating an excessively high temperature, it will be necessary to control cabin temperature by using the stand-by temperature control switch for a five or six minute warm-up period before going over to automatic control (using the automatic temperature control rheostat).

f. When the desired cabin temperature is reached (or under winter operating conditions, when the warm-up period is completed), operate the automatic temperature control rheostat for a temperature as close as possible to the existing cabin temperature. The full COLD mark can be considered 60°F, (16°C) the middle mark 75°F, (24°C) and the full HOT mark 90°F (32°C). In varying the automatic temperature control rheostat setting, the speed of the initial response will increase with a large change in control setting.

Note

When the stand-by temperature control switch is used to control temperature, repeated adjustments must be made when descending from high altitudes or an extremely high cabin temperature will result.

g. For ram air ventilation of the cabin, set cabin pressure system switch to OFF and pull lever on cabin pressure dump valve inboard. Regulate quantity of ventilation with ram air vent momentary switch. Full valve adjustment will be reached in four seconds.

h. To dump pressure, pull dump control handle (left of seat) inboard; to restore pressure, push outboard.

Note

The cabin pressure system switch must be set to ON for operation of pressurizing and temperature control.

CAUTION

When operating in combat areas or under conditions when the canopy could be lost or punctured, set cabin pressure switch to COMBAT position.

i. When diving from altitude, check that automatic temperature control rheostat is at ON.

EMERGENCY PRESSURIZING EQUIPMENT OPERATION.

In case of excessive pressure: pull dump control handle located to the left of the seat, inboard to dump pressure. Cabin temperature control (both automatic and manual) is still available.

In case of excessive cabin temperature:

a. Turn automatic temperature control rheostat to OFF position.

b. Set stand-by temperature control switch to DECREASE.

c. If ineffective, set cabin pressure switch to OFF, and reduce speed.

CAUTION

When operating in combat areas or under conditions when the canopy might be lost or punctured, set the cabin pressure switch to COMBAT position.

CABIN AIR CONDITIONING SYSTEM.[1]

Hot, high pressure air is provided by the engine compressor. Part of this air is passed through a refrigeration unit and cooled, then mixed with the remainder and fed to the cabin. Cabin temperature is regulated by the ratio of hot to cool air. This regulation is accomplished by the use of a valve that controls the amount of engine air that by-passes the refrigeration unit. The amount of air fed into the cabin varies with engine rpm and altitude. A cabin pressure regulator maintains pressure control by venting the excess air. The cabin is pressurized only above 5000 feet; however, temperature control is available on the ground as well as at any altitude. The cabin pressurization system has only the normal pressure schedule (see letters ABDFK on the graph shown in figure 4-2). There is no combat pressure schedule.

NORMAL CONTROLS.

SYSTEM CONTROL PANEL.

The air conditioning system control panel (23, figure 1-3A), located on the left console, contains the system on-off (temperature-ram air) and the increase-decrease switches.

SYSTEM ON-OFF SWITCH.

This switch permits the pilot to select conditioned air or ram ventilating air for the cabin. The switch may be set to either the ON (TEMP) position, which provides temperature control, or the OFF (RAM AIR) position, which provides ventilation.

INCREASE-DECREASE SWITCH.

When the on-off switch is in the ON (TEMP) position, the two position momentary (center off) increase-decrease switch permits the pilot to regulate the ratio of hot to cool air entering the cabin. This switch operates the by-pass valve. Full valve adjustment is made in 20 seconds. When the switch is held at INCREASE, the by-pass valve opens and allows more hot air to enter the cabin, thus increasing the cabin temperature. When the switch is held toward DECREASE, the valve closes and more air is forced through the refrigeration unit, thus decreasing the cabin temperature.

When the on-off switch is set in the OFF (RAM AIR) position, the increase-decrease switch permits the pilot to regulate the amount of ram ventilating air that enters

[1] Airplanes ser No. 130850 and subsequent.

the cabin. Holding the switch at INCREASE opens the ram air valve, and holding the switch at DECREASE closes the valve, thus regulating the amount of ram air. The ram air valve will be closed when the on-off switch is first placed in the OFF (RAM AIR) position. Full valve adjustment is made in approximately four seconds.

MANUAL CABIN AIR OUTLET CONTROLS.

The controls consist of a sliding cover plate (26, figure 1-4) controlling an outlet at the pilot's feet, on the right side, forward of the console, and a sliding shutter (8, figure 1-3), regulating a louvered outlet on the left console. The volume of ventilation air entering the cabin from these outlets may be regulated as desired by adjusting the respective control.

CANOPY DEFROSTER SHUT-OFF VALVE CONTROL.

This control consists of a lever (6, figure 1-3) mounted on the left side of the canopy. It is connected through a mechanical linkage to a butterfly valve in the canopy defroster duct. Pushing the lever forward to OFF closes the valve and moving it aft to ON opens the valve.

Note

For maximum windshield defogging and defrosting, particularly when descending from high altitude into warm humid air, manually adjust the cabin air to full hot and close the foot, console and canopy valve outlets before starting descent. This will force the maximum amount of hot air to the thick armor glass without excess heat to the pilot. After descent, readjust temperatures as dictated by frost or pilot comfort.

EMERGENCY CONTROL.

CABIN PRESSURE DUMP VALVE.

The cabin pressure dump valve lever (8, figure 1-6) is mounted on the left side of the bulkhead behind the pilot's seat. Pulling the lever inboard instantly dumps the cabin pressure, and pushing it outboard restores pressure. Cabin temperature control is still available after the pressure has been dumped.

INDICATOR.

CABIN PRESSURE ALTIMETER.

This instrument (23, figure 1-4 and figure 4-2) is mounted on the vertical panel extending from the forward end of the right console. It indicates the cabin pressure altitude and serves as a check for the proper operation of the cabin pressurization system.

OPERATING INSTRUCTIONS

a. Set on-off switch to ON (TEMP) if temperature control and cabin pressurization are desired, or to OFF (RAM AIR) if ram air ventilation only is desired.

b. Move momentary increase-decrease switch to position which will produce the state of air conditioning desired for optimum pilot comfort.

Note

Under certain atmospheric conditions of high temperature and humidity, chiefly at low altitudes, the cabin air conditioning system outlets will emit fog. This fog becomes thicker as the cabin temperature falls, but can be eliminated by placing the on-off switch to ON (TEMP) and moving the increase-decrease switch to INCREASE. The fog may be dense enough to resemble smoke; therefore, to avoid cause for undue alarm, until the pilot has become accustomed to the characteristics of the air conditioning system, take-offs should be made with the on-off switch set to OFF (RAM AIR) and the quantity of ventilating air required to clear the cabin controlled by the increase-decrease switch.

c. For ram air ventilation, set on-off switch to OFF (RAM AIR) and pull cabin pressure dump valve lever inboard. Regulate quantity of ventilating air by holding increase-decrease switch at INCREASE position until desired flow of ram air is obtained.

d. To dump pressure, PULL dump control handle (left of seat) inboard; to restore pressure, PUSH outboard.

EMERGENCY PRESSURIZING EQUIPMENT OPERATION.

In case of excessive pressure; PULL dump control handle, located to the left of the seat, inboard to dump pressure. Cabin heating and ventilating remain available. In case of excessive cabin temperature: set on-off switch to OFF (RAM AIR) and move the increase-decrease switch to INCREASE. When temperature has been reduced, attempt to regain desired cabin air condition. If ineffective, return to OFF (RAM AIR) position.

TABLE IV-I. COMMUNICATION AND ASSOCIATED ELECTRONIC EQUIPMENT

Type	*Designation*	*Function*	*Range*	*Location Of Controls*
VHF Transmitter-Receiver or	AN/ARC-1	Two-way voice communication	Line of sight	Right console
UHF Transmitter-Receiver	AN/ARC-27	Two-way voice communication	Line of sight	Right console
Radio Compass	AN/ARN-6	Navigation (ADF)	100 statute miles	Right console (Indicator on instrument panel)
IFF Equipment	AN/APX-6	Identification	Line of sight	Right console
Receiver	AN/ARR-2A	Navigation—homing	Line of sight	Right console
Ranging Radar	AN/APG-30	Range indication for sight unit	3000 yards max	Left console

ELECTRONIC EQUIPMENT.

UPON ENTERING CABIN.

a. Plug the headphones and microphone into the pilots' quick disconnect assembly.

b. Turn ON the battery and radio master switches. The radio master switch is in the master control unit C-739/ARC on the radio console. The radio master switch does not supply power to the IFF equipment, nor to the AN/APG-30 (Ranging Radar) equipment.

Note

The C-739/ARC is not installed when the AN/ARC-27 is installed.

c. Set the COMM VOLUME control to maximum (full clockwise).

AN/ARC-1—VHF TRANSMITTER-RECEIVER.

OPERATION—RECEIVER.

For an operating check of this equipment, it is necessary that signals be present on the channels on which operation is contemplated. In the absence of signals, the squelch circuit reduces the receiver output to zero, and therefore it is impractical to attempt to determine proper receiver performance.

On the vhf console control unit C-865/ARC-1 operate the rotary selector switches as follows:

a. For reception on any of the nine main channels, use position MAIN T/R and rotate CHAN SEL switch to desired channel.

b. For reception on any one of the nine main channels and on the guard channel, use position BOTH and rotate CHAN SEL switch to the desired channel.

c. For reception on the guard channel only, use position GUARD. The position of the CHAN SEL switch need not be considered.

The volume level of the vhf receiver is controlled by the COMM VOLUME on the master control unit. At the completion of this check, set the volume to minimum.

OPERATION—TRANSMITTER.

Note

These instructions are subject to local limitations regarding radio silence.

a. On the vhf console control unit, operate the rotary selector switches as follows: for transmission on any one of the nine main channels, use position MAIN T/R and rotate the CHAN SEL to the desired channel.

b. For transmission on the guard channel, use position GUARD. The position of the CHAN SEL switch need not be considered.

c. For transmission and reception on any main channel and simultaneous reception on the guard channel, use position BOTH.

d. To transmit, press throttle microphone switch and talk.

e. Release microphone switch to receive. If it is not desired to monitor the radio compass or navigation receiver while transmitting, reduce the associated SENS control.

AN/ARC-27 UHF COMMAND SYSTEM.

DESCRIPTION.

The AN/ARC-27 command equipment provides AM radio communications between the aircraft and any other station similarly equipped within the ultra high frequency range of 225.0 to 399.9 megacycles. In this system, 1750 channels are provided, any 18 of which may be made available to the pilot. In addition, a guard channel frequency is available. The system consists of an RT-178/ARC-27 transmitter-receiver, a C-905/ARC-27 console control panel, a C-626/ARC-27 master (channel setting) control box, an antenna and associated wiring and cabling.

CONTROLS.

The C-905/ARC-27 console control panel provides the controls for operating the AN/ARC-27 uhf command system. These controls are the OFF-T/R-T/R+G REC.-ADF selector switch for turning the set on for reception and transmission with or without guard channel reception, a volume control and a channel selector switch. This control panel also provides a MANUAL-PRESET switch and three decade frequency dials marked MANUAL CHANNEL. With the MANUAL-PRESET switch set at PRESET, any one of nineteen preset channels may be selected for reception and transmission by means of the channel selector switch marked PRESET CHANNEL. With the MANUAL-PRESET switch set at MANUAL, the PRESET CHANNEL control is disabled and selection of any one of the 1750 uhf channels may be accomplished by means of the three decade frequency dials marked MANUAL CHANNEL.

OPERATION.

REMOTE RECEPTION AND TRANSMISSION.

Set battery switch to BAT. & GEN. Set C-905/ARC-27 uhf console control panel switches to channel number desired and T/R. In approximately one minute signals above the squelch level will be heard on the channel selected. By operating the C-905/ARC-27 uhf console control panel selector switch to T/R + G REC., signals on both guard and channel selected may be heard. To transmit on the channel selected, depress microphone switch and talk into microphone. Sidetone will be heard in headset. To transmit on guard channel, repeat the above but with the C-905/ARC-27 channel selector set to G.

STOPPING EQUIPMENT.

On the C-905/ARC-27 console control panel set the OFF-T/R-T/R + REC.-ADF switch to OFF.

Note

Either AN/ARC-1 or AN/ARC-27 equipment may be installed, but not both.

AN/ARN-6—RADIO COMPASS.

STARTING.

The equipment is started by turning the function switch on the C-758/A (on right console) to COMP., ANT. or LOOP position.

STOPPING.

To stop the equipment, turn the function switch to OFF.

OPERATION.

GENERAL.

The equipment will perform the following three major functions:

a. Homing compass operation.

b. Position finding, using automatic and aural-null methods.

c. Receiver operation using ANT. or LOOP.

HOMING COMPASS OPERATION.

To use as a homing compass, perform the following operations:

a. Turn the function switch to COMP. position.

b. Rotate the band switch to the frequency band in which operation is desired.

c. Turn the tuning crank to the desired station frequency and tune for maximum swing of the tuning meter. Greater accuracy in tuning may be obtained by placing the CW-VOICE switch in CW position. A 900 cycle tone will be heard along with the station modulation. This will aid in accurate tuning. After tuning, return the CW-VOICE switch to VOICE to eliminate the 900 cycle tone.

d. Adjust AUDIO control for desired headset level.

e. Listen for station identification to be sure that the correct station is being received.

f. Turn the VAR knob on the indicator until the azimuth zero is at the index.

g. The indicator pointer will now show the bearing of the station relative to the aircraft heading. For example, if the pointer is to the left of zero, the station is on your left. Turn your airplane to the left until the pointer is at zero. If the airplane heading is held at zero degrees on the radio compass indicator, you will ultimately fly over the radio station antenna. Cross winds, however, will cause the flight path to be a curved line. Direction of wind drift may be determined by noting any change in magnetic bearing while homing with the radio compass. In increasing magnetic bearing indicates a wind from the right, while a decreasing magnetic bearing indicates a wind from the left. Compensate for wind drift by offsetting the aircraft heading until there is a minimum rate of change of the magnetic compass reading. The radio compass indicator now shows directly in degrees the relative airplane-to-station heading necessary to correct for wind drift.

POSITION FINDING.

GENERAL.

There are two methods of position finding, automatic and aural-null. Prior to the use of either method, the following steps should be taken in order to shorten the time required for a complete set of readings:

a. Select three stations whose geographical locations are spaced at approximately equal intervals about the airplane.

b. Tune in the stations, identify them and log their dial readings.

AUTOMATIC METHOD.

For operation as an automatic indicating position finder, perform the following operations:

a. Adjust VAR knob on the indicator until its bearing scale at the index is the same as the CORRECTED magnetic heading of the aircraft.

b. Set the function switch knob to COMP.

c. Tune in one of the selected stations and record the bearing as indicated by the TAIL of the indicator pointer.

d. Repeat step c. for the other stations, in rapid succession, while flying with a steady level heading.

Note

Because of the airplane's motion, the less time taken for observations, the greater the accuracy of the fix.

e. The recorded bearings will be the station-to-aircraft bearings from the north. Project lines from the stations at the recorded bearings. The aircraft position will be within the vicinity of the small triangle made by the intersection of the projected lines.

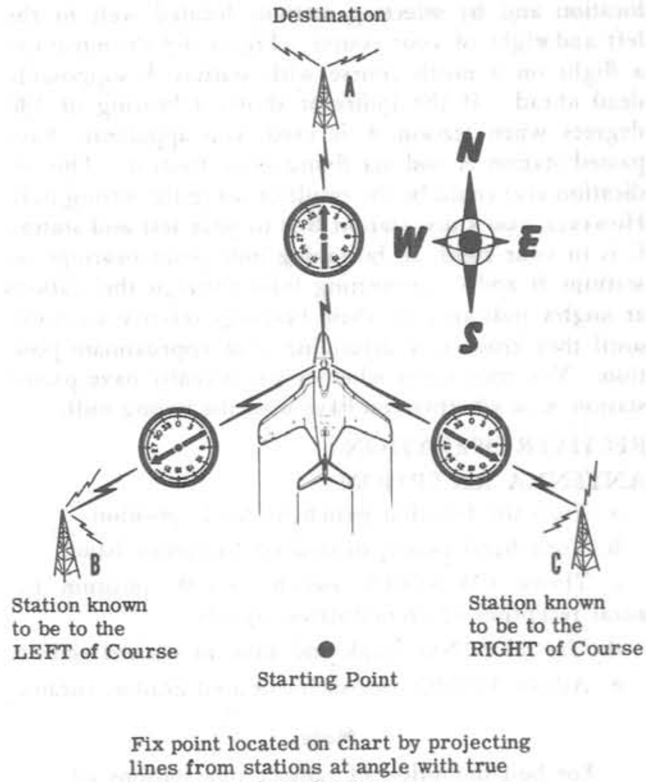


Figure 4-3. Radio Compass Position Finding Diagram

AURAL-NULL METHOD.

For operation as an aural-null position finder perform the following operations:

a. Adjust the VAR knob on the indicator until its bearing scale at the index is the same as the CORRECTED magnetic heading of the aircraft.

b. Set the function switch knob to LOOP position.

c. Tune in the desired station. To obtain good signal strength for station identification it may be necessary to rotate the loop by means of the LOOP L-R switch knob for maximum signal. Direction and speed of loop's rotation are controlled by direction and amount of LOOP L-R switch rotation, respectively.

d. Use the LOOP L-R switch knob, as in step c., and rotate loop for minimum headset volume. Record the bearing shown by the indicator pointer. Better definition of the null may be obtained by turning the AUDIO control fully clockwise and locating the null by either listening for minimum audio signal or noting a counterclockwise dip of the tuning meter pointer. The use of cw operation also improves the definition of the null. To obtain cw operation throw the CW-VOICE switch to CW position.

e. Position finding in LOOP operation is subject to a 180 degree error, since there are two null points in a 360 degree rotation of the loop. This ambiguity is overcome by keeping aware of your general geographical location and by selecting stations located well to the left and right of your course. Figure 4-3 demonstrates a flight on a north course with station A supposedly dead ahead. If the indicator shows a bearing of 180 degrees when station A is used, you apparently have passed station A and are flying away from it. This indication also could be the result of using the wrong null. However, you know station B is to your left and station C is to your right, so by taking null point bearings on stations B and C, projecting lines through the stations at angles indicated by their bearings relative to north until they cross, you determine your approximate position. You then know whether you actually have passed station A or whether you have used the wrong null.

RECEIVER OPERATION.

ANTENNA RECEPTION.

a. Turn the function switch to ANT. position.

b. Turn band switch to desired frequency band.

c. Throw CW-VOICE switch to CW position for aural reception of unmodulated signals.

d. Use TUNING crank and tune in desired station.

e. Adjust AUDIO control for desired headset volume.

Note

For best definition of radio range stations adjust the AUDIO control for the lowest usable headset volume and continue to reduce volume as the A-N signals increase in strength.

LOOP RECEPTION.

If reception on ANT. is noisy due to static, better results may be obtained by operating in LOOP position as follows:

a. Turn function switch to LOOP position.

b. Turn band switch to desired frequency band.

c. If station is unmodulated, place CW-VOICE switch in CW position.

d. Tune in desired station.

e. Rotate loop with the LOOP L-R switch until maximum signal is obtained. If flight course is not straight, readjustments may be necessary.

f. Adjust AUDIO control for desired headset volume.

g. For best definition of radio range A-N signals on LOOP, it is necessary to maintain the loop near 90 or 270 degree position and adjust the AUDIO control for lowest usable headset volume.

Note

Cone of silence indications are not always reliable while receiving on LOOP. In some cases, an increase instead of a decrease in signal may be noted. This is the result of certain types of radio range transmitting antennas and the loop location on the airplane.

SUMMARY OF PRECAUTIONS DURING OPERATION.

a. Select radio stations that provide stable bearings. Do not use a station for bearing unless it can be identified by headset signal on COMP. operation. High powered clear channel stations should be used when possible. Any interference from other stations will cause an error in bearing. Tune equipment accurately. Station identification must be checked, especially stations broadcasting network programs. Avoid taking bearings on synchronized stations except when close to desired station. If station stops transmitting or fades, bearings may change to other stations of the same frequency thus causing errors. This is especially true of code stations operating in a network.

b. Night effect or reflection of radio waves from the sky may be recognized by fluctuations in bearings. Night effect is worse at sunrise and sunset. The higher the frequency of operation, the greater the night effect. It may be present at distances over 20 miles when receiving 850 to 750 kilocycle stations; however, with 100 to 450 kilocycle stations, reliable bearings above 200 miles can be taken even when night effect is present. The remedies for night effect are: increase altitude, thereby increasing signal strength of direct waves; use stations operating on lower frequency; and take an average of the fluctuations.

c. Mountain effect is considered to be the reflection of radio waves from mountain surfaces. It is known to exist around Salt Lake City and Pittsburgh. Do not rely on bearings taken in such areas.

d. For aural reception of A-N signals, operate equipment on ANT. or LOOP instead of COMP., since the action of AVC in COMP. position will cause broad course indications. Always operate the equipment with AUDIO control set at lowest usable headset volume and reduce it as the A-N signal strength increases. Cone of silence indications are not always reliable when operating the equipment on LOOP. Use equipment on ANT. for cone of silence indication.

e. This equipment should provide compass bearings during conditions of moderate static which interrupt normal reception. When static becomes too severe it will be necessary to operate on LOOP position. In this position, satisfactory aural reception and aural-null direction finding will be possible most of the time.

f. Do not depend on two stations for fix of location. Use at least three stations, with bearings spaced at approximately equal intervals throughout 360 degrees, for greatest accuracy.

g. While taking bearings always keep airplane on a steady level heading.

h. When homing or direction finding on LOOP operation there is a 180 degree ambiguity, and station bearings may be 180 degrees from the null obtained. Use stations with good signal strength for sharply defined nulls. Width of null may be controlled by position of AUDIO control. The tuning meter may be used as a visual-null indicator.

SIMULTANEOUS OPERATION OF RECEIVERS.

One or more receivers may be monitored simply by advancing the associated volume or sensitivity control.

AN/APX-6—IFF EQUIPMENT.

PURPOSE.

The radar identification set AN/APX-6 is an airborne transponder and is one of several equipments which may be operated together to provide a system of electronic identification and recognition. The purposes of the AN/APX-6 are:

a. To identify the airplane in which it is installed as friendly when it is correctly challenged by an interrogator-responser associated with friendly shore, shipboard and airborne radars.

b. 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-responser, and transmits replies back to the interrogator-responser, where the replies are displayed, along with the associated radar targets, on the radar indicator. When a radar target is accompanied by a proper IFF reply, as transmitted by the AN/APX-6, that target is considered friendly.

OPERATION.

All controls required for operation of AN/APX-6 equipment are located on radar set control C-629/APX-6. This unit is located on the radio switch panel on the right console.

Operation is as follows:

a. To turn equipment on, rotate master selector to NORM.

b. To indicate emergency or distress, press red dial-stop and rotate master selector to EMERGENCY.

Note

The following is a suggested technique for right hand, rapid operation of the master switch to obtain emergency operation: grasp the knob between the knuckles of the first and second fingers, at the same time pressing the dial stop with the thumb, and rotate the switch to EMERGENCY position.

c. To maintain the equipment ready for instant use, but inoperative, rotate the master selector to STDBY.

d. The detent position labeled LOW on the MASTER selector should not be used except upon proper authorization.

e. The switches labeled MODE 2 and MODE 3 should be set to their OUT positions unless otherwise directed by proper authority.

f. To explode destructors within the equipment, raise the switch guard labeled DESTRUCT 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.

g. To secure the equipment, rotate the master selector to OFF.

h. If destructors were fired during the flight, notify your commanding officer.

AN/ARR-2A—NAVIGATION (HOMING) RECEIVER (R-4A/ARR-2).

a. On the C-738/ARR-2 control unit, set the PITCH selector switch to NAV and turn the CHAN SEL to the desired channel. Advance the SENS control to produce a usably weak signal or, if the desired signal cannot be heard, to produce a fairly strong background noise. When the signal is received adjust the PITCH control to produce a pleasing audible tone. Re-adjust the SENS control to obtain a usably weak signal. The secret of accurately interpreting navigation signals lies in using the lowest satisfactory setting of SENS control. Keep this control adjusted to receive only one character predominantly.

b. At the completion of this check, turn the SENS to minimum.

c. The volume control on the master control unit C-739/ARC does not affect the volume of the navigation receiver.

Note

When AN/ARC-27 is installed, the C-739/ARC master control is omitted. In this configuration the AN/ARR-2A equipment is connected directly to the power source and may be turned off only by opening the circuit breaker.

LIGHTING EQUIPMENT.

EXTERIOR LIGHTING SYSTEM.

The exterior lighting system receives power from the main bus and is controlled by switches grouped on the exterior lights control panel on the right console (3, figure 1-5). Toggle type selector switches with the positions BRIGHT, OFF, and DIM are provided for the formation, fuselage, tail position, and wing position lights. The master switch controls the exterior lights for manual, code flash, or steady operation, depending on switch position. A code selector switch permits automatic signaling in code with the fuselage lights. Manual signaling is accomplished by a keying switch. The flasher-coder unit performs the dual function of alternately flashing the wing position, fuselage and tail lights and automatically flashing the fuselage lights in code according to the letter selected on the code selector switch. When the exterior lights master switch is in any on position, and the wheels are down and locked, the flasher-coder will automatically flash the approach light if the arresting hook is not down. Circuit protection is afforded by two EXT. LIGHTS circuit breakers located on the main circuit breaker panel and fuses on the right console.

CONTROLS.

EXTERIOR LIGHTS CONTROL PANEL.

The exterior lights control panel is installed on the right console. The panel contains a master switch, a code selector switch, a keying switch, an indicator light, and individual light switches for selective control of the formation, fuselage, and wing position light circuits.

EXTERIOR LIGHTS MASTER SWITCH.

The exterior lights master switch is located on the exterior lights control panel and is of the rotary type, with OFF, MAN, CODE, FLASH, and STDY positions. The OFF position deenergizes all exterior light circuits. When the switch is set to STDY, all exterior lights are illuminated continuously, provided the associated light switches are turned on. Setting the master switch to FLASH permits the wing tip position lights and white tail position light to flash alternately with the fuselage lights and the yellow tail position light. The CODE position is used in conjunction with the code selector switch to flash the fuselage lights in code automatically according to the letter selected. The MAN position permits manual signaling with the fuselage lights by operating the keying switch. Visual indication of the manually keyed signal is provided by a red indicator light adjacent to the keying switch on the control panel.

CODE SELECTOR SWITCH.

The code selector switch is located on the exterior lights control panel and is used to flash out in code on the fuselage lights any one of the 12 letters of the alphabet that is selected. It is used only when the master switch is set at CODE.

CODE KEY.

This key is located on the exterior lights control panel. When the master switch is set at MAN, code messages can be tapped out on the fuselage lights by using this key, provided the fuselage lights selector switch is set to DIM or BRIGHT.

CODE KEY INDICATOR LIGHT.

The red indicator light on the exterior lights control panel flashes the signal being transmitted by the code key on the fuselage lights.

FUSELAGE LIGHTS.

The two fuselage lights are installed on the top and the bottom of the fuselage approximately midway between nose and tail. Each light contains a normal and a dimming lamp. The lights are controlled by the fuselage lights selector switch and the master switch.

FUSELAGE LIGHTS SELECTOR SWITCH.

The fuselage lights selector switch is a three position toggle switch located on the exterior lights control panel. It can be set to BRIGHT, DIM or OFF. When the master switch is set to STDY and the fuselage light selector switch is set to DIM or BRIGHT, the fuselage lights will burn continuously. When the master switch is set to FLASH and the fuselage lights selector switch is set to DIM or BRIGHT, the fuselage lights and the yellow tail position light will flash alternately with the wing position lights and white tail position light. When the master switch is set to CODE, the fuselage lights will automatically signal in code the letter selected on the code selector switch. If the master switch is set to MAN, the fuselage lights will operate in conjunction with the code key for manual signaling purposes.

WING POSITION LIGHTS.

The recessed type wing position lights are located on the leading edge of each wing tip. The right wing position light cover is green and the left is red. These lights are controlled by the wing position light selector switch and the master switch located on the exterior lights control panel.

WING POSITION LIGHTS SELECTOR SWITCH.

This three position toggle switch, which can be set to BRIGHT, DIM or OFF, is located on the exterior lights control panel. When the master switch is set to MAN, CODE, or STDY and the selector switch is set to DIM or BRIGHT, the wing position lights will burn continuously. The wing position lights and the white tail position light will flash alternately with the fuselage lights and yellow tail position light when the master switch is set to FLASH.

TAIL POSITION LIGHTS.

The tail position lights are installed on the end of the tail fairing. The upper light is fitted with a yellow cover, the lower with a white cover. These lights are controlled by the tail position selector switch and the master switch.

TAIL POSITION LIGHTS SELECTOR SWITCH.

This toggle switch can be set at any of three positions, BRIGHT, DIM or OFF, and is on the exterior lights control panel. When the tail position lights selector switch is set to BRIGHT or DIM, the tail position lights will burn continuously if the master switch is set to MAN, CODE or STDY. If the master switch is set to FLASH, the yellow tail position and fuselage lights will flash alternately with the white tail position and wing position lights.

FORMATION LIGHTS.

A white formation light is located on the underside of each outboard wing panel near the tip. The lights are controlled by the four positions of the master switch and by the formation light selector switch.

FORMATION LIGHT SELECTOR SWITCH.

The formation light control is a three position toggle switch on the exterior lights control panel with BRIGHT, DIM and OFF positions. The formation lights will burn continuously when the master switch is set to MAN, CODE, STDY or FLASH and the formation light switch is set to BRIGHT or DIM.

INTERIOR LIGHTING SYSTEM.

The interior lighting system consists of an edge lighted instrument panel, certain edge lighted console control panels, and two hooded lights on the left side of the cabin and two on the right side to illuminate the consoles. Power is supplied from the main bus and circuits are protected by two circuit breakers on the main circuit breaker panel (1, figure 1-5) and two fuses mounted on the fuse panel (9, figure 1-5). The interior lighting system is controlled by two rotary switches (34 and 40, figure 1-5) on the right console.

INTERIOR LIGHTS CONTROL SWITCHES.

The instrument panel edge lighting is controlled by a combination on-off switch and rheostat mounted on the right console. The edge lighted console control panels and console lights are controlled by a switch identical to the instrument panel edge lighting switch and mounted adjacent to it. Turning the switches clockwise from off turns on the respective lights and provides a range of adjustment from dim to bright.

SPARE LAMPS.

Spare lamps are mounted on a panel on the right console (25, figure 1-5).

OXYGEN SYSTEM.

DESCRIPTION.

Two 514 cu in. capacity shatter-proof oxygen cylinders are installed in brackets on the bulkhead aft of the cabin. The cylinder valves are opened when connected to the line coupling, and flow is controlled by the regulator. The diluter-demand pressure breathing regulator, with oxygen supply shut-off valve, diluter valve control, flow indicator and system pressure gage, is installed on the left console forward of the throttle quadrant. The feed tube from the regulator runs to a personal gear composite disconnect on the aft end of the console, and a face mask attaches to the tube from the assembly (1, 17, figure 1-3).

OXYGEN REGULATOR OPERATION.

The automatic pressure breathing diluter-demand regulator is designed to meet the demands of the inhalation phase of the breathing cycle and deliver either a properly proportioned mixture of air and oxygen or 100% oxygen, dependent upon the setting of the adjustable diluter valve lever. With the diluter valve set to the NORMAL OXYGEN position, air is drawn into the breathing system and is automatically mixed with oxygen from the supply cylinder to give the total needed oxygen reuired up to approximately 30000 feet, beyond which 100% oxygen is delivered. With the diluter valve set to the 100% OXYGEN position, 100% oxygen is delivered at all altitudes. Above 35000 feet cabin pressure, the regulator automatically delivers to the mask the required positive pressures of oxygen for operational flights up to an equivalent cabin pressure of 43000 feet and may be used for short periods of time at an equivalent cabin pressure of 45000 feet. In addition, sufficient pressure is delivered automatically for emergency descent from 50000 feet in the event that pressurization is lost and the cabin pressure is reduced to that of the surrounding air. With the diluter valve set to the NORMAL OXYGEN position, a relatively small inhalation suction (one inch of water suction) is sufficient to deliver a flow of 150 liters of oxygen per minute. This characteristic assures the user an adequate oxygen flow and ease of breathing. The regulator is attached directly to the high pressure oxygen supply through tubing connected to the cylinders. The pressure in the cylinders may decrease from 1800 psi to 50 psi without affecting the normal operation of the regulator.

OXYGEN PREFLIGHT CHECK.

Check the following items prior to a flight in which oxygen is to be used or is likely to be used, in order to assure proper functioning of the system:

a. After the oxygen supply control at the regulator has been turned on, oxygen supply cylinder pressure

Oxygen Duration - Hours

CABIN PRESSURE ALTITUDE	5000 feet	10000 feet	15000 feet	20000 feet	25000 feet	30000 feet	35000 feet	40000 feet
Hours Duration Using Diluted Oxygen	15	18.5	17	13.8	8	6.2	8.4	13.8
Hours Duration Using 100% Oxygen	1.5	2.4	2.9	3.8	4.6	6	8.4	13.8

From T.N. 94-45

Figure 4-4. Oxygen Duration Chart

should read 1800 to 1850 psi if the cylinders are fully charged. If the cylinder pressure has decreased by more than 50 pounds in 24 hours, the leakage is excessive and the system should be subjected to ground crew test prior to use.

b. To test the breathing tube couplings, regulator diaphragm, and diluter check valve for leakage by inserting a spare mask tube quick disconnect fitting into the open end of the disconnect. Blow into the open end of the disconnect until the flow indicator face opens. Seal the end of the disconnect with the tongue. If the flow indicator does not close within five seconds, the leakage is within acceptable limits. If leakage exists, check the couplings, outlet elbow and breathing tube hose clamps for tightness.

c. Put on face mask. Check mask fit by placing the thumb over the disconnect at the end of the breathing tube and inhaling lightly. The thumb must be removed from the disconnect after each continuous inhalation. If there is no leakage, the mask will adhere to the face tightly and a definite resistance to inhalation will be encountered. If the mask leaks, tighten the mask suspension straps.

WARNING

Do not use a mask that leaks.

d. Fully engage mating portion of the disconnect coupling to connect mask to the oxygen system breathing tube.

e. Attach clip of breathing tube to proximate strap of shoulder harness sufficiently high on the chest to permit free movement of the head without stretching the mask tube.

f. Breathe several times and observe flow indicator for blink, verifying the positive flow of oxygen.

OXYGEN SYSTEM OPERATING INSTRUCTIONS.

a. Oxygen shall be used constantly during day flights when above 10000 feet and during night flights when above 5000 feet and when on combat missions and training missions simulating combat.

b. After making certain that oxygen supply control lever is turned to open supply to regulator, see that pressure gage reads approximately 1800 psi for fully charged cylinders.

c. Set diluter valve to NORMAL OXYGEN for normal flight conditions. Only when the presence of carbon monoxide or other noxious gases (such as fumes) is suspected, should diluter valve be set to 100% OXYGEN.

d. Put on the oxygen mask, fully engaging disconnect coupling. Attach clip of breathing tube to proximate strap of shoulder harness sufficiently high on the chest to permit free movement of the head without stretching the mask tube.

e. To check mask fit during flight, turn the safety pressure control to PRESSURE ON. Take a deep breath and hold breath. Note position of the oxygen flow indicator. If flow indicator opens (i.e., all black), excessive leakage is indicated. Tighten mask straps until flow indicator closes (i.e., white face shows), indicating that a leak-tight mask seal has been obtained. The characteristics of the flow indicator are such that this test cannot be conducted at pressure breathing altitudes; however, the outward flow of oxygen into the eyes from a leaking mask is readily detectable and is an equally sensitive test.

f. Breathe normally.

g. Check cylinder pressure gage frequently for amount of oxygen remaining.

h. Check oxygen flow indicator frequently for flow of oxygen through the regulator. The oxygen flow indicator operates upon the intermittent application of from five to seven inches of water pressure created by the flow of oxygen. The automatic pressure breathing oxygen regulator delivers a pressure of five to seven inches of water to the mask at approximately 41000 feet and this pressure is likewise transmitted to the oxygen flow indicator, which will remain open as long as this pressure is applied. Accordingly, the flow indicator will not blink above this loading; however, the positive pressure in the mask is an unmistakable indication that oxygen is being delivered to the mask and no apprehension should be felt as long as the flow indicator remains open.

Note

Do not exhaust supply cylinders below 300 psi except in an emergency.

EMERGENCY OXYGEN SYSTEM OPERATION.

Should symptoms occur suggestive of the onset of anoxia, immediately turn the safety pressure control on the rim of the regulator to PRESSURE ON and descend below 10000 feet.

WARNING

If regulator becomes inoperative in flight, activate emergency oxygen supply equipment, and descend below 10000 feet.

Whenever excessive carbon monoxide or other noxious or irritating gas is present or suspected, the diluter valve should be set at 100% OXYGEN regardless of the altitude, and undiluted oxygen used until danger is past or flight completed. Should brief removal of mask from the face be necessary at high altitudes, use the following procedure:

a. Take three or four deep breaths of undiluted oxygen (diluter valve set at 100% OXYGEN).

b. Hold breath and remove mask from face.

c. As soon as practicable, replace mask to face and take three or four deep breaths of undiluted oxygen.

d. Reset diluter valve to NORMAL OXYGEN.

Above 35000 feet cabin altitude, the regulator automatically delivers to the mask the required positive pressures of oxygen for operational flights up to an equivalent cabin pressure of 43000 feet and may be used for short periods of time at an equivalent cabin pressure of 45000 feet. In addition, sufficient pressure is delivered automatically for emergency descent from 50000 feet in the event that pressurization is lost and the cabin pressure is reduced to that of the surrounding air.

NAVIGATION EQUIPMENT.

ELECTRONIC NAVIGATION EQUIPMENT.

RADIO COMPASS AND NAVIGATION (HOMING) RECEIVER.

See applicable paragraphs under Electronic Equipment.

NAVIGATION INSTRUMENTS.

STAND-BY COMPASS.

See Instruments paragraph, Section I.

G-2 COMPASS.

See Instruments paragraph, Section I, for description.

OPERATION.

a. Set battery switch to BAT. & GEN.

b. Allow sufficient time for the gyro motor to warm up, then set the control switch to COMPASS CONTROL.

c. Push in and rotate the caging knob to establish the initial "on course" heading obtained from the correspondence indicator, then pull out the knob. The instrument will now correct any deviation from the magnetic heading, as shown by the correspondence indicator, at a rate of four degrees per minute.

CAUTION

To ensure proper alignment of the gyro element, it is important that the knob be held firmly against the cover flange while it is being rotated and also for a few seconds after the correct setting has been made. Release the knob straight out—with no twisting movement.

d. When operating near polar regions or on a carrier deck, the instrument should be used as a free directional gyro; to so use, set control switch to FREE DG.

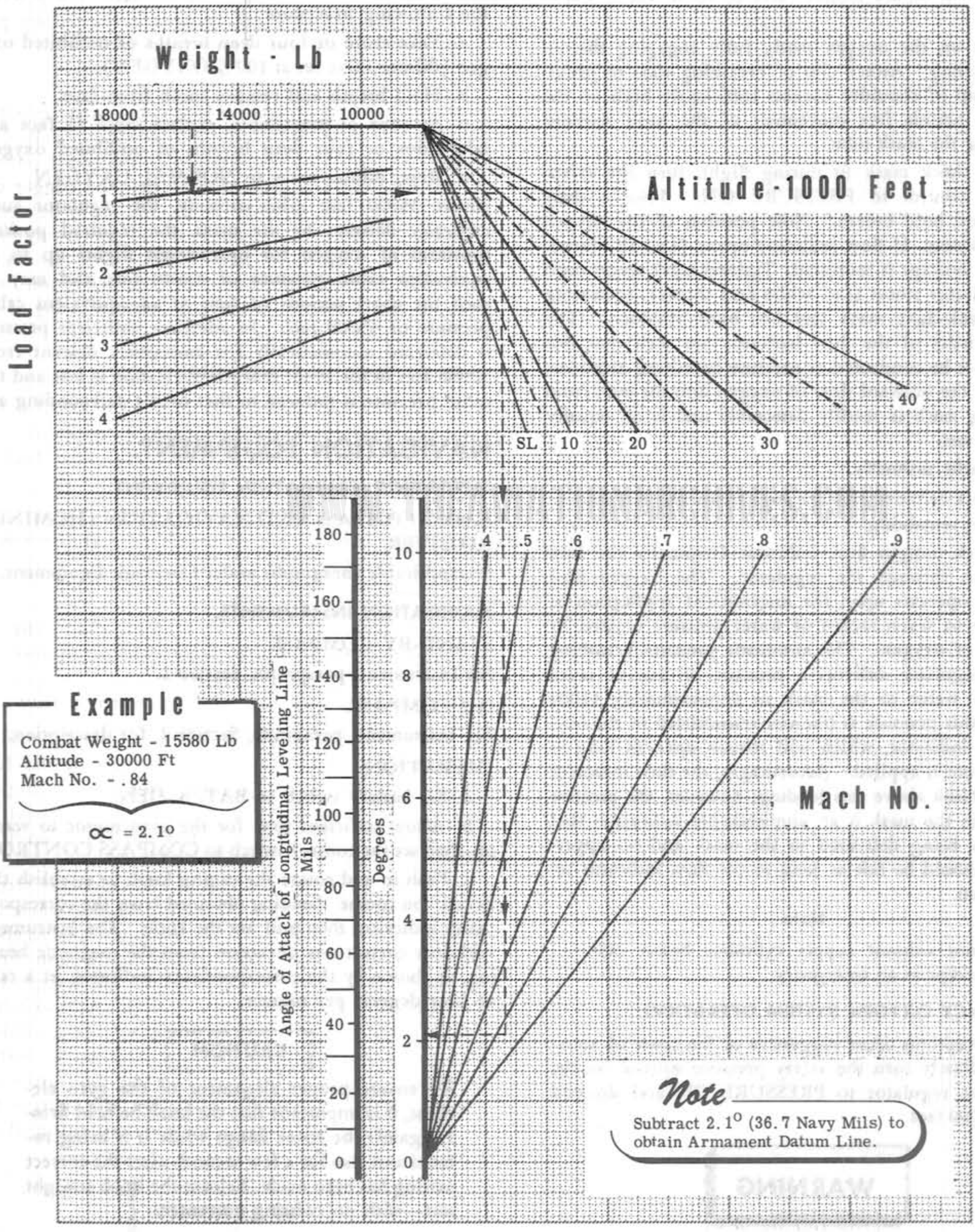


Figure 4-5. Angle of Attack Variation with Speed, Weight and Normal Acceleration

e. To return to compass controlled operation from a free directional gyro, set the control switch to COMPASS CONTROL, then push in the caging knob and reset the master direction indicator to the heading indicated by the correspondence indicator.

CAUTION

Always operate the selector switch before setting the heading with the caging knob, otherwise the instrument will be damaged.

If the difference between the correspondence indicator reading and the gyro reading is great, several minutes will be required before complete correction of the instrument will take place. To eliminate this delay, the gyro and correspondence indicator may be synchronized by turning the caging knob. Caging is not required during maneuvers.

ARMAMENT.

Four M-3 20mm guns are installed in the fuselage nose. Ammunition is loaded in four ammunition boxes connected to the guns by feed chutes. An Aero 5A armament control system is installed and an AN-N-6A gun camera is mounted on the windshield deck. Armor plate is installed on the bulkhead forward of the pilot's seat, and on the sloping bulkhead aft of the seat. The bullet resistant glass windshield is mounted in a heavy aluminum alloy plate frame.

Note

On flights in which no ammunition or ammunition for only two guns is loaded, ballast must be installed in order to maintain airplane cg within the aft limit at low fuel loads. This ballast is provided for the airplane by the contractor and is stowed in the forward (inboard guns) ammunition boxes. On flights in which full ammunition for all guns is loaded, the cases and links from fired rounds are retained in the nose shell, thereby maintaining the cg within proper limits.

GUN CONTROLS.

The trigger switch (14, figure 1-6) is on the front of the stick grip. The four gun chargers are controlled by a four way solenoid operated valve and pressure switches which, in turn, are controlled by two toggle switches (8, 9, figure 1-4) on the armament switch panel located on the windshield deck to the left of the sight unit. These switches control the inboard and outboard guns respectively, and have positions marked READY-OFF-SAFE. The armament master toggle switch is outboard of the other switches on the armament switch panel (7, figure 1-4).

GUN CONTROLS OPERATION.

READY SETTING.

When either the inboard or outboard guns are selected for firing, set the master switch to ON, set the applicable READY-OFF-SAFE switch to SAFE and then set it back to READY. This operation will permit hydraulic pressure to act on the charger pistons, which retract the breechblocks to the seared position. After the breechblocks have been seared, the fluid on the forward side of the piston in the cylinders returns to the reservoir and the gun charger piston returns to the battery position, rendering the guns ready for firing.

SAFE SETTING.

When either READY-OFF-SAFE switch is set to SAFE, the respective breechblocks are moved automatically from battery to recoil and are retained in the recoil position by the sear and charger action so that the trigger controls will not operate even if the trigger is depressed. The breechblocks will remain in recoil, preventing firing until either switch is set to READY, which releases the hydraulic pressure and permits the charger piston to return to the battery position and permits firing if the trigger button is pressed.

GUN OPERATING PROCEDURE.

a. Set armament master switch to ON.

b. Set selected READY-OFF-SAFE (outboard, inboard, or both) switch to SAFE and then back to READY for firing.

c. Press trigger button on stick grip.

d. After firing, return READY-OFF-SAFE switch, or switches, to SAFE.

Note

To operate the guns for ground check, the disabling switch on the right side of the nose wheel well must be set to energize the gun circuit which is normally broken when the landing gear control handle is at DOWN.

In order to ensure that the gun charger lug has fully returned to the battery position prior to actuating the trigger button for firing of the guns, the electrical circuit between the trigger button and the gun-firing solenoid remains open until the hydraulic pressure in the gun charging cylinder drops to the low pressure setting on the pressure switch. At high altitudes where the temperature is −40°C (−40°F) or lower it takes about three seconds to close the circuit to the gun firing solenoid. Whenever the pilot presses the trigger button after actuation of the READY-OFF-SAFE switch to READY and the guns fail to fire, it may be an indication that the charger lug has not returned to battery position. If such is the case, keeping the button depressed for several seconds will allow the charger lug to return to the battery position and start firing of the guns.

WARNING

The guns will be operative when switch is set to READY.

ARMAMENT CONTROL SYSTEM—AERO 5A.

The ACS Aero 5A comprises a sight unit MK 8 Mod 0 (a part of AFCS MK 6 Mod 0) mounted on a bracket on the cowl center line (10, figure 1-4), an Aero 2C gunsight controller located below the sight, a MK 20 Mod 0 control box on the left console (5, figure 1-3), an Aero 4C ranging control (the throttle grip) (34, figure 1-3), a MK 7 Mod 0 relay box, a radar range servo Aero 1A and an Automatic-Range-Only (ARO) radar set AN/APG-30. The radar set control C-775/APG-30 is located on the left console (7, figure 1-3) adjacent to the MK 20 Mod 0 control, and the ID-295/APG-30 tracking indicator is mounted on a bracket (11, figure 1-4) attached to the sight unit MK 8 Mod 0. This unit contains a red tracking indicator light, a range meter and an automatic frequency control meter. The red tracking indicator light will flash on while the radar is searching for a target or is radiating signals that might be detected by enemy countermeasures, and will go out when the radar has locked on a target. The range meter indicates the range of the target in feet, and the automatic frequency control meter measures crystal current in milliamperes. The latter instrument is used to check that the system is operating properly.

CAUTION

The RANGE and AFC meter dials have been rotated 90° from the normal positions to eliminate magnetic interference with the stand-by compass.

With this system, the pilot's problem is simplified to one of aiming the aircraft so that the gyro reticle image remains on the target, and following the sight line to the target until the attack has been completed. Radar set AN/APG-30 is designed for use only in air-to-air tactics. On certain airplanes,[1] an armament selector panel is installed on the left console. This panel contains a two position guns and rockets selector switch marked GUNS and ROCKETS, a two position dive angle selector switch marked 35° & OVER and 35° & UNDER, a three position rocket arming switch marked ARMING NOSE & TAIL, SAFE and TAIL ONLY, and a three position, rotary type rocket station selector switch marked LEFT, RIGHT and BOTH.

SYSTEM CHECK.

a. Set battery switch to BAT. & GEN.

b. Set power switch on C-775/APG-30 control to STDBY MAN. Check that amber light is on.

Note

Placing the radar in STDBY MAN. permits it to warm up and also permits manual ranging of the fire control system.

c. Rotate selector switch on MK 20 Mod 0 control to GYRO. The gyro motor should then start to run, and the gyro reticle image should appear on the reflector plate of the sight unit. The image should stabilize quickly and be clearly defined.

d. Rotate the selector switch to FIXED & GYRO and note that the fixed image of the sight unit is visible.

e. Rotate dimmer control knob on the MK 20 Mod 0 control from DIM to BRIGHT, noting that the dimmer control varies the intensity of the images continuously over the entire range.

f. Rotate the selector switch to the FIXED position. The gyro image should then disappear and the gyro motor come to a gradual stop.

g. Return the selector switch to the FIXED & GYRO position and rotate the throttle grip (ranging control) to its counterclockwise stop, then hold. The range scale in the sight unit should indicate 600 feet.

h. Note diameter of circle formed by the diamond-shaped pips of the gyro image, then rotate throttle grip full clockwise. The range scale in the sight unit should now indicate 2400 feet and the diameter of the circle should be smaller.

Note

Step i. below applies only if AN/APG-30 radar equipment is not being used.

i. Move the target span handle on the sight unit from right to left toward the higher setting on the span scale. The diamond-shaped pips should then move out from the center pip of the gyro image. The sight line through the center pip of the gyro reticle should be the same as that through the fixed reticle.

j. Set the guns and rockets selector switch to GUNS.

k. Sight on a distant object. Both the fixed and gyro images should appear to coincide on the object. Rotate ranging throttle grip from maximum to minimum range. The center pip of the gyro image should remain stationary. A slight vertical movement of the center pip may be found in some sight units when range is changed from maximum to minimum. This is acceptable if the total movement does not exceed four mils (this may be estimated by comparison with the ten mil arcs of the fixed images), and if the center pip coincides with the center of the fixed cross at some range between maximum and minimum.

l. Set the guns and rockets selector switch to ROCKETS.

m. Set the dive angle switch to 35° & UNDER. The center pip of the gyro image should move to a point which corresponds to the offset value specified for rocket dive angles from 15 to 35 degrees. The ten mil arcs of the fixed image may be used to gage the amount of offset from the center of the fixed cross.

n. Set the dive angle switch to 35° & OVER. The center pip should move to a point which corresponds to the offset value for rocket dive angles from 35 to 60 degrees. Check the caging circuit by changing the position

[1] Airplanes ser No. 130780 and subsequent.

of the dive angle switch while watching the pip. With the caging switch closed (throttle grip at extreme maximum range position), the pip should move to its new position. With the caging switch open, the movement should be slow.

o. If the flight is to begin immediately, leave the selector at the FIXED & GYRO setting; otherwise, return the switch to the OFF position.

p. When the AFC meter on the ID-295/APG-30 stops sweeping and drops to zero, place the power switch on the C-775/APG-30 control to ON. The AFC meter will jump to a reading between 0.5 and 1.0 ma and will hold steady. Check to see that the green light on the control is on. The ID-295/APG-30 tracking indicator will flash on while the radar is searching a target in range, and will go out when the radar has locked on a target.

Note

When the power switch on the C-775/APG-30 control is set to STDBY MAN during warm-up (approximately four minutes), the RANGE meter on the ID-295/APG-30 tracking indicator will sweep and the AFC meter will jitter. After warm-up is completed, there should be no movement on the RANGE or AFC meters. The AFC meter should indicate crystal current from 0.5 to 1.0 ma, with .7 ma desired. When the power switch is set to ON, the RANGE meter will sweep until locked on a target. When locked on, the meter will indicate target range in feet.

The radar will lock on the nearest target within its range and show distance to the target on the sight unit range scale up to 2400 feet, and up to 12000 feet on the ID-295/APG-30. Depressing the range gates switch to GATES OUT will cause the radar to unlock from this target and select another target farther away. If no other target is within the maximum range of the radar, it will sweep to its limit and again select the closest target within its range. Also note movement of the diamond shaped pips as targets at different ranges are selected.

Note

The radar range exceeds the sight unit range; therefore, the range scale on the sight unit will indicate 2400 feet for all targets beyond this range. The range meter on the ID-295/APG-30 will indicate target range continuously.

FLIGHT ADJUSTMENTS.

To use the system accurately and most effectively at the beginning of the flight:

a. On C-775/APG-30 control set power switch to STDBY MAN.

b. On MK 20 Mod 0 control turn selector switch to FIXED & GYRO if desired to see both image patterns; however, if they are confusing, setting selector to GYRO will eliminate the fixed image, or the outer markings of the fixed image can be blanked out by pushing the masking lever forward.

c. Adjust dimmer control knob on MK 20 Mod 0 control until reticle image is at desired brilliance.

d. As soon as the target is sighted, turn power switch on C-775/APG-30 control to ON. If AN/APG-30 radar equipment is not being used, set the target span into the sight unit with the span setting handle (C-775/APG-30 in STDBY MAN). This setting will be a selected dimension of the target aircraft, usually its wing span in feet.

WARNING

When no target is in view, keep the power switch in STDBY MAN. Otherwise, radiation of the radar transmitter may give your position away to enemy countermeasures.

Note

Adjustment of target span handle is required only when manual ranging is used.

e. Since the ACS Aero 5A does not compensate for gravity drop, it is necessary to make an allowance of about 16 feet (7 mils) at 2400 feet range, decreasing to about one foot (2 mils) at 600 feet.

Note

The maximum range control on the C-775/APG-30 control is used to adjust the maximum range of the radar. The proper setting of this control will depend on the altitude of the aircraft and should be adjusted so that the radar will not lock on ground reflections.

With control set at minimum, the radar range will still be more than the sight unit range. In normal operation at altitudes over 10000 feet the maximum range control may be left at the full clockwise position to allow locking on a target at maximum range.

When there is more than one target close to the radar line of sight, the desired target may be selected by operating the range gates switch to GATES OUT and noting the change in range shown on the ID-295/APG-30. When the targets are within range of the sight unit (2400 feet), note the change in diameter of the diamond-shaped pips.

Commence tracking by maneuvering the aircraft to bring the center pip exactly above the target by an amount necessary to compensate for gravity drop.

When Aircraft Armament Change No. 77 is accomplished on the Radar Range Aero 1A, the pilot may uncage the gyro in the sight unit any time he desires to do so, independent of radar lock-on, by rotating the throttle grip at least 20 degrees out of it detent position. This rotation of the throttle grip when using radar ranging in no way affects the range being fed to the sight unit from the radar. All it does is to uncage the sight unit at the pilot's discretion. The pilot should uncage as soon as possible and establish smooth tracking on the target. The radar will probably lock on in excess of 4000 feet. The sight unit will have a 2400 foot sensitivity from the time of uncaging to 2400 feet. When the range decreases to 2400 feet, the sight will already have solved for the proper lead angle if tracking is commenced at least one second before reaching 2400 feet. The red light in the ID-295/APG-30 will go out when the radar is locked on the target. If the pilot should forget to uncage the sight unit before reaching 2400 feet, the sight unit will automatically uncage at 2400 feet. However, in this case one second of tracking will be necessary before the sight unit generates the proper lead angle. It is therefore always advantageous to uncage the sight unit at least one second before reaching 2400 foot range. When the diamond-shaped pips in the sight unit begin to expand, the range is 2400 feet. Firing may be commenced at this point. When the range decreases to 600 feet the diamond-shaped pips will cease to expand. Since the sight unit will not compute the proper lead below 600 feet, pull-out should commence at or before this point. In addition, the AN/APG-30 radar will probably lose its lock-on at a range of about 675 feet. When this occurs, the sight unit diamond-shaped pips will contract to the 800 yard point. The sight unit will no longer be computing the proper lead.

f. Manual ranging may be selected by turning the power switch on the C-775/APG-30 control to STDBY MAN. After setting the estimated wing span of the target, in feet, into the sight head by means of moving the target span lever to the appropriate number, track during the run by continuously rotating the throttle grip, so as to keep the extreme tips of the target framed by the imaginary circle formed by the inner points of the pips of the gyro reticle image.

Note

On the average aircraft the distance from the junction of the wing root to the end of the tail is half a wing span. At 90 degrees off the tail of the target, ranging is accomplished by keeping the inside tip of one of the pips on the end of the tail of the target and the center pip of the reticle pattern just above the wing root fuselage junction.

During manual ranging, the gyro will remain caged as long as the throttle grip is at the maximum range position (fully clockwise). If tracking is to be started before the target is within range, uncage the gyro by rotating the control slightly counterclockwise.

g. Continue smooth tracking and ranging throughout the attack.

Note

In order to prevent the sight unit gyro from tumbling, it is recommended that the gyro be caged at all times except when tracking and ranging a target.

GUN CAMERA.

The AN-N-6A camera is mounted on a bracket on the windshield deck, forward of the sight unit. Operation is controlled by the armament master switch and the trigger switch on the stick grip. When the guns are fired, the camera operates. The camera may be operated without firing the guns by placing the ready-off-safe switch in either the OFF or SAFE position and depressing the trigger switch, or by use of a test switch located on the windshield deck.

ROCKET AND BOMB PROVISIONS.[1]

ROCKET CONTROLS.

The rocket firing push button switch is on the side of the control stick grip (17, figure 1-6). The guns and rockets selector two position toggle switch, the dive angle selector two position toggle switch, and the rockets (or bombs) station selector four position rotary switch are mounted on a panel on the left console. The guns and rockets selector switch is marked GUNS and ROCKETS. The dive angle selector switch is marked 35° & OVER and 35° & UNDER. The station selector switch is marked SAFE, LEFT, RIGHT and BOTH.

ROCKET FIRING OPERATION USING ACS AERO 5A.

To use the ACS Aero 5A as a lead-computing sight when engaging in air-to-ground rocket operations, proceed as follows:

a. On the MK 20 Mod 0 control panel, set the selector switch to GYRO or FIXED & GYRO position and adjust the dimmer control to provide the proper reticle image contrast for the particular light condition.

b. Set guns and rockets selector switch to ROCKETS.

c. Set dive angle selector switch to 35° & OVER if a steep dive approach to the target is desired, or to 35° & UNDER if a dive angle of 35 degrees or less is best suited for the operation.

d. Set armament master switch to ON.

e. Set station selector switch to LEFT, RIGHT or BOTH, as operation requires.

Note

Setting this switch to SAFE prevents firing the rockets inadvertently.

f. Cage gyro in sight unit by rotating ranging throttle grip to the extreme maximum range position.

g. When the target is approached, control the airplane so that the center pip of the gyro image is directly on the target.

Note

The system will compensate for windage and target motion as long as the pilot maneuvers the airplane so as to keep the pip on the target. For accurately aiming rockets, it is essential that the pip be held on the target smoothly from the time the approach is initiated until the rockets are released. It is not necessary to range the target by framing it when using the equipment as a lead-computing sight for rocket firing operations.

[1]Airplanes ser No. 130780 and subsequent.

h. Uncage the gyro by rotating the ranging throttle grip slightly from the extreme maximum range position.

i. After uncaging the gyro, hold the pip on the target smoothly for at least four seconds before firing the rockets.

j. Press rocket firing switch on control stick grip to fire rockets.

BOMB CONTROLS.

The station selector switch described in the Rocket Controls paragraph is used in bombing operations, together with a bomb release push button switch on the control stick grip (15, figure 1-6) and an arming selector switch on the left console. The arming selector switch has two positions marked ARMING NOSE & TAIL and TAIL ONLY.

BOMB RELEASE OPERATION.

a. Set armament master switch to ON.

b. Set arming selector switch to ARMING NOSE & TAIL or TAIL ONLY, as operation requires.

c. Set station selector switch to LEFT, RIGHT or BOTH, as operation requires.

d. Press bomb release switch on control stick grip to release bombs.

BOMBS AND ROCKETS ELECTRIC JETTISON CONTROL.

The bombs or rockets may be jettisoned in an emergency by means of the stores jettison switch on the armament control panel, located on the windshield deck. To release any stores, raise guard and move toggle switch up.

BOMBS AND ROCKETS HYDRAULIC JETTISON CONTROL.

In the event stores cannot be jettisoned by the electric jettison control switch, an emergency hydraulic jettison system is provided. This consists of a "T" handle control, located on the left console, which is pulled aft to actuate a master hydraulic cylinder. Hydraulic pressure from the master cylinder is directed to two slave units (one on each bomb rack) to actuate the stores release mechanisms on the bomb racks.

Note

This hydraulic system is independent of the airplane's hydraulic system.

ANTI-"G" SUIT EQUIPMENT.

The anti-"G" suit tube is in the personal gear composite disconnect, aft on the left console. The anti-"G" valve, outboard of the tube, has a selective feature which permits pilot selection of either high or low anti-"G" suit inflation pressure as individual pilot requirements dictate. Rotate valve cap counterclockwise for a high suit inflation pressure and clockwise for low suit inflation pressure. On the top of the valve cap is a button which can be manually depressed to inflate anti-"G" suit at any time for checking valve operation or to reduce pilot fatigue (2, figure 1-3).

MISCELLANEOUS.

Chartboard stowage is provided on the right side of the cabin, outboard of the fuse panel. To stow the board, rotate the latch below the cabin rail, set the board in place in the channel just above the fuse panel and rotate the latch to secure the board in position. To remove the board for use, rotate the latch and lift out the board. The map case is located at the aft inboard end of the right console. The relief tube is stowed on the control stick. A personal gear composite disconnect, with connections for oxygen, anti-"G" suit, radio and pilot's suit heat, is installed on the left console.

SECTION V

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Section V OPERATING LIMITATIONS

OPERATING LIMITATIONS.

The pilot should take cognizance of the operating limitations indicated by the instrument dial markings in figure 5-1. The operating limitations indicated by some of these instruments are not repeated in the text of this handbook. Discussions of engine, airspeed and acceleration limitations are included in this section.

ENGINE LIMITATIONS.

See figure 5-3 for engine operating limitations.

AIRSPEED LIMITATIONS.

Except as otherwise limited in steps f. and g., below, the maximum permissible indicated airspeeds are:

a. With landing gear retracted, flaps up, and flying in smooth air, as shown in figure 5-2.

b. In moderate turbulence 480 knots

CAUTION

In severe turbulence, speeds in the range from 230 knots to 350 knots IAS are recommended.

c. With landing gear extended 220 knots

d. With flaps extended 200 knots

e. With canopy open 220 knots

f. With external stores:

10000 feet and below	400 knots
20000 feet	325 knots
30000 feet	260 knots
40000 feet	210 knots

g. Certain airplanes[1] are restricted to airspeeds listed below until flaperette downlocks and flaperette cylinder spring return mechanisms are installed by F9F Aircraft Service Change No. 216.

Altitude	*Indicated Airspeed*
Sea level	540 knots
10000 feet	495 knots
20000 feet	430 knots
30000 feet	355 knots
40000 feet	285 knots

ACCELERATION LIMITATIONS.

a. Except as otherwise limited in steps b., c., and d. below, the maximum permissible accelerations for flight

[1]Airplanes ser No. 130752 through 130758.

ACCELEROMETER

-2 G Maximum at 15800 Pounds Gross Weight

6-1/2 G Maximum at 15800 Pounds Gross Weight

HYDRAULIC SYSTEM PRESSURE GAGE

1400 - 1500 psi Normal

AIRSPEED INDICATOR

This instrument is set so that above 20000 feet the red and white pointer will move to indicate the limiting structural airspeeds corresponding to a true Mach No. of .97. Below 20000 feet the red and white pointer will remain at 430 knots and the Flight Operating Strength Diagram, figure 5-2 shall be consulted for the correct limit airspeeds to be observed at Sea Level and 10000 feet.

200 Knots - Flaps Lowered
(220 Knots - Landing Gear Lowered)

Figure 5-1. Instrument Markings (Sheet 1 of 2)

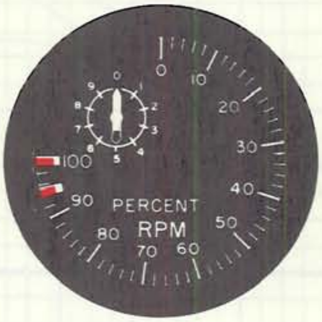
FUEL GRADE AVGAS, JP-3 OR JP-4

OIL PRESSURE INDICATOR

OIL PRESSURE	AMBIENT TEMPERATURE	ENGINE SPEED
7-50 psi	-17°C to -1°C	75% RPM or above (after-warm-up)
7-45 psi	-1°C to 15°C	75% RPM or above
7-40 psi	Above 15°C	75% RPM or above

2 psi Minimum Idle

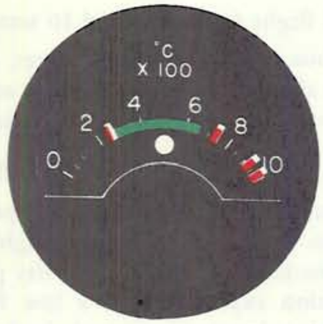
TACHOMETER



100% RPM Maximum Allowable

94.8% RPM Maximum Allowable for Continuous Operation

TAILPIPE TEMPERATURE INDICATOR



260°C - 657°C Continuous Operation (94.8% RPM Max)

260°C Minimum Allowable

732°C Maximum Allowable

Take-off or Military Thrust at 100% RPM (Limited to 30 Minutes)

913°C Maximum for Starting and Acceleration

980°C Severe Hot Start

Warning

If Tailpipe Temperature Indicator is equipped with a Limiting Pointer, it must be set at 980°C.

Figure 5-1. Instrument Markings (Sheet 2 of 2)

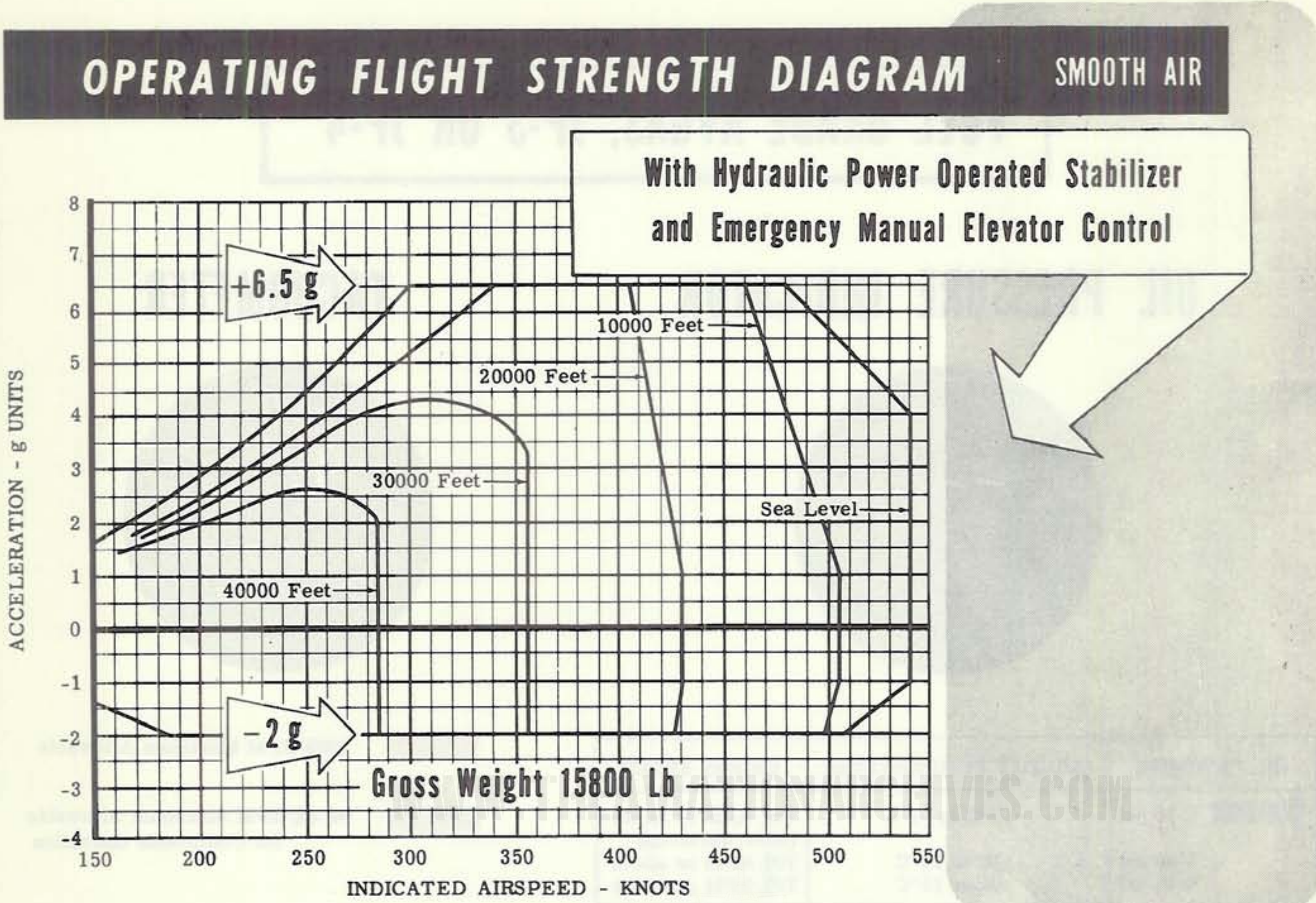


Figure 5-2. Operating Flight Strength Diagram

in smooth air at gross weights of 15800 pounds or less are as shown in figure 5-2.

b. In moderate turbulence at gross weights of 15800 pounds or less, the maximum permissible acceleration is 4.5g.

c. As gross weights are increased above 15800 pounds, the permissible accelerations decrease. To determine the maximum permissible accelerations at gross weights in excess of 15800 pounds, multiply the accelerations permitted for a gross weight of 15800 pounds by the ratio of 15800 pounds to the new gross weight.

d. When carrying external stores, the maximum permissible acceleration is 3g.

MANEUVERING FLIGHT LIMITATIONS.

a. Symmetrical and rolling pull-outs into accelerated stalls and buffet boundaries must be approached with caution to avoid wing dropping tendencies in accelerated stalls and pitch-up in the buffet boundary. Large, abrupt flaperon deflections should be avoided because of a sudden increase in acceleration (2 to 3g) resulting from such deflections.

b. The following maneuvers are permitted (all others are prohibited).

Loop
Flaperon roll
Wingover
Immelman turn
Chandelle
Inverted flight (not to exceed 10 seconds)

c. When carrying external stores, do not move flight controls abruptly. Avoid slipping and skidding. Keep rolling velocities low. Avoid buffeting.

CENTER OF GRAVITY LIMITATIONS.

The most forward center of gravity position occurs at the maximum field take-off gross weight minus wing tank fuel. The aftmost center of gravity position occurs with ammunition expended and a low fuel supply. After ammunition has been expended, the center of gravity moves progressively farther aft as fuel in the fuselage tanks is depleted, and longitudinal control becomes more sensitive, requiring greater care to avoid overcontrolling. Forward cg limit for all operations is 24% MAC. Aft cg limit for carrier operation and field carrier landing practice is 30% MAC (500 pounds fuel remaining). Aft cg limit for land based operation is 31% MAC (500 pounds fuel remaining).

ENGINE OPERATING LIMITATIONS - J33-A-16A

OPERATING CONDITIONS	RPM (Percent)	MAXIMUM ALLOWABLE TAILPIPE TEMPERATURE (Degrees Centigrade)	TIME LIMIT (Minutes)	OIL PRESSURE (PSI)	
				MINIMUM	NORMAL
Military Thrust	100	732	30	7	
Max Continuous Thrust	94.8	657	None	7	(See Note 1)
Static	100	(See Note 5)	5	7	
Idle (Sea Level)	31-32	657		2	

Note

1. Oil Pressure Limits:

-17°C to -1°C	75% rpm or above (after warm-up)	7-50 psi
-1°C to 15°C	75% rpm or above	7-45 psi
Above 15°C	75% rpm or above	7-40 psi

   Maximum oil pressure gage fluctuation - 3 psi.
   These engines use oil Spec MIL-O-6081, grade 1010.
2. Tailpipe temperature should not exceed 913°C (1675°F) during starting or acceleration.
3. These engines can use either AVGAS Spec MIL-F-5572, any grade, or JP-3 or JP-4 fuel Spec MIL-F-5624A.
4. Idling RPM increases with altitude.
5. Determine the number of thermocouples installed by visual inspection of tailpipe.
6. Tailpipe Temperature vs Ambient Air Temperature at 100% RPM:

Ambient Air Temperature (°F)	Tailpipe Temperature (°C) 3 Thermocouple System		7 Thermocouple E.G.T. System	
	Max	Min	Max	Min
110	705	693	702	691
105	703	691	700	689
100	701	689	699	687
95	700	687	697	686
90	698	686	695	684
85	698	685	694	683
80	697	685	693	682
75	697	685	693	682
70	697	685	692	681
65	698	686	692	680
60	699	687	691	680
55	700	688	691	680
50	702	690	691	680
45	704	692	691	680
40	706	694	691	680
35	708	696	691	680
30	710	698	691	680
25	712	700	692	680
20	713	702	692	681
15	716	705	693	682
10	718	707	693	682
5	721	710	694	683
0	723	712	695	684
-5	726	715	696	685
-10	728	718	697	686
-15	732	721	698	687
-20	732	723	699	688
-25	732	726	700	689
-30	732	730	701	690

Figure 5-3. Engine Operating Limitations Table

WEIGHT LIMITATIONS.

The maximum recommended gross weights are as follows:

Field take-off	21000 pounds
Field landing	16000 pounds
Catapulting	20000 pounds
Arrested landing	15000 pounds

CATAPULTING AND ARRESTED LANDINGS.

a. Catapulting and arrested landing are not permitted with external stores.

b. The maximum permissible arresting hook load is 66000 pounds and the maximum permissible longitudinal deceleration for arrested landing is 4.7g.

c. The ultimate barrier engagement force is 86500 pounds and the ultimate strength longitudinal deceleration for barrier engagement is 6.2g.

MANUAL LONGITUDINAL CONTROL TO POWERED STABILIZER CONTROL SHIFT LIMITATIONS.

Only on airplanes equipped with the interim longitudinal control system modification, marginal longitudinal nose-down control will be experienced if flaps are retracted and control system is allowed to shift from manual control to hydraulic power operation at large airplane nose-up stabilizer settings or at a very low airspeed. Therefore, DO NOT RETRACT FLAPS AT STABILIZER SETTINGS GREATER THAN 3.5 DEGREES AIRPLANE NOSE-UP TRIM, OR AT TRIMMED AIRSPEEDS LESS THAN 150 KNOTS IAS.

THESE LIMITATIONS AND RESTRICTIONS ARE SUBJECT TO CHANGE; LATEST SERVICE DIRECTIVES AND ORDERS MUST BE CONSULTED.

SECTION VI

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Section VI FLIGHT CHARACTERISTICS

GENERAL FLIGHT CHARACTERISTICS.

Flight characteristics and controllability of this airplane are good throughout its speed range, from the stall to the maximum terminal velocity attainable. These flying qualities have been achieved by incorporation of the following features: hydraulically operated stabilizer (flying tail) and flaperons (in place of ailerons) for effective longitudinal and lateral control at high speeds; manually operated elevators, wing slats, and large span wing flaps for control and performance during take-off and landing operations; speed brakes for decelerating; and a yaw damper for eliminating lateral-directional oscillations.

STALLS.

UNACCELERATED STALLS—LANDING GEAR AND FLAPS DOWN.

The attitude of the airplane in a normal, unaccelerated stall, with landing gear and flaps down, depends on the amount of power being carried. At idle rpm, the airplane stalls with the fuselage reference line level or slightly nose-down. With 100% rpm, the airplane stalls with the nose 20 to 25 degrees above the horizon, blocking forward visibility. The stick force required to stall the airplane depends on the speed at which the airplane is trimmed; the higher the trim speed, the higher the force and, conversely, the lower the trim speed, the lower the force. With the airplane trimmed at a normal carrier approach speed (about 15% above the stall), stability at speeds less than trim is weak and the pull force required to slow the airplane down to the stall is only about 5 pounds. As the airplane is slowed up from its trim speed, light air-frame buffet begins about 8 knots before the stall. This buffet becomes steadily stronger down to the stall. About 5 knots before the stall, the pull force required to hold constant airspeed begins to get lighter and at the stall, fore and aft stick forces are practically zero. In slowing up from the trim speed, stick position changes very little until 5 knots before the stall, when it may move forward an inch or so as the pull force diminishes. As the stall is approached, some wing heaviness may be encountered, but this can be readily controlled by the flaperons.

Airplane behavior at the stall varies with cg location, and since the cg varies with fuel load, airplane behavior at the stall depends on the amount of fuel remaining. At a forward cg (large amounts of fuel remaining), the stall is characterized by a straight nose-down pitch. The distance the nose drops below the horizon may be surprising. To avoid secondary stall, caution should be exercised to be sure that airspeed has increased substantially before pulling back on the stick to raise the nose.

With the cg at an intermediate position, nose-down pitch at the stall occurs hesitantly. When the cg is at an aft position (light fuel loading), the nose does not pitch down at the stall. The exact point of stall is not clearly defined and is characterized by moderate to heavy airframe buffet and increased difficulty in holding the wings level. Recovery from this stall is made by applying full forward stick and holding it until the nose of the airplane is below the horizon and speed has increased substantially. Pilots are cautioned not to expect a crisp, nose-down break at the stall in this airplane. Deep penetrations of the stall at aft cg's is not recommended, due to sharper wing dropping tendencies and slight delay and slow response of forward stick for stall recovery.

ACCELERATED STALLS—LANDING GEAR AND FLAPS DOWN.

Accelerated stalls with landing gear and flaps down are similar to unaccelerated stalls except that stall warning buffet is stronger and wing heaviness may be more pronounced. The delay in recovery after pushing the stick forward may also be longer. Recovery is made by applying forward stick and holding it until airframe buffet disappears and speed is increasing.

UNACCELERATED STALLS—CLEAN CONFIGURATION.

WARNING

On airplanes equipped with the interim longitudinal control system modification, in approaching a stall while flying on the powered longitudinal control system, do not trim the airplane all the way down to the stall. If the airplane is stalled with excessive airplane nose-up trim (greater than 3 degrees), airplane nose-down control for stall recovery may be marginal. It is important to realize that the absolute stabilizer position indicator denotes trim position only when the control stick is in neutral and no fore or aft stick force is being applied. If the airplane is stalled inadvertently with excessive airplane nose-up trim, full airplane nose-down stabilizer can be attained only by trimming the airplane nose-down with the stick in neutral and then pushing the stick full forward.

Note

On airplanes equipped with the final production longitudinal control system modification, it may be impossible to trim all the way to the stall because of the 2-1/2 degrees airplane nose-up trim limit in the clean configuration.

Airplane attitude at the stall depends on the power being carried. With idle rpm, the airplane stalls with the nose slightly above the horizon. With high rpm, the airplane stalls in a fairly steep nose-high attitude. These attitudes at the stall are somewhat more nose-high than for a straight wing airplane.

At low altitudes, stall warning buffet begins approximately 6 knots above the stall and increases in severity down to the stall. About 4 knots before the stall, the nose of the airplane tends to rise slightly and the airplane may tend to become alternately wing heavy. At the stall, the nose pitches down gently. The break at the stall is not sharp and the nose does not fall through a large arc. Recovery is made by applying forward stick and holding it until the nose is down and speed has increased substantially.

At high altitudes, light stall warning buffet begins almost 30 knots above the stall and increases in severity down to the stall. Just prior to the stall, the nose of the airplane tends to rise rather sharply and, if left unchecked, may pitch up to an alarming angle. This pitch-up is a common characteristic of swept wing airplanes and is caused by two things: (1) Stalling of the outboard aft areas of the wing, which moves the effective center of lift inboard and forward; and (2) increase in downwash angle behind the wing, requiring more airplane nose-down control for same tail effectiveness. Recovery, up to the point of pitch-up, is made simply by applying forward stick and holding it until speed has increased substantially. If the stall has progressed into the pitch-up range, move the stick forward, holding rudder and flaperon in neutral, and wait. After reaching a maximum angle of attack, the nose will drop back below the horizon, sometimes rolling off on a wing as the nose drops. Normal control will be regained as soon as the nose of the airplane is below the horizon. Allow speed to build up before completing the recovery to level flight. The airplane will not spin unless the stick is held full back, or the airplane is trimmed excessively nose-up. Consider the pre-stall buffet as a warning and be ready to ease back stick pressure or to use push force to avoid the stall.

Response of the airplane to forward stick is somewhat slower on the powered system than on the manual system, but the effectiveness is greater.

ACCELERATED STALLS—CLEAN CONFIGURATION.

The first indication of an accelerated stall is light airframe buffet. As the buffet becomes moderate, the nose of the airplane tends to rise or to pitch up. If the rate of pull-up is slow, the pitch-up can be checked and recovery made by applying forward stick and holding it until the buffet disappears. If the rate of pull-up is fast, the pitch-up can be severe, resulting in heavy buffet and sharp wing dropping, resembling a partial snap roll. The pitch-up may result in overshooting intended "g" loads and possible structural failure at high speeds. Recovery from a stall which has progressed into the strong pitch-up range is made by applying forward stick and holding it until the buffet disappears. There may be a slight delay in effectiveness of forward stick, followed by a surprisingly abrupt return of effectiveness, which may throw the airplane to less than 1g in recovery.

On the manual longitudinal control system, stick forces in the pitch-up range may reverse or "snatch" briefly. Recovery in these cases is also made by applying forward stick and holding it until control is regained. Accelerated stalls with pitch-up may occur at any speed or altitude, but will probably occur most frequently at low "g" and

STALL SPEEDS LOW ALTITUDE

STALL SPEEDS - IAS KNOTS

	Angle of Bank	Load Factor	CLEAN Gross Weight 12000	14000	16000	18000	LANDING Gross Weight 12000	14000	16000	18000
POWER ON	0	1.0	100	105	115	120	85	90	95	105
	30	1.2	110	115	125	135	95	100	110	115
	45	1.4	115	125	135	145	100	110	115	125
	60	2.0	140	150	160	170	120	130	140	145
	76	4.0	200	210	230	240	170	185	195	210
POWER OFF	0	1.0	105	115	120	130	90	95	100	110
	30	1.2	115	125	130	140	100	105	115	120
	45	1.4	125	135	145	150	105	115	120	130
	60	2.0	150	160	170	180	125	135	145	155
	76	4.0	210	225	240	255	175	190	205	215

Flight Test Data

Figure 6-1. Stall Speeds Chart

high altitudes when the control stick is moved quickly and abruptly. To avoid the troublesome characteristics of pitch-up, it is recommended that pull-ups be made smoothly in order to take advantage of the early warning buffet. Pull-ups past this point should be continued at a slow rate and with caution.

INVERTED STALLS.

INTENTIONAL INVERTED STALLS ARE PROHIBITED.

An unintentional inverted stall occurs most frequently near the top of a loop when the airplane has insufficient speed to get over the top. The attitude of the airplane with respect to the horizon determines the length of time for recovery. If the nose is within 20 degrees of the horizon, control is regained immediately as the control stick is eased back. The nose will then drop below the horizon and recovery can be completed by making a half-roll back to a normal wings-level attitude. If the nose is very high, 60 to 70 degrees, recovery takes longer, due to the lower airspeeds at the top of the flight path and the time required for the nose to drop below the horizon. Recovery in this case is also made by easing the stick back. The nose will then drop slowly below the horizon, after which recovery can be completed by making a half-roll back to a normal wings-level attitude. Caution should be exercised not to pull the stick full back abruptly, since this may cause a positive accelerated stall.

SPINS.

INTENTIONAL SPINS ARE PROHIBITED.

SPIN CHARACTERISTICS.

CLEAN CONFIGURATION SPINS.

Preliminary spins have been done up to two turns. Spin tests were performed in an airplane which was not equipped with a yaw damper. Its effect on spin characteristics is unknown. Consequently, if an inadvertent spin is encountered, set the yaw damper power switch to OFF.

The airplane is difficult to spin and enters the spin quite slowly. The clean spin entry is characterized by two separate characteristics. The first is pitch-up, which gives a very high angle of attack. This is followed by, secondly, the actual spin entry, which is wallowy and slow. When the airplane does roll off on a wing, the spin will develop if the stick is held back.

The spin is oscillatory, being steep at the 180 degree point, and shallow at the 360 degree point. Rotation is slow during the entire spin and is slowest (sometimes stopping) at the shallow portion. The airspeed is low and altitude loss is 1000-1500 feet per turn, but the altitude loss during recovery can be 6000-7000 feet. This is because a steep dive after stopping rotation is necessary to build up maneuvering airspeed.

Spins from an accelerated stall are the same after the spin is developed. The spin is preceded by a snap roll. The snap roll increases in violence with increasing speed.

LANDING CONFIGURATION SPINS.

With wheels and flaps down, the airplane spins very smoothly and slowly. Again, the spin is steep at the 180 degree point and shallow at the 360 degree point. There is little, if any, pitch-up preceding this type of spin.

INADVERTENT SPINS—CLEAN CONFIGURATION.

The airplane will not spin unless the stick is held back or EXCESSIVE nose-up trim is used. If either is done at the stall, the airplane will drop off on a wing and then will spin if the stick is held back.

RECOVERY TECHNIQUE.

CLEAN CONFIGURATION SPINS.

The spin can be prevented or recovery effected by neutralizing the rudder and flaperons and slowly pushing the stick forward. If the airplane is in a fully developed spin, opposite rudder will stop the rotation. However, at the spin entry, opposite rudder aggravates the rotation. Consequently, neutral rudder is recommended.

A rapid forward motion of the stick will stop the spin almost immediately, but this is not recommended. Overcontrolling is too easy, particularly when operating on the powered stabilizer. It is much better to ease the stick forward for a smooth recovery.

Recovery from spins entered from an accelerated stall is the same as above. The recovery can be made from the preceding snap roll or the spin with equal ease. DON'T OVERCONTROL, and be sure to keep the nose of the airplane down until maneuvering speed is attained.

LANDING CONFIGURATION SPINS.

The normal spin recovery technique of hard opposite rudder and forward stick is excellent for recovering from spins with the gear and flaps down.

WARNING

DO NOT attempt to retract the flaps until after recovery from the spin. The nose-up trim change with flap retraction can make recovery impossible without retrimming.

FLIGHT CONTROLS.

LONGITUDINAL CONTROLS.

POWER OPERATED STABILIZER SYSTEM.

Because of the greater movable surface area, the adjustable stabilizer provides a very effective longitudinal control, particularly at high speeds. The control stick forces, which are produced by a combination of bob weights and an artificial feel system, are light, but typical for a fighter type aircraft. The effectiveness of longitudinal control increases with airspeed to a peak at 0.85 Mach number, just less than maximum velocity in level flight, then falls off to a moderate value at higher speeds. The combination of light forces and high effectiveness results in a high degree of control sensitivity; therefore, abrupt stick motions should be avoided and "g" loads applied with caution, particularly at high speeds, to prevent overcontrolling and excessive "g" loads. Stabilizer trim may be used to trim out stick forces; however, trim should be applied cautiously and in small amounts, particularly at high speeds, to avoid overcontrolling. Care should be exercised not to make high "g" pull-outs at speeds above 0.90 Mach number on stabilizer trim alone, since the increase in tail effectiveness, as speed drops off in the pull-out, may subject the airplane to excessive "g" loads.

MANUAL ELEVATOR CONTROL SYSTEM.

Maneuvering stick forces with manual elevator control are two to three times higher than with hydraulic stabilizer control and tend to build up with increasing airspeed. Elevator effectiveness is good up to about 0.85 Mach number, but tends to fall off markedly at higher speeds. The combination of heavy forces and low effectiveness at high speeds results in a low degree of control sensitivity and limited maneuverability. The stabilizer maintains its effectiveness with Mach number, however, and trim may be used as necessary to supplement elevator control at high speeds. Care should be exercised not to make high "g" pull-outs at speeds above 0.09 Mach number on stabilizer trim alone, since the increase in tail effectiveness, as speed drops off in the pull-out, may subject the airplane to excessive "g" loads.

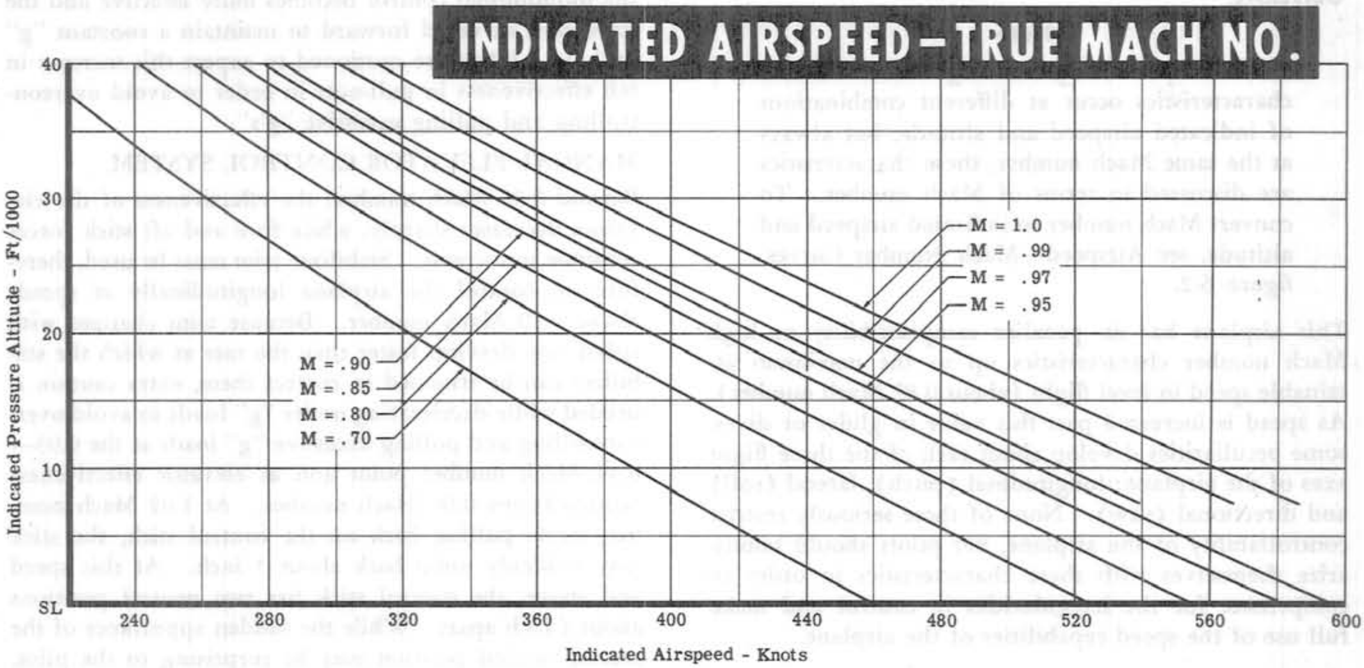
LATERAL CONTROL.

Lateral controllability and rolling performance at high speeds have been improved over those of aileron equipped airplanes by the use of flaperons (spoilers). Lateral control stick forces are supplied by an artificial feel system and are constant throughout the speed range for the clean configuration and are constant, but at a lower value, for the landing configuration. Since lateral control stick forces do not vary with speed, the pilot should familiarize himself with this characteristic and with the increased rate of roll performance at high speeds.

RUDDER CONTROL.

On airplanes equipped with the Lear yaw damper system, the rudder is automatically deflected to correct yawing oscillations. The rudder pedals are continuously connected to the rudder, and as the rudder is moved by the yaw damper, the rudder pedals in the cabin move accordingly. This may feel strange to a pilot on early familiariation flights, but becomes much less noticeable as the pilot gains experience in the airplane. Two gain settings of the yaw damper are provided; a LOW GAIN setting and a HIGH GAIN setting. On the LOW GAIN setting, effectiveness of the yaw damper is reduced, but motion of the rudder pedals is less apparent. On the HIGH GAIN setting, effectiveness of the yaw damper is high, but motion of the rudder pedals in turbulent air may be annoying. Pilots should familiarize themselves with these yaw damper gain settings on familiarization flights.

The yaw damper is operative at all times when the power switch on the right cabin rail is ON, except that the yaw damper is automatically disengaged when more



21 April 1953
GAEC Preliminary Flight Test

Figure 6-2. Indicated Airspeed—True Mach Number Curves

than 45 pounds rudder pedal force is applied to either or both rudder pedals, or whenever the control stick is displaced more than 1-1/2 inches of the way to full lateral displacement.

The feature of disconnecting the yaw damper with rudder pedal force is built in to permit intentional yawed flight, as when making a sideslip, or in correcting for drift in a cross-wind landing. Pilots are cautioned not to rest their feet on the rudder pedals so heavily that the 45-pound cut-out switches keep the yaw damper continuously disengaged. The feature of disconnecting the yaw damper with stick displacement is built in to provide the yaw damper time to discriminate between a turn entry and a yaw disturbance. Since the yaw damper may be temporarily disengaged by lateral motion of the stick during a turn entry, appropriate rudder should be used to coordinate turn entries and roll reversals exactly as if no yaw damper were installed.

TRIM CONTROLS.

LONGITUDINAL TRIM.

When flying on either the power operated stabilizer or the manual elevator control system, longitudinal trim is used in the conventional manner, as required, and is accomplished by use of the adjustable stabilizer. The rate of motion of the stabilizer is approximately one-half degree per second, a compromise setting which results in rather low sensitivity at low speeds and high sensitivity at high speeds. Care must be exercised at high speeds not to overcontrol the airplane while using the adjustable stabilizer.

WING TRIMMER.

The wing trimmer consists of a separate movable surface on the trailing edge of the left wing near the tip. Its function is to correct wing heaviness caused by out-of-rig conditions, unsymmetrical external stores, or battle damage.

RUDDER TRIMMER.

The primary function of the rudder trimmer is to correct directional asymmetry caused by out-of-rig conditions, unsymmetrical external stores, or battle damage.

SPEED BRAKES.

Speed brakes may be used at any time during maneuvering to decelerate the airplane. Speed brakes extend in approximately 5 seconds. Extension is accompanied by a slight nose-up pitch and minor buffeting, except at high speeds and low altitudes, where the buffeting may become moderately heavy. By first using speed brakes in a dive recovery, then pulling out at the maximum allowable "g", a minimum loss of altitude will result.

SLATS.

Slats extend simultaneously when flaps are lowered.

HIGH MACH NUMBER CHARACTERISTICS.

WARNING

See Section V and latest service directives and orders.

GENERAL.

> **Note**
>
> Since compressibility and high Mach number characteristics occur at different combinations of indicated airspeed and altitude, but always at the same Mach number, these characteristics are discussed in terms of Mach number. To convert Mach number to indicated airspeed and altitude, see Airspeed—Mach Number Curves, figure 6-2.

This airplane has no peculiar compressibility or high Mach number characteristics up to the maximum attainable speed in level flight (about 0.87 Mach number). As speed is increased past this value in glides or dives, some peculiarities develop about each of the three flight axes of the airplane: longitudinal (pitch), lateral (roll) and directional (yaw). None of these seriously restrict controllability of the airplane, but pilots should familiarize themselves with these characteristics in order to compensate for the irregularities in control and make full use of the speed capabilities of the airplane.

LONGITUDINAL CHARACTERISTICS.

GENERAL.

Between about 0.83 and 0.87 Mach number, this airplane is neutrally stable (i.e., the airplane can be flown at any speed in this range with the same stick force, or same stabilizer trim setting). Between 0.87 and 0.93 Mach number, the airplane becomes slightly unstable and tends to nose over slightly. Low pull forces on the stick or small amounts of airplane nose-up trim are required to hold the airplane steady at these speeds. At about 0.93—0.94 Mach number, stability increases rather abruptly and the airplane tends to buffet lightly and to hesitate in accelerating. This point can be passed by moving the stick forward and applying airplane nose-down control. At 0.95 Mach number, longitudinal control problems are over, and from this point on, the airplane is smooth, stable, and easily controllable. Because of the discontinuity in stability at 0.93—0.94 Mach number, the airplane is difficut to fly continuously in this range without overcontrolling, and the range should be avoided except in accelerating or decelerating. In decelerating through this 0.93—0.94 Mach number range, particularly under "g's", the airplane may tend to pitch up somewhat and cause temporary overcontrolling. Pilots are cautioned, therefore, to avoid decelerating through 0.93—0.94 Mach number while pulling high "g" loads, to prevent overcontrolling and excessive "g" loads.

POWER OPERATED STABILIZER SYSTEM.

Beyond 0.85 Mach number, the effectiveness of the power operated stabilizer decreases and larger amounts of control surface deflections are required for maneuvering. In decelerating toward 0.85 Mach number, therefore, the longitudinal control becomes more effective and the stick must be eased forward to maintain a constant "g" pull-out. Pilots are cautioned to expect this increase in tail effectiveness in pull-outs in order to avoid overcontrolling and pulling excessive "g's".

MANUAL ELEVATOR CONTROL SYSTEM.

Beyond 0.85 Mach number, the effectiveness of the elevators decreases sharply, while fore and aft stick forces continue to increase. Stabilizer trim must be used, therefore, to control the airplane longitudinally at speeds above 0.90 Mach number. Because trim changes with speed may develop faster than the rate at which the stabilizer can be trimmed to correct them, extra caution is needed while decelerating under "g" loads to avoid overcontrolling and pulling excessive "g" loads at the 0.93—0.94 Mach number point and as elevator effectiveness returns below 0.90 Mach number. At 1.02 Mach number, while pulling back on the control stick, the stick may suddenly jump back about 1 inch. At this speed and above, the control stick has two neutral positions about 1 inch apart. While the sudden appearance of the second neutral position may be surprising to the pilot, it is not serious and is due to supersonic airflow characteristics over the horizontal tail.

LATERAL CHARACTERISTICS.

At about 0.88—0.91 Mach number, the airplane becomes erratically wing heavy, usually first to one side, then the other. This wing heaviness can be corrected by use of the flaperons or the rudder. At about 0.90—0.92 Mach number, the flaperons may exhibit reverse effectiveness for very small stick displacements from neutral (i.e., as the stick is moved 1/4 inch right, the airplane may roll slowly to the left). At larger stick displacements, the situation corrects itself and becomes normal again. The characteristics of erratic wing heaviness and reversed flaperon effectiveness tend to make the airplane laterally touchy and sensitive between 0.88 and 0.92 Mach number. The best technique for controlling the airplane laterally in this speed range is to be smooth and steady, avoiding small, abrupt stick motions as much as possible. Beyond about 0.93 Mach number, no further lateral difficulties arise and the airplane has good roll characteristics.

DIRECTIONAL CHARACTERISTICS.

Directionally, the airplane becomes very stiff with increasing airspeed and rudder pedal forces are high. There is normally no need for using any rudder at high speeds, and the yaw damper will continue to operate normally. At about 1.03 Mach number, light vibrations may be detected in the rudder pedals and, with the yaw damper off, the rudder pedals may appear to "walk" back and forth about neutral. The vibration and pedal walking can be suppressed by increasing foot pressure on both pedals.

DIVING.

WARNING

Descents with the low fuel level warning light on must be made in accordance with the procedure given in Appendix I, Description of Charts and Tables paragraph, step h.

SPEED BRAKES AND DIVE FAMILIARIZATION.

Speed brakes may be used within the normal restrictions of the airplane. Because of the effectiveness of the speed brakes, deceleration with full speed brake extension occurs rapidly. Trim changes associated with these speed changes appear more pronounced. For initial dive familiarization, it is recommended that dives be started from approximately 40000 feet and at maximum level flight speed at that altitude. With this technique, limit speeds may be approached with flatter dive angles and at lower indicated airspeeds, tending to minimize chances of overshooting restricted speeds and accelerations.

DIVE RECOVERY.

POWER OPERATED STABILIZER CONTROL SYSTEM.

Use of speed brakes in dive recovery is optional, although less altitude will be lost in dive recovery if they are used. If they are not used, recovery should be made by pulling back smoothly on the control stick, watching for the trim change at 0.93—0.94 Mach number and the increase in tail effectiveness as speed drops off. If the speed brakes are used, speed will decrease rapidly and the trim changes and increase in tail effectiveness will be more pronounced. It is recommended, therefore, that "g's" be held low until speed has decreased below 0.93 Mach number to avoid overcontrolling and pulling excessive "g's".

MANUAL ELEVATOR CONTROL SYSTEM.

Since elevator effectiveness at high Mach number is low, recoveries from dives where speeds are above 0.95 Mach number are best made by cautious use of stabilizer trim. Since trim changes with speed may develop faster than the rate at which the stabilizer can be trimmed to correct them, extra caution is required while decelerating under "g" loads to avoid overcontrolling and pulling excessive "g" loads at the 0.93—0.94 Mach number point and as tail effectiveness returns below 0.90 Mach number. If speed brakes are used, it is recommended that the speed be allowed to drop below 0.93 Mach number before starting to pull high "g" loads.

TRIM CHANGES.

WING FLAP OPERATION.

RETRACTION.

On airplanes equipped with the interim longitudinal control system modification, there is little or no trim change as the flaps are retracted, until the flaps indicate one-half up, at which time the nose of the airplane tends to rise and a steadily increasing PUSH force is required to maintain constant attitude. The push force is about 10 pounds when the flaps are full up if no retrimming is done. To minimize the trim change with flap retraction, begin trimming the airplane nose-down as the flaps start up.

WARNING

On airplanes equipped with the interim longitudinal control system modification, do not retract flaps at trimmed airspeeds less than 150 knots or at stabilizer trim settings greater than 3-1/2 degrees airplane nose-up while allowing longitudinal control to shift from the manual to the powered system. In some cases, full forward stick may not be effective in checking the nose-up tendency as the flaps retract.

On airplanes equipped with the final production longitudinal control system modification, the trim changes are identical with those described above, provided the flaps are retracted at stabilizer settings of 2-1/2 degrees airplane nose-up or less. Because of the automatic retrimming feature, the flaps may be retracted at stabilizer settings up to 6 degrees airplane nose-up if so desired. If the flaps are retracted at stabilizer settings greater than 2-1/2 degrees airplane nose-up, the airplane will tend to become nose heavy during the early stages of flap retraction, then tail heavy as the flaps near the full retracted position. If the automatic retrim circuit is by-passed by using either the emergency manual control knob (down) or the emergency trim switch, the trim changes are identical to those obtained with the interim modification. In these cases, the 3-1/2 degrees airplane nose-up—150 knots Warning is applicable.

EXTENSION.

As the flaps extend, the airplane pitches over gently to maintain approximately constant airspeed. Little or no stick force is required until the flaps reach one-half down, when a steadily increasing PULL force develops, which reaches a maximum of 10 pounds when the flaps are full down. The trim change can be reduced somewhat by trimming airplane nose-up shortly after the flaps start down.

LANDING GEAR OPERATION.

RETRACTION.

There is no trim change as the landing gear retracts.

EXTENSION.

At moderate speeds, there is no trim change as the landing gear extends. At the limiting speed for landing gear operation, a slight pitch-up may occur momentarily as the landing gear doors open.

SHIFTING LONGITUDINAL CONTROL SYSTEMS.

The manual and powered control systems are adjusted, with respect to each other, so that when switching from the powered system to the manual system in straight and level flight, the nose of the airplane will rise slightly. (Conversely, in switching from manual to powered, the nose will dip slightly.) The tendency becomes more noticeable with increasing airspeed. The trim change is at a minimum at 250 knots.

If switch-over from powered to manual is made in a turn or "g" maneuver, trim change during switch-over will be small, but stick forces required to hold the same "g" will increase by more than double.

If switch-over from powered to manual is made at very high Mach numbers, trim change will be small, but the effectiveness of the elevators will be low and electric stabilizer trim should be used, as necessary, to control the flight path of the airplane in recovering to level flight.

SPEED BRAKES.

Extension of the speed brakes is characterized by a slight nose-up pitch and minor buffeting, except at high speeds and low altitudes, where the buffeting may be moderately heavy.

Trim changes with speed brake retraction are minor.

POWER.

Trim changes with power setting changes are small and hardly noticeable. As power is added, the nose of the airplane may tend to rise slightly. As power is reduced, the nose may drop slightly.

There are no directional or lateral effects as on a single engine propeller driven airplane.

SECTION VII

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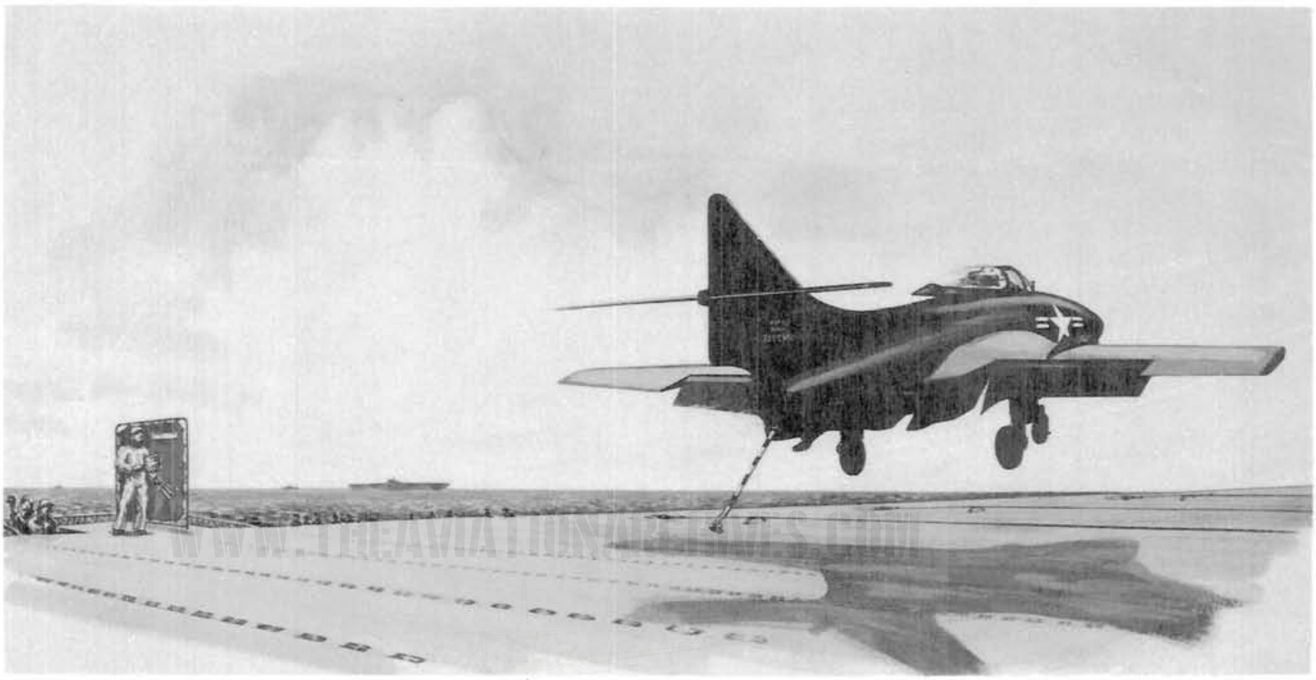
Section VII SYSTEMS OPERATION



ENGINE OPERATION—GENERAL FLYING.

Tailpipe temperature control in conjunction with rpm is of the utmost importance to the life of the engine; therefore, it is essential that the limiting temperature or rpm for any given condition not be exceeded. When operating, the following characteristics are present:

a. After making an increase in power setting, the full tailpipe temperature rise may lag. After the initial rise is noted, the temperature may continue to rise slowly for as long as 5 minutes. The stabilized temperature should be within limits established for the various power conditions. (See figure 5-3.)

b. Rapid deceleration may be made without flame-outs.

c. The engine fuel control unit provides compensation to maintain, within close limits, any selected engine speed throughout broad ranges of altitude and airplane speed.

d. While operating using Military Thrust (100% rpm) at high altitude or during climbs, a 3% drop in rpm may be experienced. This is not an indication of system malfunction. RPM will correspond to throttle setting when throttle is retarded to obtain Maximum Continuous Thrust (94.8% rpm).

ENGINE ACCELERATING CONDITIONS.

a. In performance of snap or maximum rate accelerations at high altitude (around 40000 feet), the ideal fuel control setting produces a smooth acceleration throughout the entire engine speed range.

b. As fuel control settings become richer, rough operation ranges become apparent. As richness is further increased, the roughness becomes increasingly severe and extends over slightly wider engine speed ranges until the point of rich flame-out is reached. This roughness would be expected to be most severe in the 90-95% rpm range, although another roughness range is sometimes noted at approximately 85% rpm.

c. Warning of approaching flame-out with an overrich fuel control setting manifests itself in the form of a decrease in frequency and an increase in severity of roughness during the acceleration, together with a slowing, sometimes to zero, of the rate of engine speed rise. As the flame-out is approached, the roughness can be described as changing from a buzz to a heavy stutter, together with a slowing or stopping of the acceleration rate. This condition occurs very close to the flame-out point and if reached, the throttle should be retarded immediately to some intermediate point to prevent flame-out.

d. It has been found that in accelerating from intermediate rpm settings, rather than from idle, roughness will sometimes be more severe than through the same engine speed during snap acceleration from idle. Identification of proximity to flame-out and remedial action for this condition is the same as above.

e. A decrease in the rate of advance of the throttle will decrease the tendency for flame-out with an over-rich fuel control setting and will decrease the severity of an acceleration roughness. Decreasing airplane altitude has the same effect.

SECTION VIII
CREW DUTIES

(NOT APPLICABLE)

SECTION IX
ALL WEATHER OPERATION

(TO BE SUPPLIED WHEN AVAILABLE)

APPENDIX I

TABLE OF CONTENTS

ILLUSTRATIONS

Appendix I OPERATING DATA

INTRODUCTION.

GENERAL.

The information contained in this Appendix covers flight within the operating limits of the airplane. Data based on flight tests are printed in black in the tables and as solid lines in the graphs. Data based on estimates or extrapolations are printed in red in the tables or as lines of short dashes in the graphs (except where the entire graph is labelled estimated). Unless otherwise noted, these charts are based on zero wind and standard atmosphere. Allowances for formation flying or variations among airplanes must be established locally.

AIRPLANE WEIGHT AND CONFIGURATION.

The in-flight gross weight of this airplane with full ammunition but no fuel is 12600 pounds. To this should be added the weight of fuel on board.

The symbol A appearing on the charts and tables represents the clean (no racks) airplane configuration.

FUEL GRADE.

Several different fuel grades may be used. Those most generally available are:

a. Specification MIL-F-5624A, JP-3 or JP-4; approximate density is 6.5 lb/gal.

b. Specification MIL-F-5572, aviation gasoline; approximate density is 6.0 lb/gal. The fuel grades for which the individual charts are valid are indicated in the lower right corners of the charts. The internal fuselage tanks contain 763 gallons of usable fuel and the internal wing tanks each contain 78 gallons of usable fuel, making the total usable fuel capacity 919 gallons. The fuel quantity indicator registers the weight of internal fuselage fuel directly, regardless of the fuel density.

DESCRIPTION OF CHARTS AND TABLES.

a. *Airspeed Installation Correction Curves* and *Airspeed—Mach Number Curves.* In order to obtain correct airplane speeds, several corrections must be applied to the airspeed indicator reading. The first correction to be made is for the instrument error and is obtained from the airspeed correction card. When applied to the instrument reading, the result is indicated airspeed, IAS. The second correction is for the error due to the airspeed system installation. This correction is obtained from figure A-1 and when added to the IAS, provides the calibrated airspeed, CAS. The third correction is for the effects of compressibility, altitude, and temperature. These corrections are made using figure A-2. Enter at the CAS and move vertically to the proper altitude.

Moving horizontally to the left gives the True Mach Number for the given CAS and pressure altitude regardless of air temperature. Moving to the right parallel to a True Airspeed line gives the TAS for the standard day.

If the temperature is known, move from the CAS—Altitude intersection horizontally to the Sea Level line, then vertically to the Air Temperature, then horizontally to the TAS. Adding the effective tail wind (or subtracting the effective head wind) to the TAS provides the ground speed. The effective wind is the component of wind velocity along the airplane flight path.

b. Example: Suppose the airplane is at 15000 feet with the airspeed indicator showing 265 knots. The indicator correction is, for example, +4 knots. The IAS is then 269 knots. From figure A-1, the installation correction is approximately +1 knot, then the CAS is 270 knots. In figure A-2, at 270 knots CAS and 15000 feet pressure altitude, the True Mach Number is .535. The TAS would be 335 knots if a standard day were assumed. If the air temperature is known to be +10°C, for example, the TAS is 352 knots.

c. *Standard Altitude Table and Density Altitude Curves.* In figure A-3 the various quantities for the NACA standard atmosphere are tabulated. In figure A-4 the relations of temperature, pressure altitude and density altitude are shown graphically.

d. *Take-off Distance Curves.* Estimated take-off distances are presented graphically in figures A-5 and A-6. Figure A-5 shows the minimum ground run distance for any likely combination of gross weight, altitude, temperature, and head wind velocity. In figure A-6, the total take-off distance from start of roll to clear a 50 foot obstacle is plotted against the minimum ground run. The minimum ground run distance to be used in figure A-6 is that obtained from figure A-5, including corrections for all of the variables. Since the average airspeed during ground run is less than the average during the airborne part of the take-off, the curves of figure A-6 show, for a given ground run, increasing total distance with increasing head wind velocity. The calibrated airspeeds for lift-off and for climb over a 50 foot obstacle are given in figures A-5 and A-6. The take-off technique given in Section II should be followed. The fuel allowance for start, taxi, take-off, and acceleration to climb speed is 480 pounds.

e. Example: Assume that the airplane is fueled with JP-4 at 6.5 lb/gal so that the gross weight is 12600 pounds + 919 x 6.5) = 18510 pounds. The runway altimeter indicates 2000 feet and the ambient air temperature is 22°C. The head wind velocity is 15 knots. In figure A-5 enter the density altitude grid at 22°C and move vertically to 2000 feet pressure altitude. Move right to a weight of 18760 pounds and then straight down to the top of the air temperature grid. Follow the nearest guide line to 22°C, then move straight down to the top of the head wind grid. Follow the nearest guide line to 15 knots and then move straight down to the distance scale which shows 3400 feet minimum ground run. The total distance to clear a 50 foot obstacle is obtained by entering figure A-6 at 3400 feet minimum ground run and moving vertically to 15 knot head wind, then left to read 7650 feet total distance.

f. *Climb Curves.* Figure A-7 presents curves of distance and time vs weight for Military Thrust climbs to various altitudes. The difference between the weights at the initial and final altitudes is the fuel used. The climbing speed schedule and factors for the effect of non-standard temperatures are also given. The broken line represents the approximate cruise ceiling, i.e., the altitude at which rate of climb is 100 feet per minute at Normal Rated Thrust. Note that it is possible to climb above this altitude at Military Thrust and to maintain level flight at this altitude at less than Normal Rated Thrust. The effect of above-standard temperatures on climb performance is similar to the effect of reduced rpm. At higher temperatures the thrust is decreased and so the time to climb is increased. However, the fuel flow also decreases so that the fuel quantity used does not increase as much as the time does. For a given CAS, the TAS increases with temperature so that the distance covered increases more than the time does. The net result is a greater time to climb but an increased specific range during climb. The temperature correction factors for the three items of climb performance are given in a note in figure A-7. These factors are approximate, since they vary somewhat with altitude. For temperatures below standard, the climb data should be decreased by the respective factors.

g. Example of use of Climb Curves: Suppose that at 15000 feet the weight is 16200 pounds and it is desired to climb to 35000 feet. In figure A-7 enter the chart at sea level at 16200 pounds and move vertically to 15000 feet. Read the values of 25 nautical miles and 3.5 minutes. Proceed up to 35000 feet moving parallel to the nearest guide line. Here read 73 nautical miles, 9.7 minutes, and 15750 pounds gross weight. The results for the standard day are 48 air nautcial miles, 6.2 minutes and 450 pounds of fuel used. If the ambient temperatures are 5°C above standard, the results are: 48 + (48 x 5 x .021) = 53 air nautical miles; 6.2 + (6.2 x 5 x .019) = 6.8 minutes; 450 + (450 x 5 x .013) = 480 pounds.

h. *Descent Curves.* The descent data are presented graphically in figures A-8 and A-9. The distance, fuel used, and the times are those from the given altitude to sea level. Figure A-9 is entitled Minimum Time Descent Curves, Configuration A. A minimum time descent is obtained by following the given airspeed schedule with speed brakes extended and idle rpm. Such a steep descent cannot be continued to sea level, of course; the approximate altitude loss during dive recovery is listed in figure A-9 for several constant values of normal acceleration. After recovery, it will usually be desirable to retract the speed brakes. The minimum time descent is included in the range tabulations of the Flight Operation

Instruction Charts and is used in the Sample Problems. Figure A-8, Optimum Descent Curves, Configuration A, presents the optimum descent data, so called because it results in the least time for the best total range. The optimum descent is made with speed brakes retracted and idle rpm. The data of figures A-8 and A-9 are based on flight tests in Configuration A.

At certain combinations of low fuel quantities and nose-down attitudes, the fuel available is only that contained in the forward fuel tank reservoir. This is approximately 40 pounds (if at least 450 pounds is shown on the fuel quantity indicator), which is sufficient for two minutes operation at idle rpm. Therefore, an optimum descent must be started with at least as much fuel remaining as is shown in figure A-8. For descents steeper than the optimum descent such as the minimum time descent, the same minimum starting fuel quantities must be observed. For descents shallower than the optimum descent, increased minimum fuel quantities are required, the increase in fuel to be equal to the increased descent time (minutes) times 20 pounds of fuel per minute) for idle rpm descents.

i. *Landing Distance Curves.* Estimated landing distances are presented in figure A-10 covering probable altitudes, gross weights and head wind velocities.

Note

For maximum recommended gross weight for field landings, see Section V.

The recommended touch-down CAS, equal to 110% of the stalling speeds, is given for each weight. The total distance from over a 50 foot height to a stop on the runway may be obtained by multiplying the ground roll distance by 1.43. The approach speeds given are 130% of the stalling speeds. (See Section II for further discussion of landing technique.)

j. Landing Distance Example: Assume that the runway is at sea level pressure altitude with an ambient temperature of 36°C. The airplane gross weight is 14000 pounds and the wind along the runway is 15 knots. Entering the density altitude grid, it is seen that the density altitude is 2400 feet. Move horizontally to the 14000 pound line, then vertically to the top of the head wind grid. Then move parallel to the nearest guide line to 15 knots head wind and then vertically to read 2270 feet ground roll distance. The total distance from over a 50 foot height is 2270 x 1.43 = 3250 feet.

k. *Maximum Endurance Curves.* Figure A-11 presents the maximum endurance based on the Recommended Maximum Endurance Airspeeds noted on the Specific Range Curves. These endurance curves are integrals of specific endurance vs gross weight and therefore should be used on an incremental basis. Two items are involved in determining the flight conditions for maximum endurance: first, operation at minimum rpm possible gives lowest fuel flow; second, at various altitudes there are minimum airspeeds below which control of the airplane is too sensitive for normal formation flying. The Recommended Endurance Airspeed schedule is given in figure A-11. (See Specific Range Curves.)

l. Endurance Example: Assume that the airplane weight is 16300 pounds at 35000 feet altitude and it is desired to fly at maximum endurance conditions for 46 minutes. How much fuel will be consumed? Enter figure A-11 at 16300 pounds and move vertically to 35000 feet altitude, then left to read 69 minutes. Add 46 minutes to 69 obtaining 115 minutes. Enter the chart at 115 minutes, move to the right to the 35000 foot line and vertically to read 15100 pounds. The fuel required is 16300—15100 = 1200 pounds. The airspeed will decrease from 203 knots CAS at 16300 pounds to 200 knots at 16000 pounds and remain constant below 16000 pounds.

m. *Combat Allowance Table.* The fuel flows for Maximum Continuous (Normal) and Military Thrusts are tabulated in pounds per minute for various altitudes in figure A-12.

n. *Maximum Continuous Thrust Summary.* Figure A-13 presents the approximate CAS, TAS, and fuel flow for Maximum Continuous (Normal) Thrust for several weights.

o. *Flight Operation Instruction Charts.* These charts, presented in figure A-14, give the range of the airplane at recommended cruise airspeeds and the procedure required to obtain this range. Also given are range at the optimum cruise altitudes and the effect of wind on range. Instructions for use are given on the charts and are illustrated in Sample Problems No. 1 and 2. Note that the CAS specified in the charts must be maintained and that the approximate rpm will decrease as weight diminishes. Except for the climb distance included in the optimum altitude tabulations, the range values given are independent of air temperature if the given CAS is maintained. The tabulated fuel flows and engine speeds will vary with temperature, however. Theoretically, the CAS for cruise with winds should vary with wind velocity, increasing for head winds and decreasing for tail winds. However, for this airplane in the flight conditions given in the chart, the range loss suffered by maintaining constant CAS for all except uncommonly high winds is negligible. The Range Factor given in the charts is the actual ratio of the cruise distance with wind over cruise distance at zero wind, all at the given CAS.

Note

These charts make no allowance for take-off, initial climb, landing, combat, formation flying, etc, but the fuel and distance for descent and for enroute climb to optimum altitude are included.

If altitude, wind, or configuration do not remain reasonably constant, break the flight up into several sections and plan each section separately (the descent to sea level which is included in each range tabulation will cause a small error). Study the sample problems for a better understanding of the use of these charts.

Although the minimum time descent is included in the given range figures, an increase of 3 to 5% in total range will be obtained for altitudes of 25000 feet or less if the optimum descent schedule is used.

p. *Specific Range Curves.* In figure A-15 are curves of Specific Range vs CAS for various altitudes. Lines of constant per cent rpm and constant fuel flow are superimposed on the curves as are lines of Recommended Maximum Endurance Airspeed and Recommended Cruise Airspeed. At any point, for a given altitude and weight, may be read the specific range, CAS, TAS and Mach number (from the sub-scale), and the approximate per cent rpm and fuel flow may be interpolated. The line for Recommended Cruise Airspeed is given for the higher speed at which 99% of the maximum specific range may be obtained. This allows a substantial increase in cruise speed for only 1% decrease in range. These curves illustrate the advantage of flying at the specified CAS for range instead of maintaining constant rpm as the weight decreases. If the pressure altitude and CAS (or Mach number) are maintained, the specific range given is independent of temperature but the TAS, fuel flow and engine speed will vary with temperature. Little is gained in range in a jet aircraft by increasing the cruise airspeed when flying into a headwind or by decreasing the airspeed in a tail wind except in uncommonly high winds. The ground miles per 1000 pounds of fuel may be determined by subtracting the head wind or adding the tail wind to the chart (no wind) TAS along a line of constant fuel flow. The lower ends of the Specific Range Curves are terminated at the line of minimum rpm required or at the minimum flyable airspeed. The Specific Range Curves are especially useful for planning flights for conditions other than those covered in the tabulated data. Use of these curves is illustrated in Sample Problems No. 1 through 3.

q. *Long Range Prediction—Distance Curves.* In figure A-16 are curves for Long Range Prediction—Distance based on the Recommended Cruise Speeds of the Specific Range Curves. They are integrals of specific range vs weight and therefore are used on an incremental basis. They give the maximum range attainable at a constant altitude and do not include climb or descent. These curves are independent of temperature.

r. Long Range Prediction—Distance Example: Assume that the gross weight is 16300 pounds at 35000 feet and it is desired to cruise for 303 air nautical miles. How much fuel will be consumed? Enter figure A-16 at 16300 pounds, move vertically to 35000 feet altitude, then left and read 522 air nautical miles. Add 303 and 522 obtaining 825 air nautical miles. Enter the chart at 825, move horizontally to the 35000 foot line, then vertically and read 15100 pounds. The fuel used will be 16300—15100 = 1200 pounds.

s. *Long Range Prediction—Time Curves.* In figure A-17 are curves for Long Range Prediction—Time. These curves give the cruise time for the ranges found in figure A-16. (They do not give maximum endurance.) They are similar to figure A-16 except that they are valid for standard temperatures only.

t. Long Range Prediction—Time Example: Find the cruise time required on a standard day for the example given in step r. In figure A-17 at 35000 feet read 76 minutes for 16300 pounds and 116 minutes for 15100 pounds. The cruise time is then 40 minutes.

u. *Maximum Range—Variable Altitude Curves.* In figure A-18 are curves which show the maximum cruise distance obtainable and the operating procedure required. This procedure takes advantage of the increase in specific range when the cruise altitude is allowed to increase as fuel is used. The recommended procedure for standard day conditions is to make a Military Thrust climb to the cruise ceiling (which is the cruise altitude shown in figure A-18), then level off and maintain .78 Mach number and the recommended rpm. This will allow the altitude to increase (at about 40 feet per minute) as fuel is consumed and will result in the maximum distance obtainable. The cruise distance and time shown are integrals of specific range and specific time vs fuel consumption and therefore, must be used incrementally.

v. Maximum Range—Variable Altitude Example: In planning a flight, it is determined that the cruise distance required (total distance minus climb and descent distance) is 580 air nautical miles and that when the cruise ceiling is reached during the Military Thrust climb, the weight will be 17000 pounds (cruise ceiling at 17000 pounds is 38300 feet). Entering figure A-18 at 17000 pounds, the initial cruise conditions are determined as 38300 feet, 92.5 per cent rpm and 246 knots CAS. On the distance and time curves are read 240 air nautical miles and 33 minutes, respectively. Adding the cruise distance of 580 air nautical miles to the initial indicated value of 240 air nautical miles results in the final indicated distance of 820 air nautical miles. Entering figure A-18 at 820 air nautical miles, the final weight is 14750 pounds and the indicated time is 110 minutes. The cruise fuel required is then 17000 −14750 =2250 pounds and the time required is 110 −33 =77 minutes. The final cruise conditions are 41200 feet altitude, 93.5 percent rpm and 230 knots CAS.

SAMPLE PROBLEM NO. 1—RADIUS PROBLEM.

Determine the maximum radius of a fighter mission. Take off with full fuel and climb immediately to optimum altitude for cruise-out. Descend to 30000 ft at the maximum radius and allow for 15 minutes of Military Thrust at 30000 ft. Expend 200 lb of ammunition. Climb to optimum altitude for cruise-back to the carrier. Allow for a reserve of 1000 lb when over the carrier at sea level. Since solution of a radius problem involves repetitive trial and error, it is allowable to decrease the reserve somewhat if necessary to avoid excessive calculating. The minimum reserve is 600 lb. The problem may be solved by use of either tables or graphs. Explanations of chart use are given in the following paragraphs. It is obvious that the tabular method, despite the interpolation required, is the simpler, but that the graphical method is the more accurate and allows the more complete use of the capabilities of the airplane. Standard atmosphere and zero winds are assumed.

SOLUTION USING TABLES.

a. The turn-up gross weight is 18570 lb, which may be obtained from 12600 lb (no fuel) + 5970 lb of fuel (JP-3 at 6.5 lb/gal).

b. The take-off fuel allowance is 460 lb obtained from figure A-5.

c. The descent distance and fuel are included in the range values in the Flight Operation Instruction Charts. However, reference should be made to the Minimum Time Descent Curves, figure A-9, to determine the proper airspeeds for descent.

d. The combat fuel allowance is obtained from figure A-12. The fuel flow at 30000 ft for Military Thrust is 59 lb/min. The total used for 15 minutes is 59 x 15 = 890 lb.

e. The reserve fuel is initially assumed to be 1000 lb.

f. The fuel available for climbs and cruise is 5970 (total) —460 (take-off) —890 (combat) —1000 (reserve) = 3620 lb. Assume that 2160 lb are used for climb and cruise-out. The weight after take-off is 18570 (turn-up) —460 (take-off) = 18110 lb. Entering the Flight Operation Instruction Charts, figure A-14, sheet 1, in the sea level column read 390 nautical miles range at optimum altitude of 35000 ft for 2200 lb of fuel and 292 nautical miles for 1800 lb of fuel. Interpolating for 2160 lb, the difference between these tabulations is 98 nautical miles for 400 lb. For 2160 lb the distance will be 292 + (98 x 360 ÷ 400) = 380 nautical miles, which includes the climb-out to 35000 ft and descent to sea level. Although in this problem the descent after cruise-out is to only 30000 ft instead of to sea level, it is considered unnecessary to correct for the discrepancy because the specific range in the minimum-time descent is very nearly that of the cruise conditions.

g. The initial operating conditions for cruise-out are found at the bottom of the 35000 ft altitude column, figure A-14, sheet 2. Cruise should be at 270 knots CAS, requiring approximately 91% rpm. The ground speed is 455 knots. When the fuel on board is reduced to 3800 lb, the airplane gross weight will be 16400 lb and the operating conditions of figure A-14, sheet 4, should be followed.

h. The fuel available for climb and cruise-back is 3620 (total climb and cruise fuel) —2160 ("out" fuel) = 1460 lb. The weight at 30000 ft after combat is 18570 (turn-up) —460 (take-off) —2160 (climb and cruise-out) —890 (combat) —200 (ammunition) = 14860 lb. This value could have been obtained from 12600 (no fuel) + 1460 (climb and cruise-back) + 1000 (reserve) —200 (ammunition) = 14860 lb. The desired "back" distance is 380 nautical miles. Entering the Flight Operation Instruction Charts, figure A-14, sheet 4, in the 30000 ft column read 427 nautical miles range at the optimum altitude of 35000 ft for 1800 lb of fuel, and 329 nautical miles for 1400 lb of fuel. The difference between these tabulations is 98 nautical miles for 400 lb. For 380 nautical miles distance the fuel required is 1400 + (400 x 49 ÷ 98) = 1610 lb.

i. As 1460 lb were initially allowed for climb and cruise-back, actual reserve is 1000 + 1460 —1610 = 850 lb.

j. The initial operating conditions for cruise-back are found at the bottom of the 35000 ft column in figure A-14, sheet 4. Cruise should be at 270 knots CAS, requiring approximately 90% rpm. The ground speed is 455 knots and let-down should be started 14 nautical miles from the carrier.

k. When 2100 lb of fuel remain on board, the airplane gross weight will be 12600 (no fuel) —200 (ammunition) + 2100 (fuel) = 14500 lb and the operating conditions for this weight, given in figure A-14, sheet 6, should be followed. At this weight, the fuel remaining for cruise is 2100 —1000 (reserve) = 1100 lb. Note that for this fuel tabulation at 35000 ft the optimum altitude remains 35000 ft. The CAS is 250 knots; approximate rpm required is 89%; let-down should be started 14 nautical miles from the carrier.

l. The approximate time may be found by using the total distance and the cruise speed. For the "out" leg: 380 (nautical miles) ÷ 455 (ground speed) gives 50.1 minutes. For the "back" leg: 380 (nautical miles) ÷ 450 (ground speed) gives 50.7 minutes.

SOLUTION USING GRAPHS.

a. The data from Solution Using Tables, steps a., b., d. and e. apply here: turn-up gross weight is 18570 lb, take-off fuel is 460 lb, combat allowance is 890 lb, and the reserve is initially assumed to be 1000 lb.

b. The initial climb-out weight is 18570 (turn-up) —460 (take-off) = 18110 lb. Entering the Climb Curves, figure A-7, at 18110 lb at sea level and moving up parallel to the guide line, it is seen that the cruise ceiling is approximately 35000 ft. The climb data to 35000 ft are: 83 nautical miles; time, 11.0 minutes; final climb weight, 17190 lb; fuel used, 18110 —17190 = 920 lb.

c. The descent data from 35000 ft to 30000 ft would be obtained from figure A-9, but for such a short descent the distance, fuel and time are negligible.

d. The Climb Curves, figure A-7, show that the cruise ceiling is approximately 40000 ft at 15250 lb weight. Since the weight at end of cruise-back will be approximately 12600 lb (no fuel) + 1000 (reserve) —200 (ammunition) = 13400 lb, the final cruise-back altitude will be 40000 ft. The descent-back will be from 40000 ft to sea level. Data from figure A-9: distance, 19 nautical miles; time, 3 minutes; fuel used, 50 lb.

e. The fuel available for cruise and climb-back is 5970 (total) —460 (take-off) —920 (climb-out) —890 (combat) —50 (descent-back) —1000 (reserve) = 2650 lb. Assume 250 lb of fuel for climb-back. The cruise fuel is then 2650 —250 = 2400 lb. Assume 1280 lb of fuel for cruise-out. The initial climb-back weight would be 17190 (initial cruise-out) —1280 (cruise-out) —0 (descent) —890 (combat) —200 (ammunition) = 14820 lb. From figure A-7 the climb-back data to 40000 ft are: distance, 36 nautical miles; time, 4.7 minutes; final climb weight, 14560 lb; fuel used, 14820 —14560 = 260 lb. (An error in the assumed initial climb weight of up to 200 lb has negligible effect.)

f. The assumed total cruise fuel is 2650 —260 = 2390 lb. With 1280 lb of cruise-out fuel and an initial cruise-out weight of 17190 lb, the final cruise-out weight is 15910 lb. In the Long Range Prediction—Distance Curves, figure A-16, at 35000 ft read 302 nautical miles for 17190 lb and 620 nautical miles for 15910 lb. The cruise-out distance is 620 —302 = 318 air nautical miles. The total out distance is 83 (climb) + 318 (cruise) = 401 air nautical miles.

g. The required cruise-back distance is 401 (total-out) —36 (climb-back) —19 (descent-back) = 346 nautical miles. The initial cruise-back weight is 14560 lb (step e.). In figure A-16 for 40000 ft read 930 nautical miles and 14560 lb. For 930 + 346 = 1276 nautical miles read 13300 lb. Cruise-back fuel required is 14560 —13300 = 1260 lb. The actual reserve is 5970 (total) —460 (take-off) —920 (climb-out) —1280 (cruise-out) —890 (combat) —260 (climb-back) —1260 (cruise-back) —50 (descent-back) = 850 lb.

h. The cruise times are found from the Long Range Prediction—Time Curves. For cruise-out, in figure A-17, at 35000 ft read 48 minutes for 17190 lb and 89 minutes for 15910 lb. The cruise-out time is 89 —48 = 41 minutes. The total out time is 11.0 (climb) + 41 (cruise) + 0 (descent) = 52 minutes.

i. For cruise-back time, in figure A-17 at 40000 ft read 122 minutes for 14560 lb and 168 minutes for 13300 lb. The cruise-back time is 46 minutes. The total back time is 4.7 (climb) + 46 (cruise) + 3 (descent) = 53.7 minutes.

j. The initial operating conditions for cruise-out are found from the Specific Range Curves, figure A-15, sheet 8. For the initial cruise-out weight of 17190 lb read recommended cruise airspeed of 270 knots CAS, which requires approximately 91% rpm and 1920 lb/hr fuel flow. The TAS (ground speed in zero wind) is 457 knots.

k. The initial operating conditions for cruise-back are found from figure A-15, sheet 9. For the initial cruise-back weight of 14560 lb read recommended cruise airspeed of 240 knots CAS, which requires approximately 93% rpm and 1670 lb/hr fuel flow. The TAS is 453 knots.

l. Note that for both solutions the reserves were equal but that the radius obtained by the tabular method was 380 nautical miles while the graphical method resulted in 401 nautical miles.

SAMPLE PROBLEM NO. 2—RANGE PROBLEM.

Determine the maximum ferry range that can be obtained with full fuel so that there will be a reserve of 1000 lb when over the destination at sea level. Winds along the route are of the following intensities: sea level to 15000 ft, zero wind; 20000 to 40000 ft, 40 knot head wind.

SOLUTION USING TABLES.

a. The turn-up gross weight is 12600 (no fuel) + 5970 (JP-4 at 6.5 lb/gal) = 18570 lb.

b. Take-off fuel, from figure A-5, is 460 lb.

c. The initial climb weight at sea level is 18570 (turn-up) —460 (take-off) = 18110 lb.

d. Reserve is 1000 lb.

e. Fuel available for climb and cruise is 5970 (turn-up) —460 (take-off) —1000 (reserve) = 4510 lb.

f. In the sea level column of the Flight Operation Instruction Charts gross weight of 18110 lb, figure A-14, sheet 1, it is seen that the best distance would be made by climbing immediately to 35000 ft, if there were no wind. Under those conditions, the range with 4600 lb of fuel would be 993 air nautical miles, and with 4200 lb of fuel it would be 887 air nautical miles. The difference is 106 nautical miles for 400 lb. Interpolating for 4510 lb the range would be 887 + (106 x 310 ÷ 400) = 969 air nautical miles. With the 40 knot head wind, the range factor of .91 found in the 35000 ft column (figure A-14, sheet 2) must be applied. The resulting range is 969 x .91 = 882 ground nautical miles.

g. The initial cruise CAS is 270 knots, which requires approximately 91% rpm and results in 415 knot ground speed. Let-down should be started 13 ground nautical miles from destination.

h. Since the best specific range for a given wind condition is obtained at the highest attainable altitude, and since the head wind velocity at 15000 ft and below is zero, it may be that the range at 15000 ft will be better than at 35000 ft. The climb data from sea level at 18110 lb gross weight to 15000 ft are obtained from figure A-7. The distance is 27 nautical miles and the weight at 15000 ft is 17700 lb. The fuel used is therefore 18110 —17700 = 410 lb. The fuel available for cruise and descent is then 5970 (turn-up) —460 (take-off) —1000 (reserve) —410 (climb) = 4100 lb. Entering figure A-14, sheet 1, in the 15000 ft column, the range for 4200 lb is 599 (cruise) + 27 (climb) = 626 nautical miles. Since this is much less than the 882 nautical miles range attainable at 35000 ft, the flight should be made at 35000 ft.

i. Note that if the head wind velocities were different for all altitudes, it might be necessary to find the range at three or more altitudes to determine the optimum cruise altitude.

j. When the fuel on board has decreased to 1900 lb, the airplane gross weight will be 14500 lb and the operating instructions should be obtained from figure A-14, sheet 6. At this weight the optimum altitude remains at 35000 ft.

SOLUTION USING GRAPHS.

a. The turn-up gross weight is 12600 (no fuel) +5970 (JP-4 at 6.5 lb/gal) = 18570 lb.

b. Take-off fuel from figure A-5, is 460 lb.

c. The initial climb weight at sea level is 18570 (turn-up) —460 (take-off) = 18110.

d. Reserve is 1000 lb.

e. Fuel available for climb and cruise is 5970 (turn-up) —460 (take-off) —1000 (reserve) = 4510 lb.

f. The highest cruise altitude for this initial weight is found by entering the Climb Curves, figure A-7, at 18110 lb at sea level and moving parallel to the guide line up to the altitude line just below the cruise ceiling. At 35000 ft the distance during climb is 83 air nautical miles and the weight after climb is 17190 lb. The fuel used is 18110 —17190 = 920 lb.

g. The descent data found in figure A-9 from 35000 ft to sea level are 14 air nautical miles and 40 lb of fuel.

h. Fuel available for cruise at 35000 ft is 5970 (turn-up) —460 (take-off) —920 (climb) —40 (descent) —1000 (reserve) = 3550 lb. In figure A-16 at 35000 ft for 17190 lb read 302 air nautical miles. For 17190 —3550 = 13640 lb read 1215 air nautical miles. The cruise distance is 1215 —302 = 913 air nautical miles. The total range at 35000 ft is 83 (climb) + 913 (cruise) + 14 (descent) = 1010 air nautical miles.

i. The operating conditions are found in the Specific Range Curves, figure A-15, to be 270 knots CAS, requiring approximately 91% rpm initially. The TAS is 457 knots and the ground speed with a 40 knot head wind is 417 knots. The range factor is then 417 ÷ 457 = .91. The actual range is 1010 air nautical miles x .91 = 919 ground nautical miles. This compares with the 882 ground nautical miles obtained by the tabular method.

j. It may be determined from the Climb Curves, figure A-7, and the Long Range Prediction—Distance Curves, figure A-16, that at a weight of 15250 lb or less, flight may be maintained at 40000 ft without exceeding the cruise ceiling. The range will be recalculated based on cruising at 40000 ft when possible.

k. To arrive at 40000 ft at 15250 lb, figure A-7 shows that the weight at 35000 ft must be 15450 lb resulting in 200 lb required for climb. The climb distance is 26 air nautical miles.

l. From step h., the initial cruise weight at 35000 ft is 17190 lb. The final weight is 15450 lb when fuel on board is 4590 lb, or 5970 (turn-up) —460 (take-off) —920 (climb to 35000 ft) = 4590 lb. From figure A-16 the distance covered at 35000 ft is 435 air nautical miles. Fuel used is 1740 lb.

m. The descent from 40000 ft to sea level requires 50 lb of fuel and 19 air nautical miles from figure A-9.

n. The fuel available for cruise at 40000 ft is 5970 (turn-up) —460 (take-off) —920 (sea level to 35000 ft) —1740 (cruise at 35000 ft) —200 (35000 to 40000 ft) —50 (40000 ft to sea level) —1000 (reserve) = 1600 lb. The final cruise weight at 40000 ft is 15250 —1600 = 13650 lb, and fuel on board is 5970 (turn-up) —460 (take-off) —920 (sea level to 35000 ft) —1740 (cruise at 35000 ft) —200 (35000 to 40000 ft) —1600 (cruise at 40000 ft) = 1050 lb. The cruise distance at 40000 ft from figure A-16, is 436 air nautical miles.

o. The total distance covered is 83 (sea level to 35000 ft) + 435 (cruise at 35000 ft) + 26 (35000 to 40000 ft) + 436 (cruise at 40000 ft) + 19 (40000 ft to sea level) = 999 air nautical miles. This figure compares with 1010 air nautical miles obtained by the graphical method of conducting the entire cruise at 35000 ft constant altitude and 969 air nautical miles obtained by the tabular method cruising at 35000 ft constant altitude.

SAMPLE PROBLEM NO. 3—IN-FLIGHT RANGE PROBLEM—ARBITRARY AIRSPEED.

While returning from a mission, a request is received to escort closely another aircraft which is making 240 knots CAS at 20000 ft. The fuel on board is 1500 lb. Determine if it is possible to maintain this escort the 150 nautical miles to the carrier and have sufficient (600 lb) reserve when over the carrier at sea level. The effective wind is zero.

SOLUTION TO SAMPLE PROBLEM NO. 3.

a. The descent data from 20000 ft to sea level are obtained from figure A-9: time, 1.0 minutes; distance, 4 nautical miles; fuel, 20 lb. The cruise distance is then 150 —4 = 146 nautical miles. The fuel remaining for cruise and reserve is 1500 —20 = 1480 lb.

b. The initial cruise weight is 12600 + 1500 (fuel on board) = 14100 lb. Assuming 600 lb reserve, the cruise fuel will be 1500 (on board) —20 (descent) —600 (reserve) = 880 lb. The assumed average cruise weight is 14100 —(880 ÷ 2) = 13660 lb. In the Specific Range Curves, figure A-15, sheet 5, for 240 knots CAS and 13660 lb weight at 20000 ft altitude the average specific range is .171 miles per pound of fuel. Dividing the 146 nautical miles cruise distance by .171 gives approximately 850 lb of fuel required for cruise.

c. The reserve will be 1500 (fuel on board) —850 (cruise) —20 (descent) =630 lb.

d. The average operating conditions read from figure A-15, sheet 5, for 240 knots CAS are approximately 81.5% rpm and 1900 lb/hr fuel flow. The TAS obtained from the bottom scale is 322 knots.

e. The cruise time is 146 ÷ 322 = .453 hour = 27.2 minutes. The total time to the carrier is 27.2 + 1.0 = 28.2 minutes.

SYMBOLS AND DEFINITIONS.

CAS = Calibrated Airspeed = Instrument Reading + Instrument Correction + Position Error Correction

IAS = Indicated Airspeed = Instrument Reading + Instrument Correction

TAS = True Airspeed

N.MI/LB = Air Nautical Miles per Pound Fuel

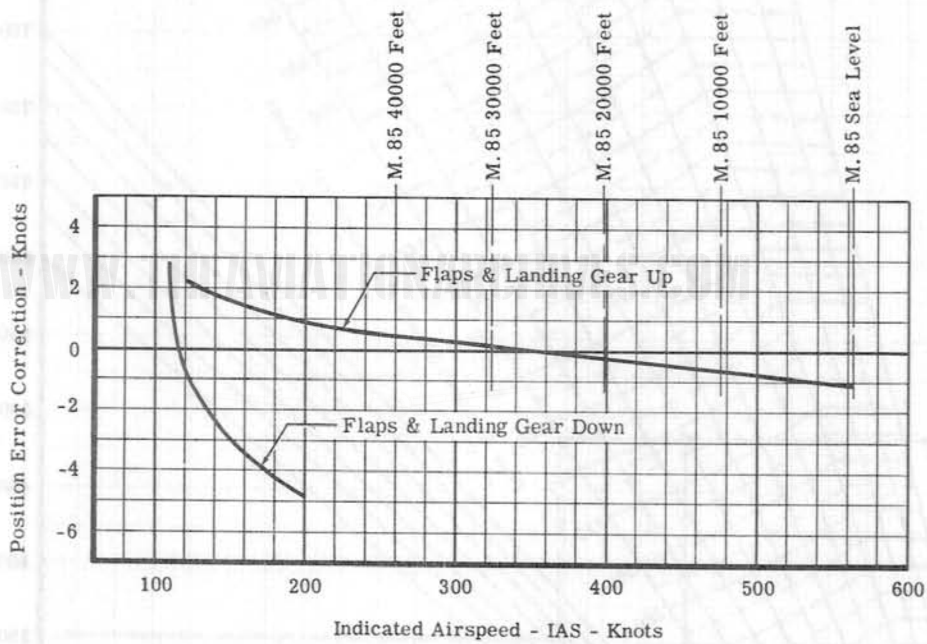
W = Airplane Gross Weight in Pounds

Appendix I of this publication shall not be carried in aircraft on combat missions or when there is a reasonable chance of its falling into the hands of an unfriendly nation.

AIRSPEED POSITION ERROR CORRECTIONS

NO EXTERNAL STORES

MODEL(S): F9F-7



REMARKS:
1. Add correction to corrected instrument reading (IAS) to obtain CAS.
2. Valid for all weights.
3. Valid only below Mach 0.85.

DATA AS OF: 15 January 1953
DATA BASIS: GAEC Calibration No. 31

Figure A-1. Airspeed Installation Error Correction Curves

AIRSPEED - MACH NUMBER CURVES

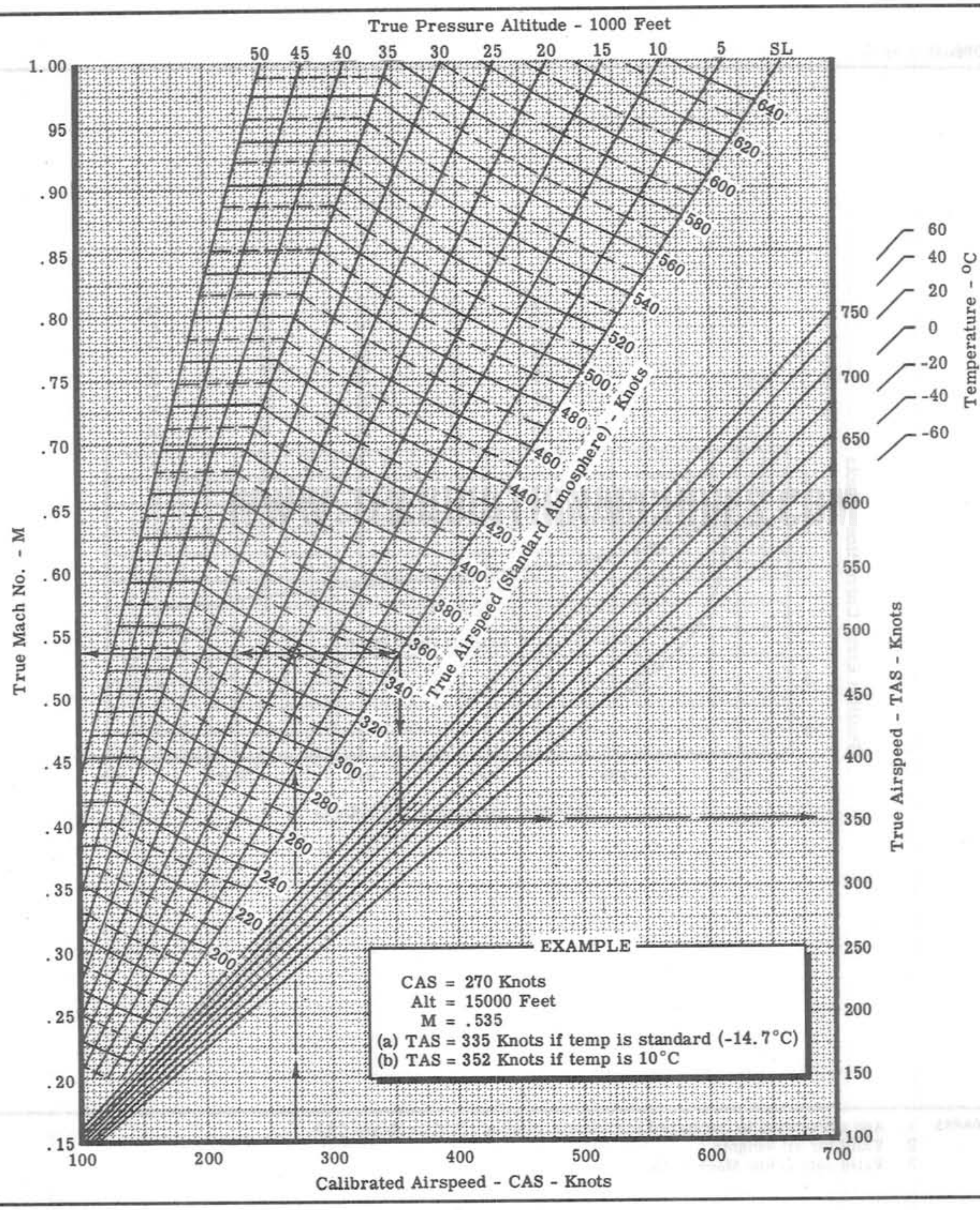


Figure A-2. Airspeed-Mach Number Curves

STANDARD ALTITUDE TABLE

Standard Sea Level Air:
T = 15° C. W = .07651 lb/cu. ft. ρ_0 = .002378 slugs/cu. ft.
P = 29.921 in. of Hg. 1" of Hg. = 70.732 lb/sq. ft. = 0.4912 lb/sq. in.
This table is based on NACA Technical Report No. 218 a_o - 1116 ft./sec.

Altitude feet	Density Ratio ρ/ρ_0	$\frac{1}{\sqrt{\sigma}}$	Temperature Deg. C	Temperature Deg. F	Speed of Sound Ratio a/a_o	Pressure In. of Hg.	Pressure Ratio P/Po
0	1.0000	1.0000	15.000	59.000	1.0000	29.92	1.0000
1000	.9710	1.0148	13.019	55.434	.997	28.86	.9644
2000	.9428	1.0299	11.038	51.868	.993	27.82	.9298
3000	.9151	1.0454	9.056	48.301	.990	26.81	.8962
4000	.8881	1.0611	7.075	44.735	.986	25.84	.8636
5000	.8616	1.0773	5.094	41.169	.983	24.89	.8320
6000	.8358	1.0938	3.113	37.603	.979	23.98	.8013
7000	.8106	1.1107	1.132	34.037	.976	23.09	.7716
8000	.7859	1.1280	-0.850	30.471	.972	22.22	.7427
9000	.7619	1.1456	-2.831	26.904	.968	21.38	.7147
10000	.7384	1.1637	-4.812	23.338	.965	20.58	.6876
11000	.7154	1.1822	-6.793	19.772	.962	19.79	.6614
12000	.6931	1.2012	-8.774	16.206	.958	19.03	.6359
13000	.6712	1.2206	-10.756	12.640	.954	18.29	.6112
14000	.6499	1.2404	-12.737	9.074	.950	17.57	.5873
15000	.6291	1.2608	-14.718	5.507	.947	16.88	.5642
16000	.6088	1.2816	-16.699	1.941	.943	16.21	.5418
17000	.5891	1.3029	-18.680	-1.625	.940	15.56	.5202
18000	.5698	1.3247	-20.662	-5.191	.936	14.94	.4992
19000	.5509	1.3473	-22.643	-8.757	.932	14.33	.4790
20000	.5327	1.3701	-24.624	-12.323	.929	13.75	.4594
21000	.5148	1.3937	-26.605	-15.890	.925	13.18	.4405
22000	.4974	1.4179	-28.586	-19.456	.922	12.63	.4222
23000	.4805	1.4426	-30.568	-23.022	.917	12.10	.4045
24000	.4640	1.4681	-32.549	-26.588	.914	11.59	.3874
25000	.4480	1.4940	-34.530	-30.154	.910	11.10	.3709
26000	.4323	1.5209	-36.511	-33.720	.906	10.62	.3550
27000	.4171	1.5484	-38.493	-37.287	.903	10.16	.3397
28000	.4023	1.5768	-40.474	-40.853	.899	9.720	.3248
29000	.3879	1.6056	-42.455	-44.419	.895	9.293	.3106
30000	.3740	1.6352	-44.436	-47.985	.891	8.880	.2968
31000	.3603	1.6659	-46.417	-51.551	.887	8.483	.2834
32000	.3472	1.6971	-48.399	-55.117	.883	8.101	.2707
33000	.3343	1.7295	-50.379	-58.684	.879	7.732	.2583
34000	.3218	1.7628	-52.361	-62.250	.875	7.377	.2465
35000	.3098	1.7966	-54.342	-65.816	.871	7.036	.2352
36000	.2962	1.8374	-55.000	-67.000	.870	6.708	.2242
37000	.2824	1.8818	-55.000	-67.000	.870	6.395	.2137
38000	.2692	1.9273	-55.000	-67.000	.870	6.096	.2037
39000	.2566	1.9738	-55.000	-67.000	.870	5.812	.1943
40000	.2447	2.0215	-55.000	-67.000	.870	5.541	.1852
41000	.2332	2.0707	-55.000	-67.000	.870	5.283	.1765
42000	.2224	2.1207	-55.000	-67.000	.870	5.036	.1683
43000	.2120	2.1719	-55.000	-67.000	.870	4.802	.1605
44000	.2021	2.2244	-55.000	-67.000	.870	4.578	.1530
45000	.1926	2.2785	-55.000	-67.000	.870	4.364	.1458
46000	.1837	2.3332	-55.000	-67.000	.870	4.160	.1391
47000	.1751	2.3893	-55.000	-67.000	.870	3.966	.1325
48000	.1669	2.4478	-55.000	-67.000	.870	3.781	.1264
49000	.1591	2.5071	-55.000	-67.000	.870	3.604	.1205
50000	.1517	2.5675	-55.000	-67.000	.870	3.436	.1149

Figure A-3. Standard Atmosphere Table

DENSITY ALTITUDE CURVE

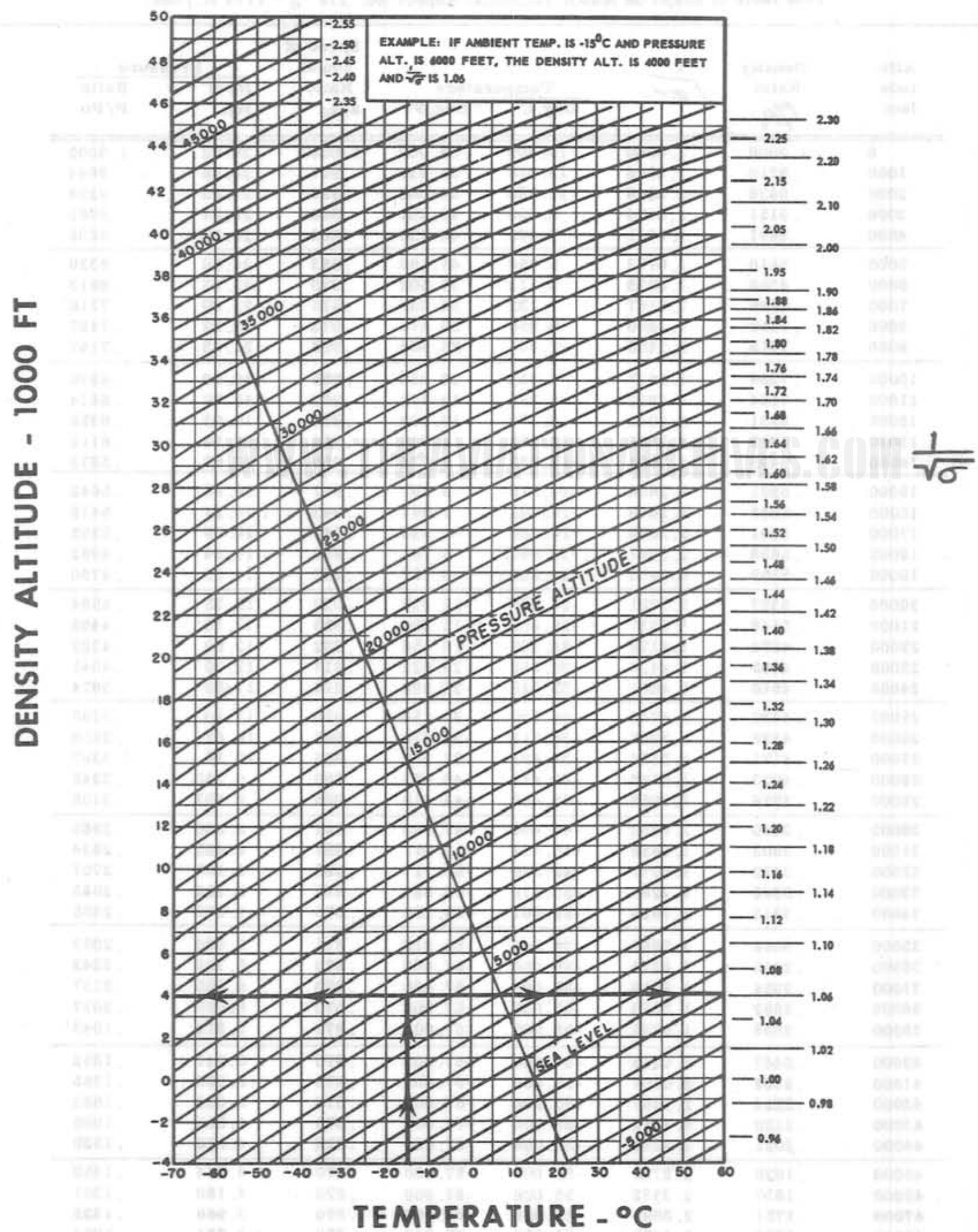


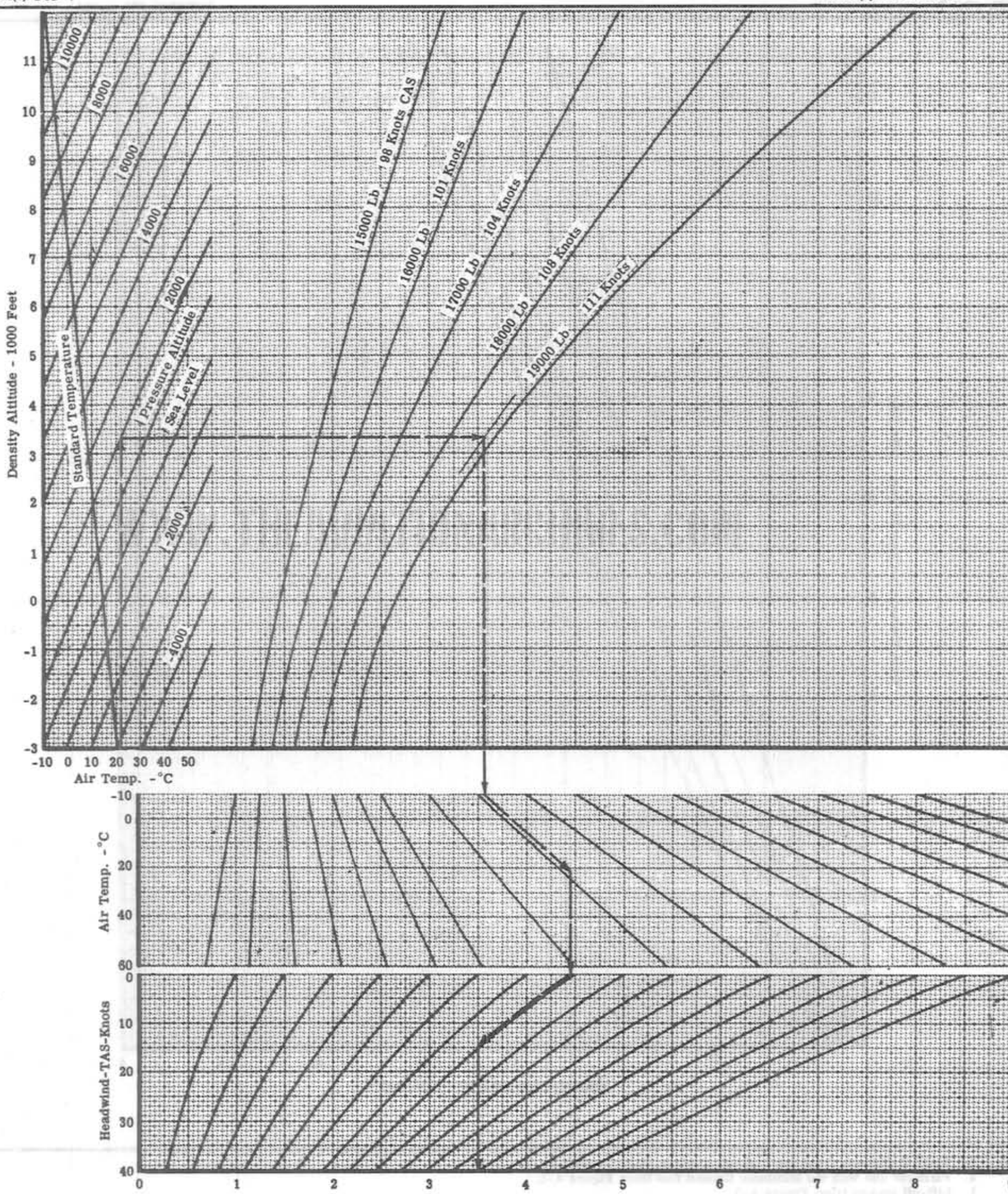
Figure A-4. Density Altitude Curves

TAKE-OFF CURVES

HARD SURFACE RUNWAY

MODEL(S): F9F-7

ENGINE(S): J33-A-16A



REMARKS:
1. Lift-off CAS is given for each weight.
2. See Section II, Take-off paragraph for take-off technique.
3. Allow 460 Lb of fuel for Start, Taxi, Take-off and Accelerate to Climb Speed.

DATA AS OF: 15 January 1953
DATA BASIS: Estimated

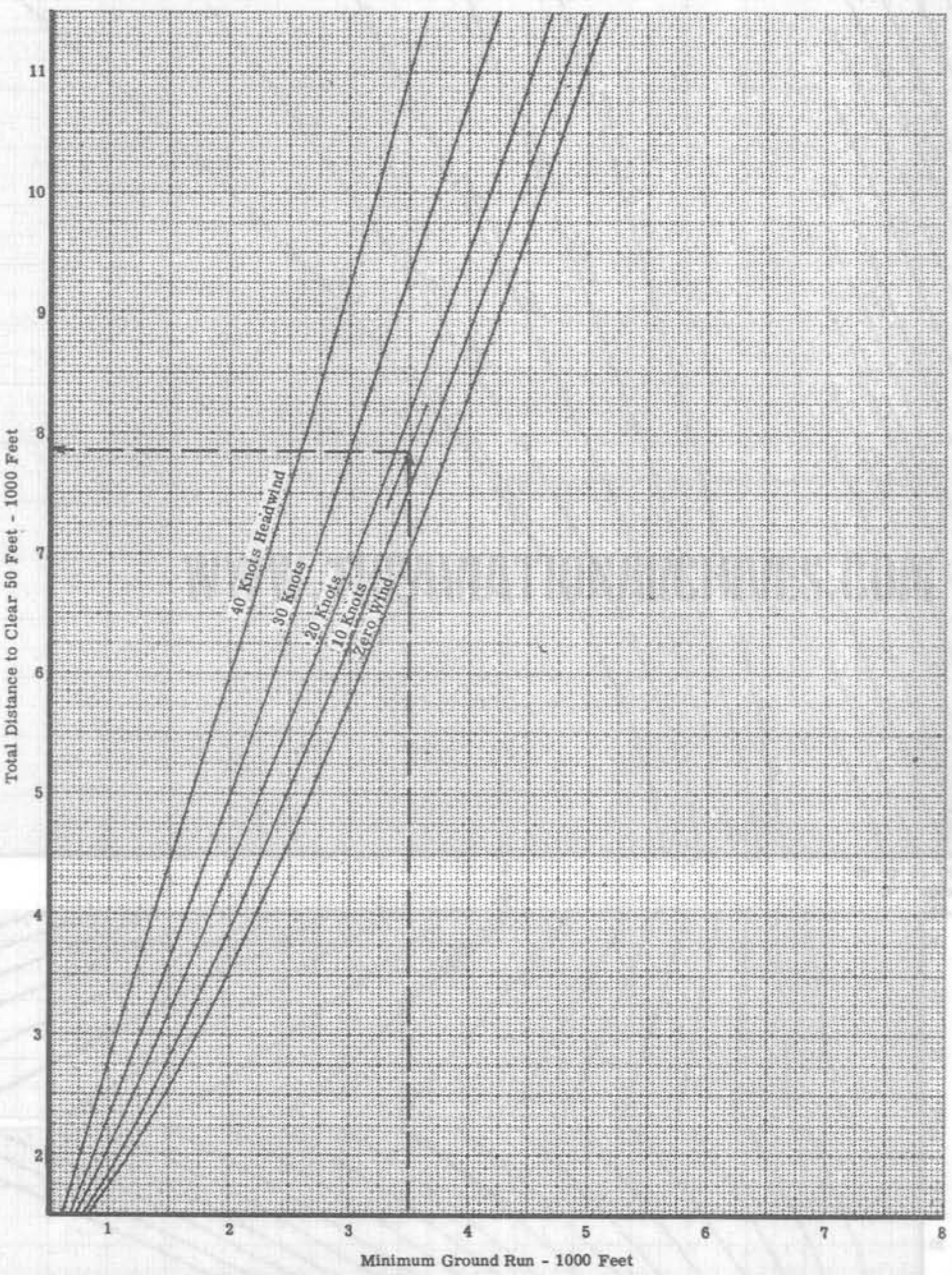
FUEL GRADE AND DENSITY: MIL-F-5624A (JP-3 or JP-4) 6.5 Lb/Gal; MIL-F-5572 (AVGAS) 6.0 Lb/Gal

Figure A-5. Take-Off Distance Curves

TAKE-OFF DISTANCE OVER 50 FOOT HEIGHT

HARD SURFACE RUNWAY

MODEL(S): F9F-7 ENGINE(S): J33-A-16A



REMARKS:
1. Total distance is from start of roll to clear 50 foot height.
2. Valid for use with the Minimum Ground Run from Figure A-5.
3. Lift-off speeds from Figure A-5.
4. Prescribed calibrated airspeeds for climb over a 50 foot height: 15000 Lb - 113 Knots, 16000 Lb - 117 Knots, 17000 Lb - 120 Knots, 18000 Lb - 124 Knots, 19000 Lb - 127 Knots.
5. See Section II of AN 01-85FGE-1 for take-off technique.

DATA AS OF: 15 January 1953
DATA BASIS: Estimated

FUEL GRADE AND DENSITY: MIL-F-5624A (JP-3 or JP-4) 6.5 Lb/Gal; MIL-F-5572 (AVGAS) 6.0 Lb/Gal

Figure A-6. Take-Off Distance to Clear 50 Foot Obstacle Curves

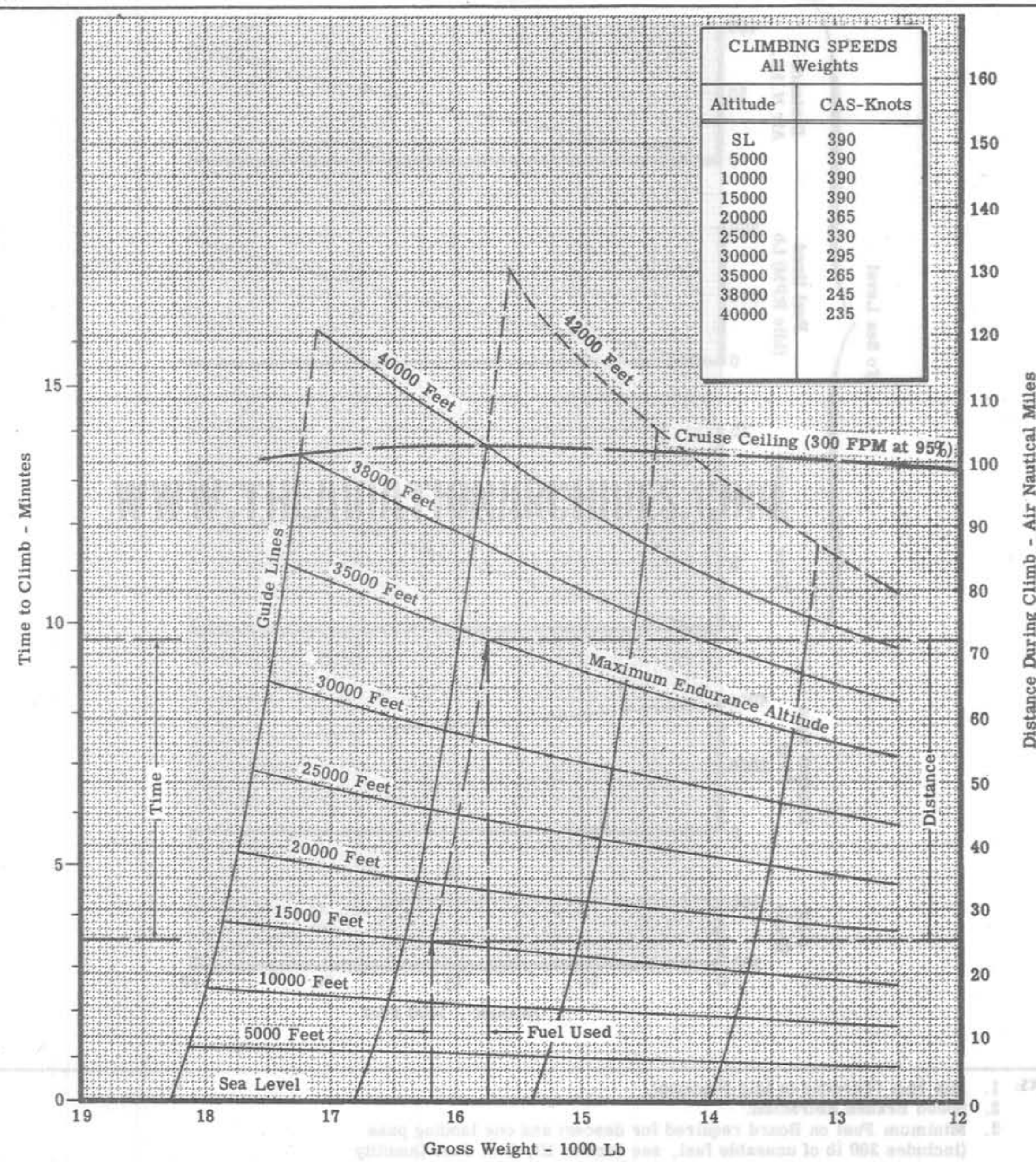
MILITARY THRUST CLIMB, DISTANCE, FUEL and TIME

STANDARD DAY

CONFIGURATION A

MODEL(S): F9F-7

ENGINE(S): J33-A-16A



REMARKS:
1. Climb at 100% RPM.
2. Observe Tailpipe Temperature Limits (See Figure 5-3 Engine Operating Limitation Table).
3. For Each 1°C above Standard Temperature, increase Distances by 2.1%, Fuel Used by 1.3%, and Time by 1.9%.
4. Example from step g., Description of Charts and Tables.

DATA AS OF: 30 March 1953

DATA BASIS: NATC Report FT31-0107 and GAEC Flight Tests.

FUEL GRADE AND DENSITY: MIL-F-5624A (JP-3 or JP-4) 6.5 Lb/Gal; MIL-F-5572 (AVGAS) 6.0 Lb/Gal

Figure A-7. Climb Curves

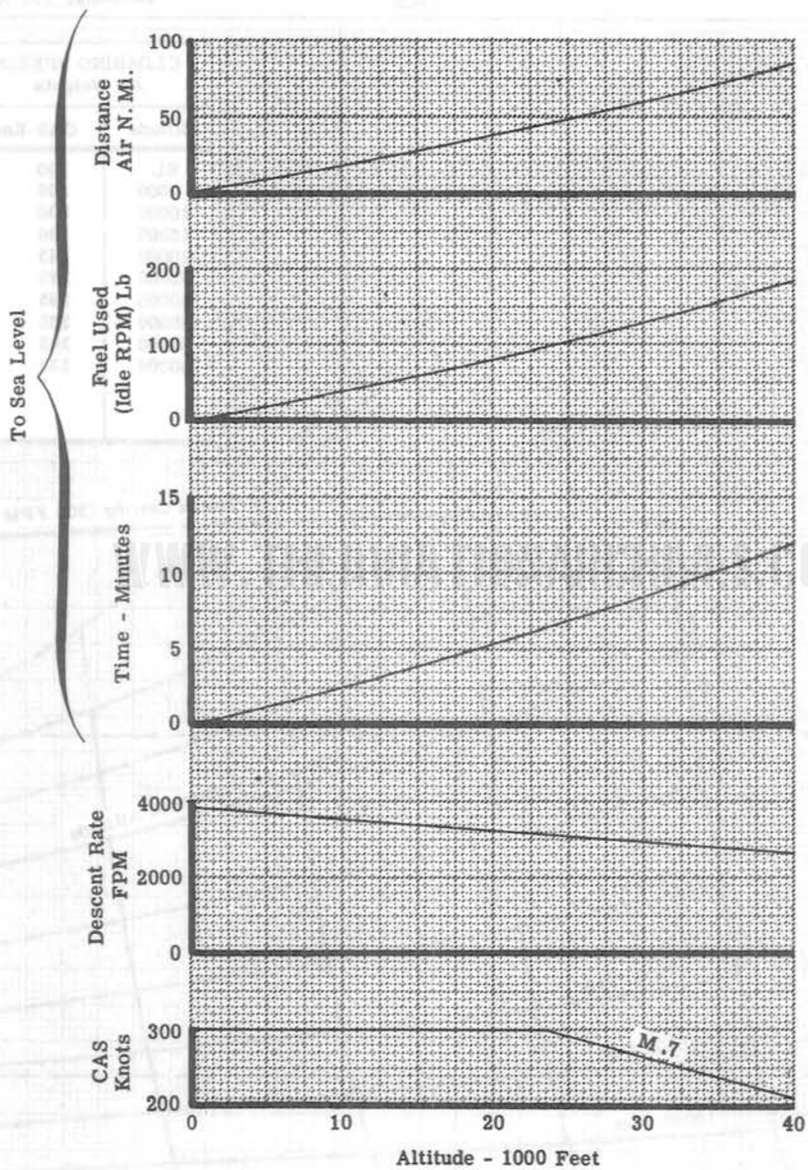
OPTIMUM DESCENT

STANDARD DAY

CONFIGURATION A

MODEL(S): F9F-7

ENGINE(S): J33-A-16A



REMARKS:
1. Idle rpm (Throttle in Idle Position).
2. Speed Brakes Retracted.
3. Minimum Fuel on Board required for descent and one landing pass (includes 200 lb of unusable fuel, see Section III, Low Fuel Quantity paragraph).

Altitude - Feet	40000	30000	20000	10000	SL
Fuel - Lb	640	580	530	490	450

DATA AS OF: 16 June 1953
DATA BASIS: NATC Flight Tests; Report TT31-73

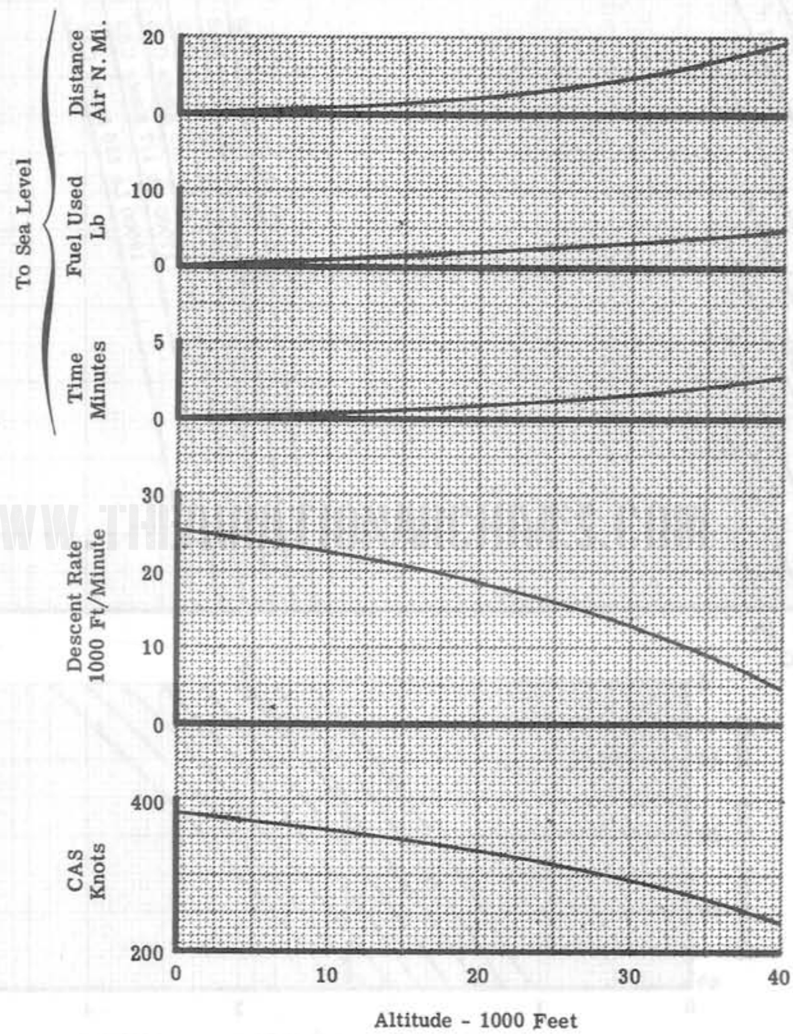
FUEL GRADE AND DENSITY: MIL-F-5624A (JP-3 or JP-4) 6.5 Lb/Gal; MIL-F-5572 (AVGAS) 6.0 Lb/Gal

Figure A-8. Optimum Descent Curves, Configuration A

MINIMUM TIME DESCENT

CONFIGURATION A

MODEL(S): F9F-7 | SPEED BRAKES EXTENDED | ENGINE(S): J33-A-16A



REMARKS:
1. Throttle in Idle Detent.
2. Maintain specified airspeed.
3. Based on 15500 Lb Weight.
4. Approximate altitude loss during pull-out
   2500 Feet at 4 "g"
   2000 Feet at 5 "g"
   1500 Feet at 6 "g"

DATA AS OF: 15 January 1953
DATA BASIS: GAEC Flight Test

FUEL GRADE AND DENSITY: MIL-F-5624A (JP-3 or JP-4) 6.5 Lb/Gal; MIL-F-5572 (AVGAS) 6.0 Lb/Gal

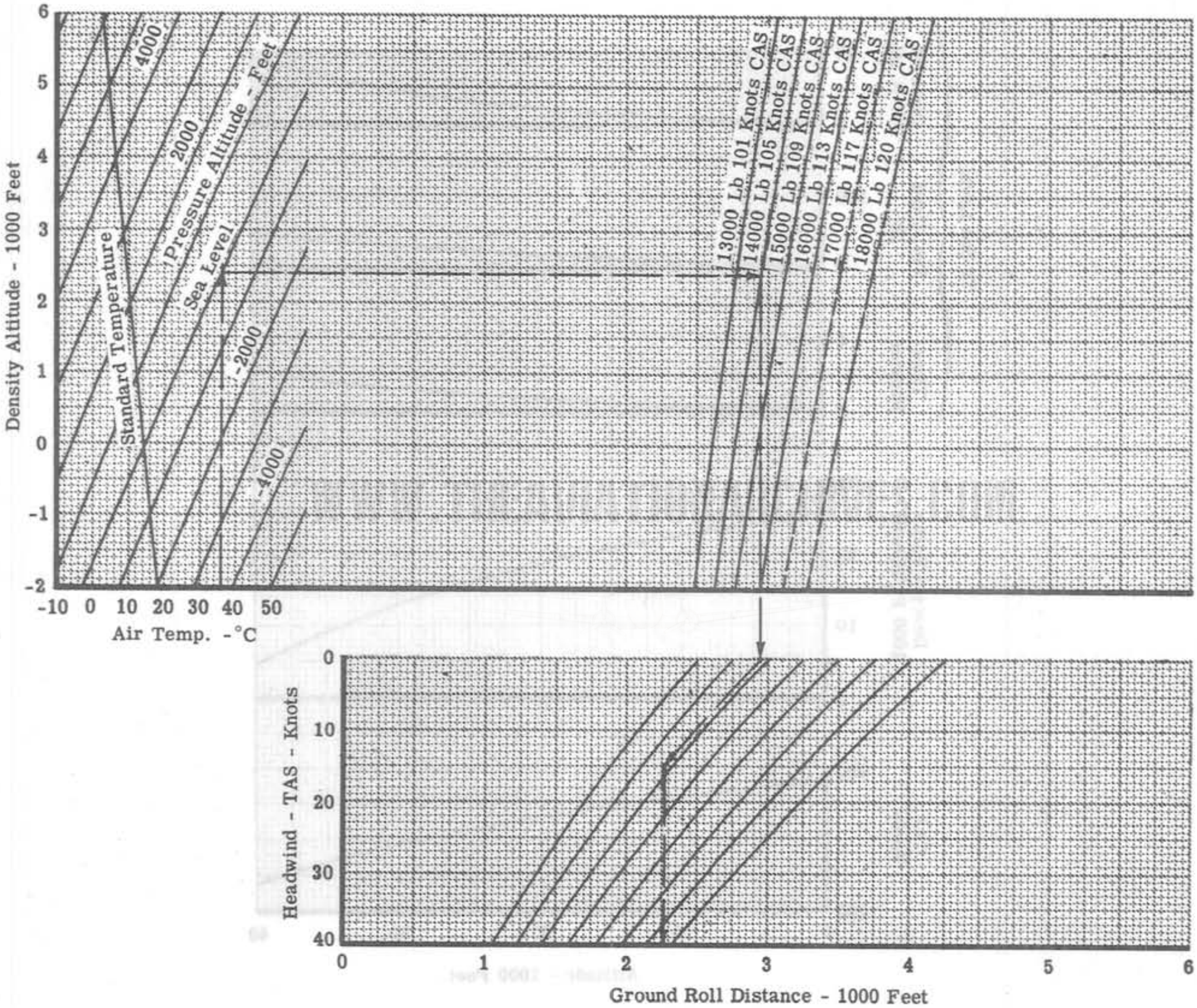
Figure A-9. Minimum Time Descent Curves

LANDING GROUND ROLL

HARD SURFACE RUNWAY

STANDARD DAY

MODEL(S): F9F-7 **ENGINE(S):** J33-A-16A



REMARKS:
1. Touchdown CAS is given for each weight.
2. Multiply Ground Roll Distance by 1.43 to obtain Total Distance from 50 Foot Obstacle.
3. Recommended approach airspeeds:

Weight - Lb	13000	14000	15000	16000	17000	18000
CAS - Knots	120	125	129	134	138	142

4. Example from step j., Description of Charts and Tables.
5. Dump wing tank fuel before landing.
6. For Maximum Allowable Landing Weights, see Section V.

DATA AS OF: 1 April 1953
DATA BASIS: Estimated

FUEL GRADE AND DENSITY: MIL-F-5624A (JP-3 or JP-4) 6.5 Lb/Gal; MIL-F-5572 (AVGAS) 6.0 Lb/Gal

Figure A-10. Landing Distance Curves

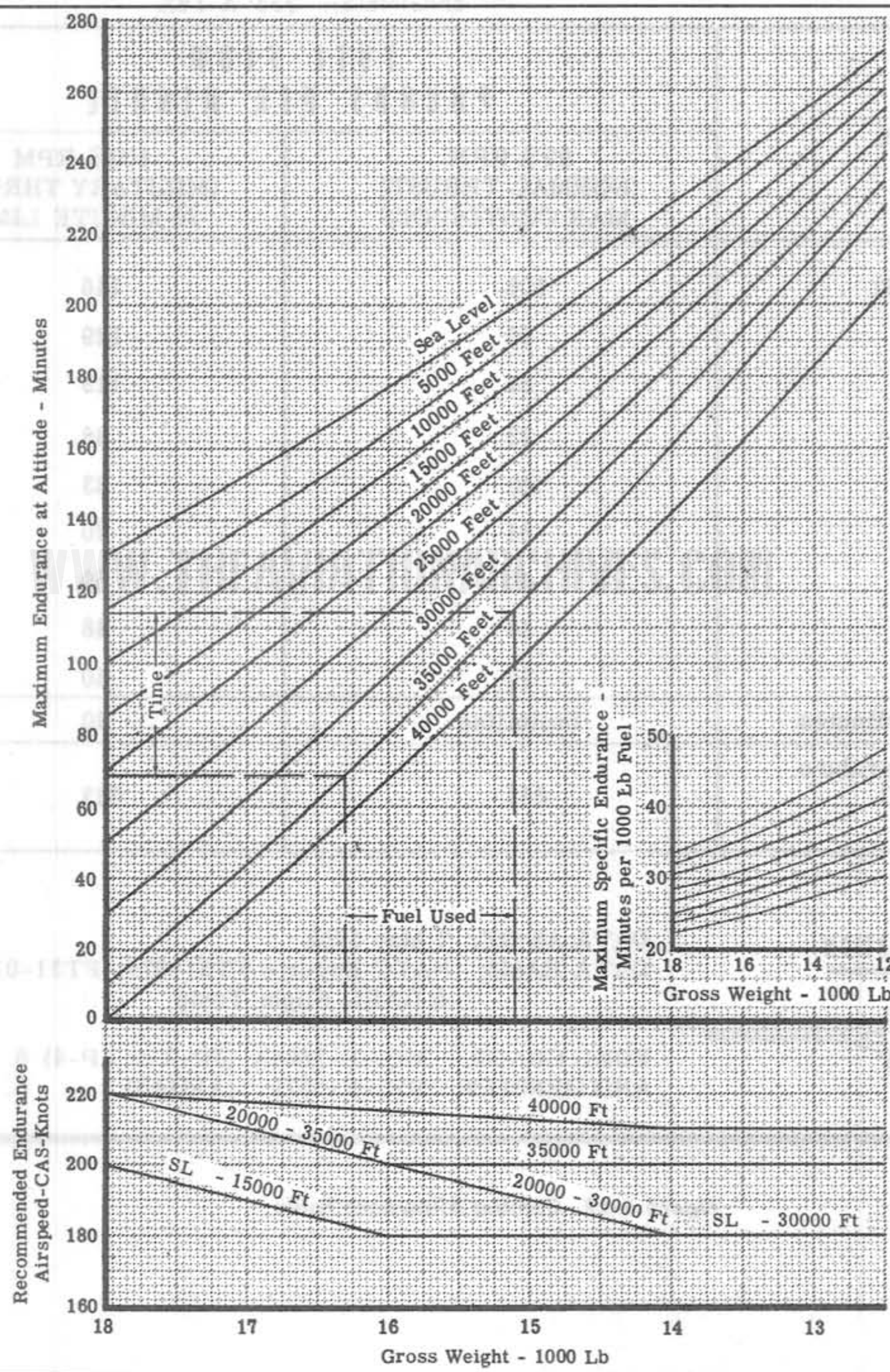
MAXIMUM ENDURANCE

STANDARD DAY

CONFIGURATION

MODEL(S): F9F-7

ENGINE(S): J33-A-16A



REMARKS: 1. Use on an incremental basis. Example from step 1., Description of Charts and Tables.
2. The maximum Endurance given is obtained with the Recommended Endurance Airspeeds.

DATA AS OF: 7 May 1952
DATA BASIS: NATC Reports FT31-075, FT31-0107 & GAEC Flight Tests

FUEL GRADE AND DENSITY: MIL-F-5624A (JP-3 or JP-4) 6.5 Lb/Gal
MIL-F-5572 (AVGAS) 6.0 Lb/Gal

Figure A-11. Maximum Endurance Curves

COMBAT ALLOWANCE CHART
STANDARD DAY

MODEL(S): F9F-7 ENGINE(S): J33-A-16A

AT ALTITUDE FEET	FUEL FLOW POUNDS PER MINUTE	
	95% RPM (NORMAL THRUST) MAX CONTINUOUS	100% RPM (MILITARY THRUST) 30 MINUTE LIMIT
SEA LEVEL	106	146
5000	95	129
10000	84	113
15000	73	98
20000	63	83
25000	54	70
30000	46	59
35000	38	48
40000	32	40
Time Limit - Minutes	Unlimited	30
Tailpipe Temperature Limit °C	657	732

REMARKS:

CONFIGURATION A

DATA AS OF: 7 May 1952
DATA BASIS: NATC Reports FT31-075, FT31-0107 & GAEC Flight Tests

FUEL GRADE AND DENSITY: MIL-F-5624A (JP-3 or JP-4) 6.5 Lb/Gal; MIL-F-5572 (AVGAS) 6.0 Lb/Gal

Figure A-12. Combat Allowance Table

MAXIMUM CONTINUOUS THRUST SUMMARY

STANDARD DAY

MODEL(S): F9F-7 **ENGINE(S):** J33-A-16A

WEIGHT: 18300 Lb | **WEIGHT:** 16400 Lb

APPROXIMATE LB/HR	APPROXIMATE TAS	APPROXIMATE CAS	% RPM	PRESSURE ALTITUDE FEET	% RPM	APPROXIMATE CAS	APPROXIMATE TAS	APPROXIMATE LB/HR
6350	495	495	95	Sea Level	95	495	495	6350
5700	505	475	95	5000	95	480	510	5700
5050	515	450	95	10000	95	450	515	5050
4400	520	425	95	15000	95	425	520	4400
3800	510	390	95	20000	95	395	515	3800
3250	510	360	95	25000	95	360	510	3250
2750	500	325	95	30000	95	325	500	2750
2300	480	285	95	35000	95	290	490	2300
--	-	-	95	40000	95	245	465	1900

WEIGHT: 14500 Lb | **WEIGHT:**

APPROXIMATE LB/HR	APPROXIMATE TAS	APPROXIMATE CAS	% RPM	PRESSURE ALTITUDE FEET	% RPM	APPROXIMATE CAS	APPROXIMATE TAS	APPROXIMATE LB/HR
6350	500	500	95	Sea Level				
5700	510	480	95	5000				
5050	515	450	95	10000				
4400	520	425	95	15000				
3800	515	395	95	20000				
3250	510	360	95	25000				
2750	510	330	95	30000				
2300	495	295	95	35000				
1900	475	250	95	40000				

REMARKS:

CAS: CALIBRATED AIRSPEED KNOTS
TAS: TRUE AIRSPEED KNOTS
LB/HR: FUEL CONSUMPTION

DATA AS OF: 7 May 1952
DATA BASIS: NATC Reports FT31-075, FT31-0107 & GAEC Flight Tests

FUEL GRADE AND DENSITY: MIL-F-5624A (JP-3 or JP-4) 6.5 Lb/Gal; MIL-F-5572 (AVGAS) 6.0 Lb/Gal

Figure A-13. Maximum Continuous Thrust Summary

Appendix I of this publication shall not be carried in aircraft on combat missions or when there is a reasonable chance of its falling into the hands of an unfriendly nation.

AIRCRAFT MODEL (S): F9F-7

ENGINE (S): J33-A-16A

FLIGHT OPERATION INSTRUCTION CHART

STANDARD DAY

CHART WT LIMITS 18300 TO 16400 POUNDS

CONFIGURATION

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

Tabulated range values include distance covered during Minimum Time Descent.

DATA AS OF: 7 May 1952

DATA BASIS: NATC Reports FT31-075, FT31-0107 & GAEC Flight Tests

LOW ALTITUDE

IF YOU ARE AT SEA LEVEL			FUEL LB	IF YOU ARE AT 5000 FT			IF YOU ARE AT 10000 FT			IF YOU ARE AT 15000 FT			FUEL LB	IF YOU ARE AT 20000 FT		
RANGE IN AIR MILES				RANGE IN AIR MILES			RANGE IN AIR MILES			RANGE IN AIR MILES				RANGE IN AIR MILES		
BY CRUISING AT SL	OPT. ALT 1000 FT	BY CRUISING AT OPT. ALT		BY CRUISING AT 5000 FT	OPT. ALT 1000 FT	BY CRUISING AT OPT. ALT	BY CRUISING AT 10000 FT	OPT. ALT 1000 FT	BY CRUISING AT OPT. ALT	BY CRUISING AT 15000 FT	OPT. ALT 1000 FT	BY CRUISING AT OPT. ALT		BY CRUISING AT 20000 FT	OPT. ALT 1000 FT	BY CRUISING AT OPT. ALT
				(RANGE FIGURES INCLUDE ALLOWANCES FOR PRESCRIBED CLIMB & DESCENT TO SEA LEVEL)												
544	40	1297	5800	622	40	1349	718	40	1378	834	40	1401	5800	977	40	1424
506	35	1204	5400	578	35	1235	668	35	1265	776	35	1285	5400	908	35	1307
467	35	1099	5000	534	35	1129	617	35	1158	717	35	1179	5000	830	35	1200
429	35	993	4600	490	35	1024	567	35	1053	658	35	1073	4600	771	35	1095
390	35	887	4200	446	35	918	516	35	947	599	35	968	4200	702	35	989
352	35	782	3800	402	35	812	465	35	841	541	35	862	3800	634	35	883
315	35	684	3400	360	35	712	416	35	739	482	35	757	3400	565	35	777
277	35	586	3000	317	35	612	366	35	640	425	35	659	3000	497	35	677
239	35	488	2600	275	35	516	317	35	542	368	35	561	2600	431	35	579
201	35	390	2200	232	35	417	268	35	444	311	35	462	2200	364	35	481
164	35	292	1800	189	35	319	218	35	346	254	35	364	1800	297	35	383
127	35	198	1400	147	35	224	169	35	249	197	35	267	1400	231	35	284
91	25	118	1000	105	25	137	121	30	158	141	30	172	1000	165	35	189
55	10	57	600	64	15	68	73	20	83	85	25	93	600	100	25	105
18	SL	18	200	22	5	22	25	10	25	29	15	29	200	34	20	34

CRUISING AT SEA LEVEL						EFFECTIVE WIND KNOTS	CRUISING AT 5000 FT						CRUISING AT 10000 FT						CRUISING AT 15000 FT						EFFECTIVE WIND KNOTS	CRUISING AT 20000 FT					
	APPROXIMATE							APPROXIMATE						APPROXIMATE						APPROXIMATE							APPROXIMATE				
CAS	% RPM	LB/HR	G.S.	RANGE FACTOR	LET-DOWN DIST.		CAS	% RPM	LB/HR	G.S.	RANGE FACTOR	LET-DOWN DIST.	CAS	% RPM	LB/HR	G.S.	RANGE FACTOR	LET-DOWN DIST.	CAS	% RPM	LB/HR	G.S.	RANGE FACTOR	LET-DOWN DIST.		CAS	% RPM	LB/HR	G.S.	RANGE FACTOR	LET-DOWN DIST.
355	85	3900	235	.66	0	120 HW	350	86	3550	255	.68	1	345	87	3300	275	.70	1	335	88	2950	295	.71	2	120 HW	330	88	2650	315	.72	4
355	85	3900	275	.78	0	80 HW	350	86	3550	295	.79	1	345	87	3300	315	.80	2	335	88	2950	335	.81	2	80 HW	330	88	2650	355	.82	4
355	85	3900	315	.89	0	40 HW	350	86	3550	335	.89	1	345	87	3300	355	.90	2	335	88	2950	375	.90	3	40 HW	330	88	2650	395	.91	5
355	85	3900	355	1.00	0	0	350	86	3550	375	1.00	1	345	87	3300	395	1.00	2	335	88	2950	415	1.00	3	0	330	88	2650	435	1.00	5
355	85	3900	395	1.11	0	40 TW	350	86	3550	415	1.11	1	345	87	3300	435	1.10	2	335	88	2950	455	1.10	3	40 TW	330	88	2650	475	1.09	5
355	85	3900	435	1.23	0	80 TW	350	86	3550	455	1.21	1	345	87	3300	475	1.20	2	335	88	2950	495	1.19	4	80 TW	330	88	2650	515	1.18	6
355	85	3900	475	1.34	0	120 TW	350	86	3550	495	1.32	1	345	87	3300	515	1.30	3	335	88	2950	535	1.29	4	120 TW	330	88	2650	555	1.28	6

Figure A-14. Flight Operation Instruction Charts (Sheet 1 of 6)

AIRCRAFT MODEL (S): F9F-7

ENGINE (S): J33-A-16A

HIGH ALTITUDE

CHART WT LIMITS 18300 TO 16400 POUNDS

CONFIGURATION

IF YOU ARE AT 25000 FT			FUEL LB	IF YOU ARE AT 30000 FT			IF YOU ARE AT 35000 FT			IF YOU ARE AT 40000 FT			FUEL LB	IF YOU ARE AT 45000 FT		
RANGE IN AIR MILES				RANGE IN AIR MILES			RANGE IN AIR MILES			RANGE IN AIR MILES				RANGE IN AIR MILES		
BY CRUISING AT 25000 FT	OPT. ALT 1000 FT	BY CRUISING AT OPT. ALT		BY CRUISING AT 30000 FT	OPT. ALT 1000 FT	BY CRUISING AT OPT. ALT	BY CRUISING AT 35000 FT	OPT. ALT 1000 FT	BY CRUISING AT OPT. ALT	BY CRUISING AT 40000 FT	OPT. ALT 1000 FT	BY CRUISING AT OPT. ALT		BY CRUISING AT 45000 FT	OPT. ALT 1000 FT	BY CRUISING AT OPT. ALT
				(RANGE FIGURES INCLUDE ALLOWANCES FOR PRESCRIBED CLIMB & DESCENT TO SEA LEVEL)												
1138	40	1447	5800	1304	40	1469	1476	35		1518			5800			
1058	35	1326	5400	1211	35	1349	1369	35		1409			5400			
977	35	1221	5000	1119	35	1242	1264	35		1300			5000			
897	35	1116	4600	1027	35	1136	1158	35		1192			4600			
817	35	1010	4200	934	35	1030	1052	35		1083			4200			
737	35	904	3800	842	35	925	946	35		974			3800			
657	35	798	3400	750	35	819	840	35		865			3400			
578	35	696	3000	657	35	717	732	35		757			3000			
500	35	598	2600	570	35	618	634	35		649			2600			
423	35	500	2200	482	35	520	536	35		549			2200			
346	35	402	1800	393	35	422	438	35		450			1800			
268	35	304	1400	305	35	324	340	35		350			1400			
192	35	207	1000	216	35	226	242	35		250			1000			
116	30	116	600	132	35	132	147	35		152			600			
41	25	41	200	46	30	46	52	35		55			200			

CRUISING AT 25000 FT						EFFECTIVE WIND KNOTS	CRUISING AT 30000 FT						CRUISING AT 35000 FT						CRUISING AT 40000 FT						EFFECTIVE WIND KNOTS	CRUISING AT 45000 FT					
	APPROXIMATE							APPROXIMATE						APPROXIMATE						APPROXIMATE							APPROXIMATE				
CAS	% RPM	LB/HR	G.S.	RANGE FACTOR	LET-DOWN DIST.		CAS	% RPM	LB/HR	G.S.	RANGE FACTOR	LET-DOWN DIST.	CAS	% RPM	LB/HR	G.S.	RANGE FACTOR	LET-DOWN DIST.	CAS	% RPM	LB/HR	G.S.	RANGE FACTOR	LET-DOWN DIST.		CAS	% RPM	LB/HR	G.S.	RANGE FACTOR	LET-DOWN DIST.
315	89	2400	330	.73	5	120 HW	295	90	2150	335	.74	7	270	91	1950	335	.74	10	240	95	1900	335	.74	14	120 HW						
315	89	2400	370	.82	6	80 HW	295	90	2150	375	.82	8	270	91	1950	375	.82	11	240	95	1900	375	.82	16	80 HW						
315	89	2400	410	.91	6	40 HW	295	90	2150	415	.91	9	270	91	1950	415	.91	13	240	95	1900	415	.91	17	40 HW						
315	89	2400	450	1.00	7	0	295	90	2150	455	1.00	10	270	91	1950	455	1.00	14	240	95	1900	455	1.00	19	0						
315	89	2400	490	1.09	8	40 TW	295	90	2150	495	1.09	11	270	91	1950	495	1.09	15	240	95	1900	495	1.09	21	40 TW						
315	89	2400	530	1.18	8	80 TW	295	90	2150	535	1.18	12	270	91	1950	535	1.18	17	240	95	1900	535	1.18	22	80 TW						
315	89	2400	570	1.27	9	120 TW	295	90	2150	575	1.26	13	270	91	1950	575	1.26	18	240	.95	1900	575	1.26	24	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 Tabulated range values include distance covered during Minimum Time Descent.

DATA AS OF: 7 May 1952
DATA BASIS: NATC Reports FT31-075, FT31-0107 & GAEC Flight Tests

EXAMPLE

If you are at 25000 feet with 3400 lb of available fuel, you can fly 657 air miles by holding 315 knots CAS. However, you can fly 798 air miles by immediately climbing to 35000 feet using 100% RPM. At 35000 feet, cruise at 270 knots CAS and start letdown 14 air miles from destination. With a 40 knot head wind the range at 35000 feet will be 726 ground miles. Cruise at 270 knots CAS with this wind and start letdown 13 ground miles from destination.

LEGEND

EFFECTIVE WIND: HW-Head Wind, TW-Tail Wind
RANGE FACTOR: Ground Distance (Effective Wind) / Range in Air Miles (Zero Wind)
G. S.: Ground Speed in Knots
CAS: Calibrated Airspeed in Knots
LB/HR: Fuel Consumption—Pounds per Hour
RANGE: Nautical Miles
( ) RANGE IN PARENTHESIS FOR INTERPOLATION PURPOSES ONLY.
FUEL GRADE: MIL-F-5624A (JP-3 or JP-4) 6.5 Lb/Gal
FUEL DENSITY: MIL-F-5572 (AVGAS) 6.0 Lb/Gal

Figure A-14. Flight Operation Instruction Charts (Sheet 2 of 6)

Appendix I of this publication shall not be carried in aircraft on combat missions or when there is a reasonable chance of its falling into the hands of an unfriendly nation.

AIRCRAFT MODEL (S): F9F-7

ENGINE (S): J33-A-16A

FLIGHT OPERATION INSTRUCTION CHART

STANDARD DAY

CHART WT LIMITS 16400 TO 14500 POUNDS

CONFIGURATION

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

Tabulated range values include distance covered during Minimum Time Descent.

DATA AS OF: 7 May 1952

DATA BASIS: NATC Reports FT31-075, FT31-0107 & GAEC Flight Tests

LOW ALTITUDE

(RANGE FIGURES INCLUDE ALLOWANCES FOR PRESCRIBED CLIMB & DESCENT TO SEA LEVEL)

IF YOU ARE AT SEA LEVEL			FUEL LB	IF YOU ARE AT 5000 FT			IF YOU ARE AT 10000 FT			IF YOU ARE AT 15000 FT			FUEL LB	IF YOU ARE AT 20000 FT		
RANGE IN AIR MILES				RANGE IN AIR MILES			RANGE IN AIR MILES			RANGE IN AIR MILES				RANGE IN AIR MILES		
BY CRUISING AT SL	OPT. ALT 1000 FT	BY CRUISING AT OPT. ALT		BY CRUISING AT 5000 FT	OPT. ALT 1000 FT	BY CRUISING AT OPT. ALT	BY CRUISING AT 10000 FT	OPT. ALT 1000 FT	BY CRUISING AT OPT. ALT	BY CRUISING AT 15000 FT	OPT. ALT 1000 FT	BY CRUISING AT OPT. ALT		BY CRUISING AT 20000 FT	OPT. ALT 1000 FT	BY CRUISING AT OPT. ALT
362	40	858	3800	412	40	881	475	40	902	551	40	920	3800	644	40	937
323	35	745	3400	367	35	770	425	35	791	492	35	809	3400	576	35	826
285	35	641	3000	323	35	664	374	35	685	434	35	703	3000	507	35	720
246	35	535	2600	280	35	559	323	35	580	375	35	598	2600	439	35	615
208	35	430	2200	236	35	453	273	35	474	317	35	492	2200	370	35	509
170	35	326	1800	193	35	348	223	35	367	258	35	389	1800	302	35	405
132	35	224	1400	150	35	247	174	35	267	201	35	289	1400	235	35	306
94	30	129	1000	108	30	150	124	30	170	144	35	188	1000	168	35	206
57	15	58	600	65	20	70	75	25	85	87	25	98	600	102	30	114
19	SL	19	200	22	5	22	25	10	25	30	15	30	200	35	20	35

CRUISING AT SEA LEVEL						EFFECTIVE WIND KNOTS	CRUISING AT 5000 FT						CRUISING AT 10000 FT						CRUISING AT 15000 FT						EFFECTIVE WIND KNOTS	CRUISING AT 20000 FT					
	APPROXIMATE							APPROXIMATE						APPROXIMATE						APPROXIMATE							APPROXIMATE				
CAS	% RPM	LB/HR	G.S.	RANGE FACTOR	LET-DOWN DIST.		CAS	% RPM	LB/HR	G.S.	RANGE FACTOR	LET-DOWN DIST.	CAS	% RPM	LB/HR	G.S.	RANGE FACTOR	LET-DOWN DIST.	CAS	% RPM	LB/HR	G.S.	RANGE FACTOR	LET-DOWN DIST.		CAS	% RPM	LB/HR	G.S.	RANGE FACTOR	LET-DOWN DIST.
345	84	3650	225	.65	0	120 HW	340	85	3400	245	.67	1	335	86	3100	265	.69	1	330	87	2850	285	.70	2	120 HW	320	87	2550	310	.72	4
345	84	3650	265	.77	0	80 HW	340	85	3400	285	.78	1	335	86	3100	305	.79	2	330	87	2850	325	.80	2	80 HW	320	87	2550	350	.81	4
345	84	3650	305	.89	0	40 HW	340	85	3400	325	.89	1	335	86	3100	345	.90	2	330	87	2850	365	.90	3	40 HW	320	87	2550	390	.91	5
345	84	3650	345	1.00	0	0	340	85	3400	365	1.00	1	335	86	3100	385	1.00	2	330	87	2850	405	1.00	3	0	320	87	2550	430	1.00	5
345	84	3650	385	1.12	0	40 TW	340	85	3400	405	1.11	1	335	86	3100	425	1.10	2	330	87	2850	445	1.10	3	40 TW	320	87	2550	470	1.09	5
345	84	3650	425	1.23	0	80 TW	340	85	3400	445	1.22	1	335	86	3100	465	1.21	2	330	87	2850	485	1.20	4	80 TW	320	87	2550	510	1.19	6
345	84	3650	465	1.35	0	120 TW	340	85	3400	485	1.33	1	335	86	3100	505	1.31	3	330	87	2850	525	1.30	4	120 TW	320	87	2550	550	1.28	6

Figure A-14. Flight Operation Instruction Charts (Sheet 3 of 6)

AIRCRAFT MODEL(S): F9F-7

ENGINE(S): J33-A-16A

HIGH ALTITUDE

CHART WT LIMITS 16400 TO 14500 POUNDS

CONFIGURATION

IF YOU ARE AT 25000 FT				IF YOU ARE AT 30000 FT			IF YOU ARE AT 35000 FT			IF YOU ARE AT 40000 FT				IF YOU ARE AT 45000 FT		
RANGE IN AIR MILES			FUEL LB	RANGE IN AIR MILES			RANGE IN AIR MILES			RANGE IN AIR MILES			FUEL LB	RANGE IN AIR MILES		
BY CRUISING AT 25000 FT	OPT. ALT 1000 FT	BY CRUISING AT OPT. ALT		BY CRUISING AT 30000 FT	OPT. ALT 1000 FT	BY CRUISING AT OPT. ALT	BY CRUISING AT 35000 FT	OPT. ALT 1000 FT	BY CRUISING AT OPT. ALT	BY CRUISING AT 40000 FT	OPT. ALT 1000 FT	BY CRUISING AT OPT. ALT		BY CRUISING AT 45000 FT	OPT. ALT 1000 FT	BY CRUISING AT OPT. ALT
				(RANGE FIGURES INCLUDE ALLOWANCES FOR PRESCRIBED CLIMB & DESCENT TO SEA LEVEL)												
751	40	948	3800	860	40	959	973	40	977	996			3800			
671	35	837	3400	768	35	848	867	35	866	887			3400			
591	35	731	3000	675	35	742	761	35	760	779			3000			
511	35	626	2600	583	35	637	655	35	655	670			2600			
431	35	520	2200	490	35	531	549	35	549	561			2200			
351	35	417	1800	400	35	427	446	35	446	455			1800			
274	35	318	1400	312	35	329	348	35	348	355			1400			
197	35	219	1000	223	35	230	250	35	250	256			1000			
119	30	125	600	135	30	135	151	35	152	156			600			
42	25	42	200	47	30	47	53	35	53	56			200			

CRUISING AT 25000 FT						EFFECTIVE WIND KNOTS	CRUISING AT 30000 FT						CRUISING AT 35000 FT						CRUISING AT 40000 FT						EFFECTIVE WIND KNOTS	CRUISING AT 45000 FT					
	APPROXIMATE							APPROXIMATE						APPROXIMATE						APPROXIMATE							APPROXIMATE				
CAS	% RPM	LB/HR	G.S.	RANGE FACTOR	LET-DOWN DIST.		CAS	% RPM	LB/HR	G.S.	RANGE FACTOR	LET-DOWN DIST.	CAS	% RPM	LB/HR	G.S.	RANGE FACTOR	LET-DOWN DIST.	CAS	% RPM	LB/HR	G.S.	RANGE FACTOR	LET-DOWN DIST.		CAS	% RPM	LB/HR	G.S.	RANGE FACTOR	LET-DOWN DIST.
310	88	2300	320	.73	5	120 HW	290	89	2050	335	.74	7	270	90	1850	335	.74	10	240	94	1810	330	.73	14	120 HW						
310	88	2300	360	.82	6	80 HW	290	89	2050	375	.83	8	270	90	1850	375	.83	12	240	94	1810	370	.82	16	80 HW						
310	88	2300	400	.91	6	40 HW	290	89	2050	415	.91	9	270	90	1850	415	.91	13	240	94	1810	410	.91	17	40 HW						
310	88	2300	440	1.00	7	0	290	89	2050	455	1.00	10	270	90	1850	455	1.00	14	240	94	1810	450	1.00	19	0						
310	88	2300	480	1.09	7	40 TW	290	89	2050	495	1.09	11	270	90	1850	495	1.09	15	240	94	1810	490	1.09	21	40 TW						
310	88	2300	520	1.18	8	80 TW	290	89	2050	535	1.18	12	270	90	1850	535	1.18	17	240	94	1810	530	1.18	22	80 TW						
310	88	2300	560	1.27	9	120 TW	290	89	2050	575	1.26	13	270	90	1850	575	1.26	18	240	94	1810	570	1.27	24	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 Tabulated range values include distance covered during Minimum Time Descent.

DATA AS OF: 7 May 1952
DATA BASIS: NATC Reports FT31-075, FT31-0107 & GAEC Flight Tests

EXAMPLE

If you are at 25000 feet with 2200 lb of available fuel, you can fly 431 air miles by holding 310 knots CAS. However, you can fly 520 air miles by immediately climbing to 35000 feet using 100% RPM. At 35000 feet, cruise at 270 knots CAS and start letdown 14 air miles from destination. With a 80 knot headwind the range at 35000 feet will be 432 ground miles. Cruise at 270 knots CAS with this wind and start letdown 12 ground miles from destination.

LEGEND

EFFECTIVE WIND: HW-Head Wind, TW-Tail Wind

RANGE FACTOR: $\frac{\text{Ground Distance (Effective Wind)}}{\text{Range in Air Miles (Zero Wind)}}$

G. S.: Ground Speed in Knots
CAS: Calibrated Airspeed in Knots
LB/HR: Fuel Consumption—Pounds per Hour
RANGE: Nautical Miles
( ) RANGE IN PARENTHESIS FOR INTERPOLATION PURPOSES ONLY.

FUEL GRADE: MIL-F-5624A (JP-3 or JP-4) 6.5 Lb/Gal
FUEL DENSITY: MIL-F-5572 (AVGAS) 6.0 Lb/Gal

Figure A-14. Flight Operation Instruction Charts (Sheet 4 of 6)

Appendix I of this publication shall not be carried in aircraft on combat missions or when there is a reasonable chance of its falling into the hands of an unfriendly nation.

AIRCRAFT MODEL (S): F9F-7

ENGINE (S): J33-A-16A

FLIGHT OPERATION INSTRUCTION CHART

STANDARD DAY

CHART WT LIMITS 14500 TO 12600 POUNDS

CONFIGURATION

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

Tabulated range values include distance covered during Minimum Time Descent.

DATA AS OF: 7 May 1952

DATA BASIS: NATC Reports FT31-075, FT31-0107 & GAEC Flight Tests

LOW ALTITUDE

IF YOU ARE AT SEA LEVEL			FUEL	IF YOU ARE AT 5000 FT			IF YOU ARE AT 10000 FT			IF YOU ARE AT 15000 FT			FUEL	IF YOU ARE AT 20000 FT		
RANGE IN AIR MILES			LB	RANGE IN AIR MILES			RANGE IN AIR MILES			RANGE IN AIR MILES			LB	RANGE IN AIR MILES		
BY CRUISING AT SL	OPT. ALT 1000 FT	BY CRUISING AT OPT. ALT		BY CRUISING AT 5000 FT	OPT. ALT 1000 FT	BY CRUISING AT OPT. ALT	BY CRUISING AT 10000 FT	OPT. ALT 1000 FT	BY CRUISING AT OPT. ALT	BY CRUISING AT 15000 FT	OPT. ALT 1000 FT	BY CRUISING AT OPT. ALT		BY CRUISING AT 20000 FT	OPT. ALT 1000 FT	BY CRUISING AT OPT. ALT
(RANGE FIGURES INCLUDE ALLOWANCES FOR PRESCRIBED CLIMB & DESCENT TO SEA LEVEL)																
192	35	424	2000	220	35	453	254	35	465	295	40	476	2000	345	40	495
154	35	316	1600	176	35	345	203	35	357	236	35	367	1600	276	35	386
115	35	207	1200	132	35	237	153	35	249	178	35	260	1200	207	35	279
77	30	109	800	89	35	129	102	30	143	119	35	153	800	139	35	172
38	5 or SL	38	400	45	15 or 10	47	51	15	54	60	20	63	400	70	25	77

EFFECTIVE WIND KNOTS	CRUISING AT SEA LEVEL						CRUISING AT 5000 FT						CRUISING AT 10000 FT					
	CAS	APPROXIMATE					CAS	APPROXIMATE					CAS	APPROXIMATE				
		% RPM	LB/HR	G.S.	RANGE FACTOR	LET-DOWN DIST.		% RPM	LB/HR	G.S.	RANGE FACTOR	LET-DOWN DIST.		% RPM	LB/HR	G.S.	RANGE FACTOR	LET-DOWN DIST.
120 HW	330	82	3400	210	.64	0	325	84	3200	230	.66	1	325	85	2950	250	.68	1
80 HW	330	82	3400	250	.76	0	325	84	3200	270	.77	1	325	85	2950	290	.78	2
40 HW	330	82	3400	290	.87	0	325	84	3200	310	.89	1	325	85	2950	330	.89	2
0	330	82	3400	330	1.00	0	325	84	3200	350	1.00	1	325	85	2950	370	1.00	2
40 TW	330	82	3400	370	1.12	0	325	84	3200	390	1.11	1	325	85	2950	410	1.11	2
80 TW	330	82	3400	410	1.24	0	325	84	3200	430	1.23	1	325	85	2950	450	1.22	2
120 TW	330	82	3400	450	1.36	0	325	84	3200	470	1.34	1	325	85	2950	490	1.32	3

EFFECTIVE WIND KNOTS	CRUISING AT 15000 FT						CRUISING AT 20000 FT					
	CAS	APPROXIMATE					CAS	APPROXIMATE				
		% RPM	LB/HR	G.S.	RANGE FACTOR	LET-DOWN DIST.		% RPM	LB/HR	G.S.	RANGE FACTOR	LET-DOWN DIST.
120 HW	315	86	2700	270	.69	2	310	86	2400	295	.71	4
80 HW	315	86	2700	310	.79	2	310	86	2400	335	.81	4
40 HW	315	86	2700	350	.90	3	310	86	2400	375	.90	5
0	315	86	2700	390	1.00	3	310	86	2400	415	1.00	5
40 TW	315	86	2700	430	1.10	3	310	86	2400	455	1.10	6
80 TW	315	86	2700	470	1.21	4	310	86	2400	495	1.19	6
120 TW	315	86	2700	510	1.31	4	310	86	2400	535	1.29	6

Figure A-14. Flight Operation Instruction Charts (Sheet 5 of 6)

AIRCRAFT MODEL (S): F9F-7

ENGINE (S): J33-A-16A

HIGH ALTITUDE

CHART WT LIMITS 14500 TO 12600 POUNDS

CONFIGURATION

IF YOU ARE AT 25000 FT			FUEL	IF YOU ARE AT 30000 FT			IF YOU ARE AT 35000 FT			IF YOU ARE AT 40000 FT			FUEL	IF YOU ARE AT 45000 FT		
RANGE IN AIR MILES				RANGE IN AIR MILES			RANGE IN AIR MILES			RANGE IN AIR MILES				RANGE IN AIR MILES		
BY CRUISING AT 25000 FT	OPT. ALT 1000 FT	BY CRUISING AT OPT. ALT	LB	BY CRUISING AT 30000 FT	OPT. ALT 1000 FT	BY CRUISING AT OPT. ALT	BY CRUISING AT 35000 FT	OPT. ALT 1000 FT	BY CRUISING AT OPT. ALT	BY CRUISING AT 40000 FT	OPT. ALT 1000 FT	BY CRUISING AT OPT. ALT	LB	BY CRUISING AT 45000 FT	OPT. ALT 1000 FT	BY CRUISING AT OPT. ALT
				(RANGE FIGURES INCLUDE ALLOWANCES FOR PRESCRIBED CLIMB & DESCENT TO SEA LEVEL)												
403	40	511	2000	465	40	520	533	40	539	549			2000			
323	35	403	1600	372	35	415	427	40	429	440			1600			
243	35	296	1200	280	35	308	321	35	321	332			1200			
153	35	189	800	188	35	202	215	35	215	223			800			
83	30	86	400	96	35 or 30	96	109	35	109	114			400			

CRUISING AT 25000 FT						EFFEC-TIVE WIND KNOTS	CRUISING AT 30000 FT						CRUISING AT 35000 FT						CRUISING AT 40000 FT						EFFEC-TIVE WIND KNOTS	CRUISING AT 45000 FT					
	APPROXIMATE							APPROXIMATE						APPROXIMATE						APPROXIMATE							APPROXIMATE				
CAS	% RPM	LB/HR	G.S.	RANGE FACTOR	LET-DOWN DIST.		CAS	% RPM	LB/HR	G.S.	RANGE FACTOR	LET-DOWN DIST.	CAS	% RPM	LB/HR	G.S.	RANGE FACTOR	LET-DOWN DIST.	CAS	% RPM	LB/HR	G.S.	RANGE FACTOR	LET-DOWN DIST.		CAS	% RPM	LB/HR	G.S.	RANGE FACTOR	LET-DOWN DIST.
300	87	2150	310	.72	5	120 HW	290	88	1950	330	.73	7	250	89	1700	330	.73	10	240	93	1650	330	.73	14	120 HW						
300	87	2150	350	.81	6	80 HW	290	88	1950	370	.82	8	250	89	1700	370	.82	11	240	93	1650	370	.82	16	80 HW						
300	87	2150	390	.91	6	40 HW	290	88	1950	410	.91	9	250	89	1700	410	.91	13	240	93	1650	410	.91	17	40 HW						
300	87	2150	430	1.00	7	0	290	88	1950	450	1.00	10	250	89	1700	450	1.00	14	240	93	1650	450	1.00	19	0						
300	87	2150	470	1.09	8	40 TW	290	88	1950	490	1.09	11	250	89	1700	490	1.09	15	240	93	1650	490	1.09	21	40 TW						
300	87	2150	510	1.19	8	80 TW	290	88	1950	530	1.18	12	250	89	1700	530	1.18	17	240	93	1650	530	1.18	22	80 TW						
300	87	2150	550	1.28	9	120 TW	290	88	1950	570	1.27	13	250	89	1700	570	1.27	18	240	93	1650	570	1.27	24	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 Tabulated range values include distance covered during Minimum Time Descent.

DATA AS OF: 7 May 1952
DATA BASIS: NATC Reports FT31-075, FT31-0107 & GAEC Flight Tests

EXAMPLE

If you are at 25000 feet with 2000 lb of available fuel, you can fly 403 air miles by holding 300 knots CAS. However, you can fly 511 air miles by immediately climbing to 40000 feet using 100% RPM. At 40000 feet, cruise at 240 knots CAS and start letdown 19 air miles from destination. With a 40 knot headwind the range at 40000 feet will be 465 ground miles. Cruise at 240 knots CAS with this wind and start letdown 17 ground miles from destination.

LEGEND

EFFECTIVE WIND: HW-Head Wind, TW-Tail Wind
RANGE FACTOR: Ground Distance (Effective Wind) / Range in Air Miles (Zero Wind)
G. S.: Ground Speed in Knots
CAS: Calibrated Airspeed in Knots
LB/HR: Fuel Consumption—Pounds per Hour
RANGE: Nautical Miles
( ) RANGE IN PARENTHESIS FOR INTERPOLATION PURPOSES ONLY.
FUEL GRADE: MIL-F-5624A (JP-3 of JP-4) 6.5 Lb/Gal
FUEL DENSITY: MIL-F-5572 (AVGAS) 6.0 Lb/Gal

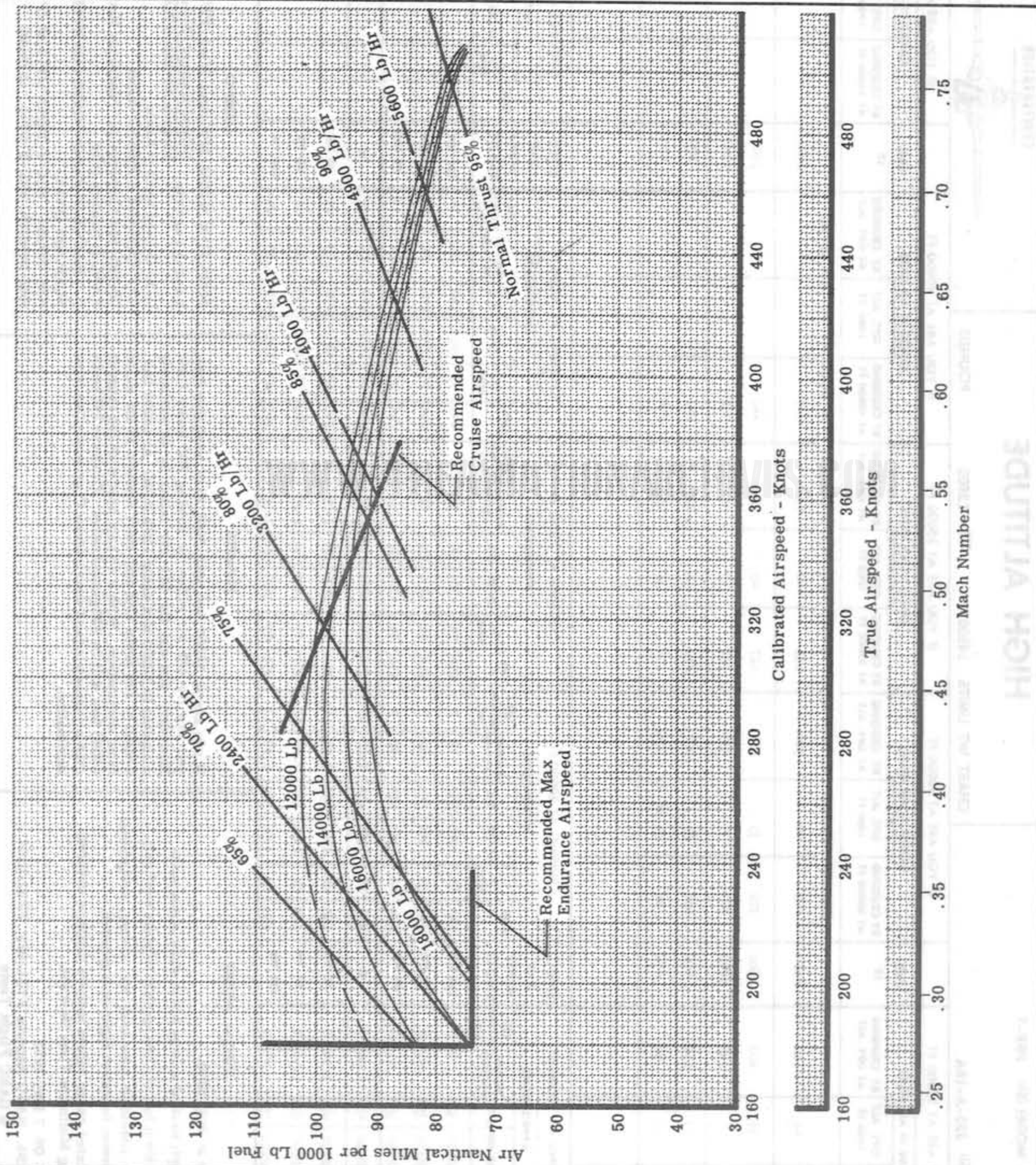
Figure A-14. Flight Operation Instruction Charts (Sheet 6 of 6)

SPECIFIC RANGE vs AIRSPEED

STANDARD DAY | CONFIGURATION | **SEA LEVEL**

MODEL(S): F9F-7

ENGINE(S): J33-A-16A



DATA AS OF: 7 May 1952
DATA BASIS: NATC Reports FT31-075, FT31-0107 & GAEC Flight Tests

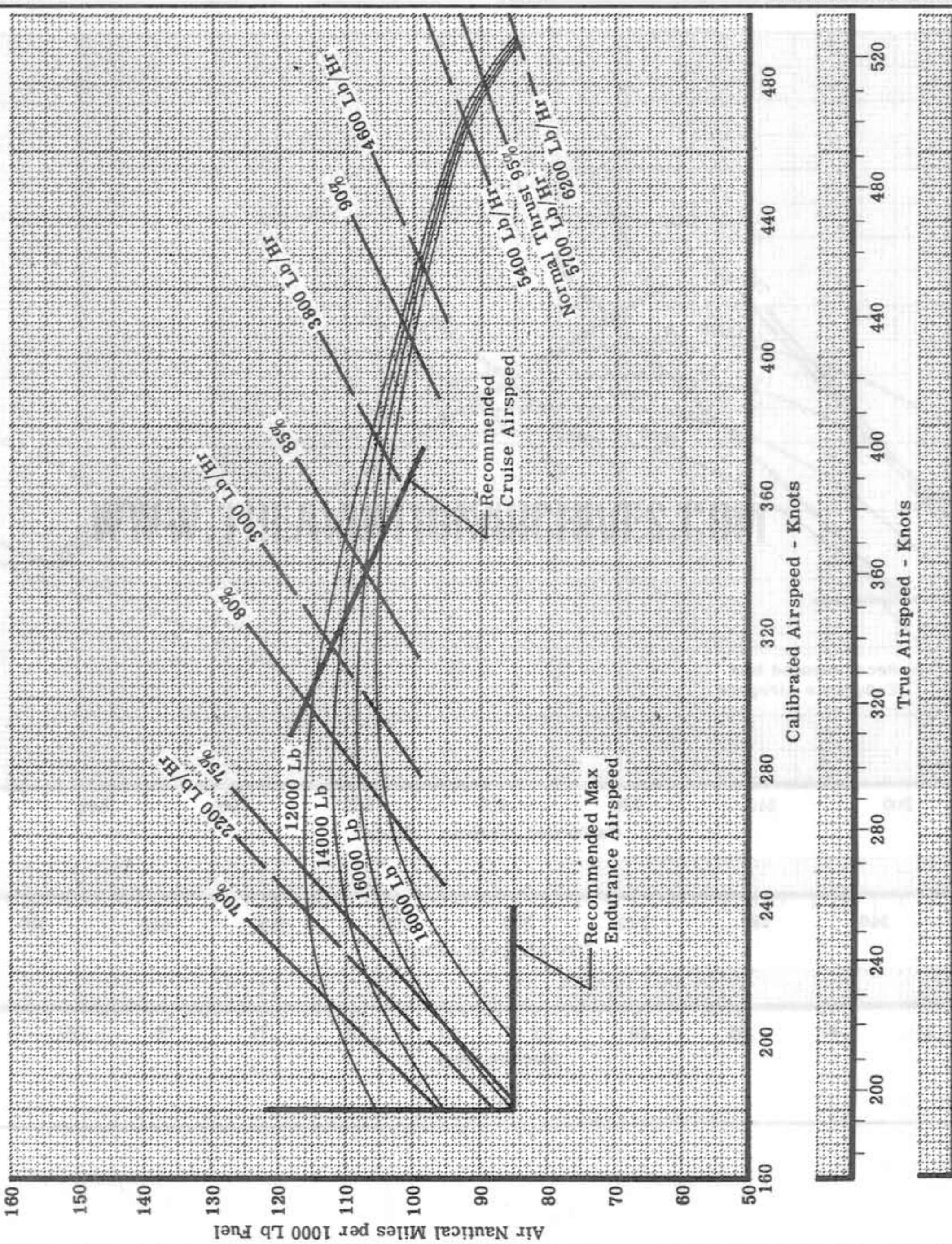
FUEL GRADE AND DENSITY: MIL-F-5624A (JP-3 or JP-4) 6.5 Lb/Gal
MIL-F-5572 (AVGAS) 6.0 Lb/Gal

Figure A-15. Specific Range Curves (Sheet 1 of 9)

SPECIFIC RANGE vs AIRSPEED

STANDARD DAY CONFIGURATION **5000 FEET ALTITUDE**

MODEL(S): F9F-7 **ENGINE(S):** J33-A-16A



DATA AS OF: 7 May 1952
DATA BASIS: NATC Reports FT31-075, FT31-0107 & GAEC Flight Tests

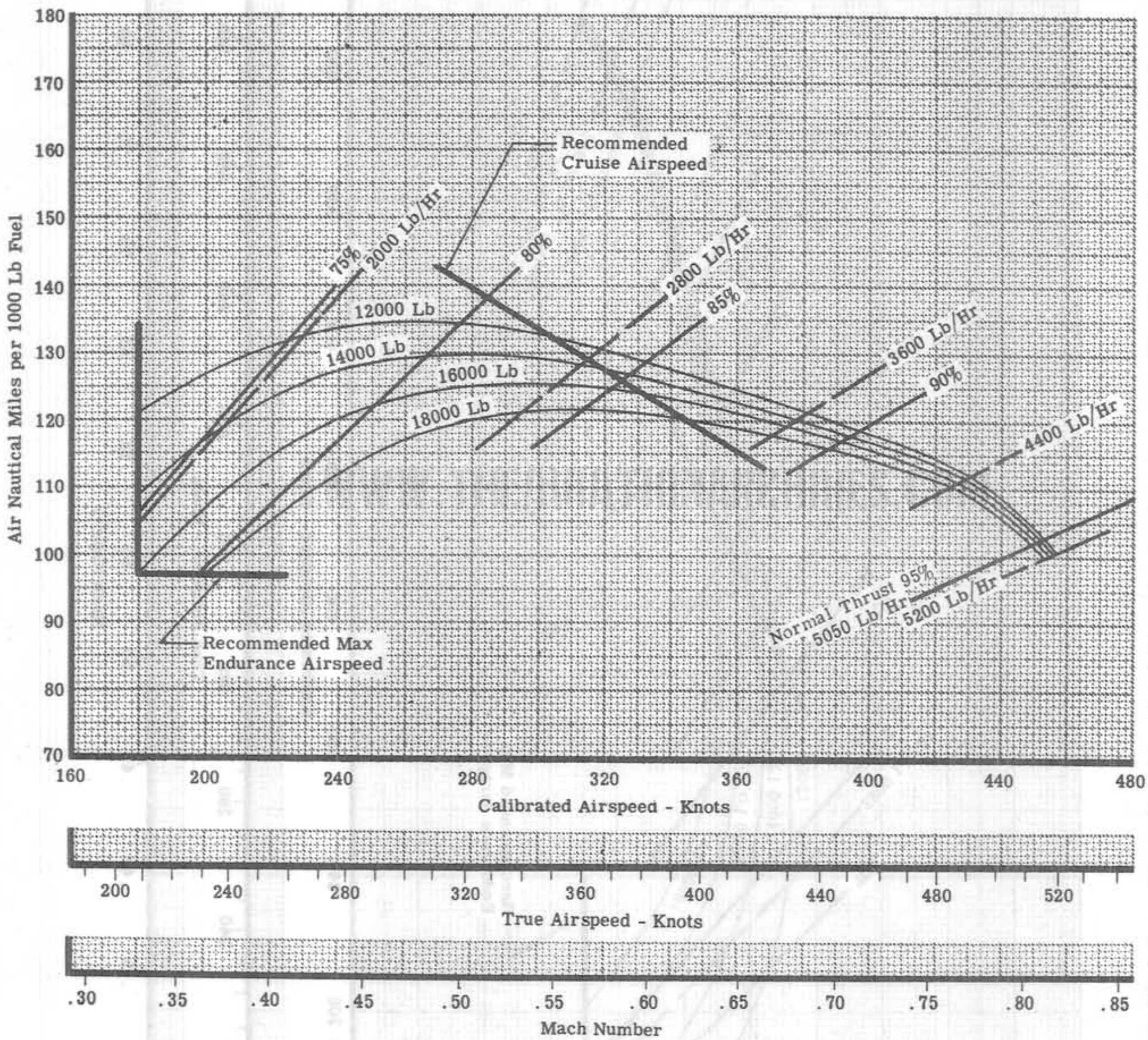
FUEL GRADE AND DENSITY: MIL-F-5624A (JP-3 or JP-4) 6.5 Lb/Gal; MIL-F-5572 (AVGAS) 6.0 Lb/Gal

Figure A-15. Specific Range Curves (Sheet 2 of 9)

SPECIFIC RANGE vs AIRSPEED

STANDARD DAY | CONFIGURATION A | **10000 FEET ALTITUDE**

MODEL(S): F9F-7 | **ENGINE(S):** J33-A-16A



REMARKS:

DATA AS OF: 7 May 1952
DATA BASIS: NATC Reports FT31-075, FT31-0107 & GAEC Flight Tests

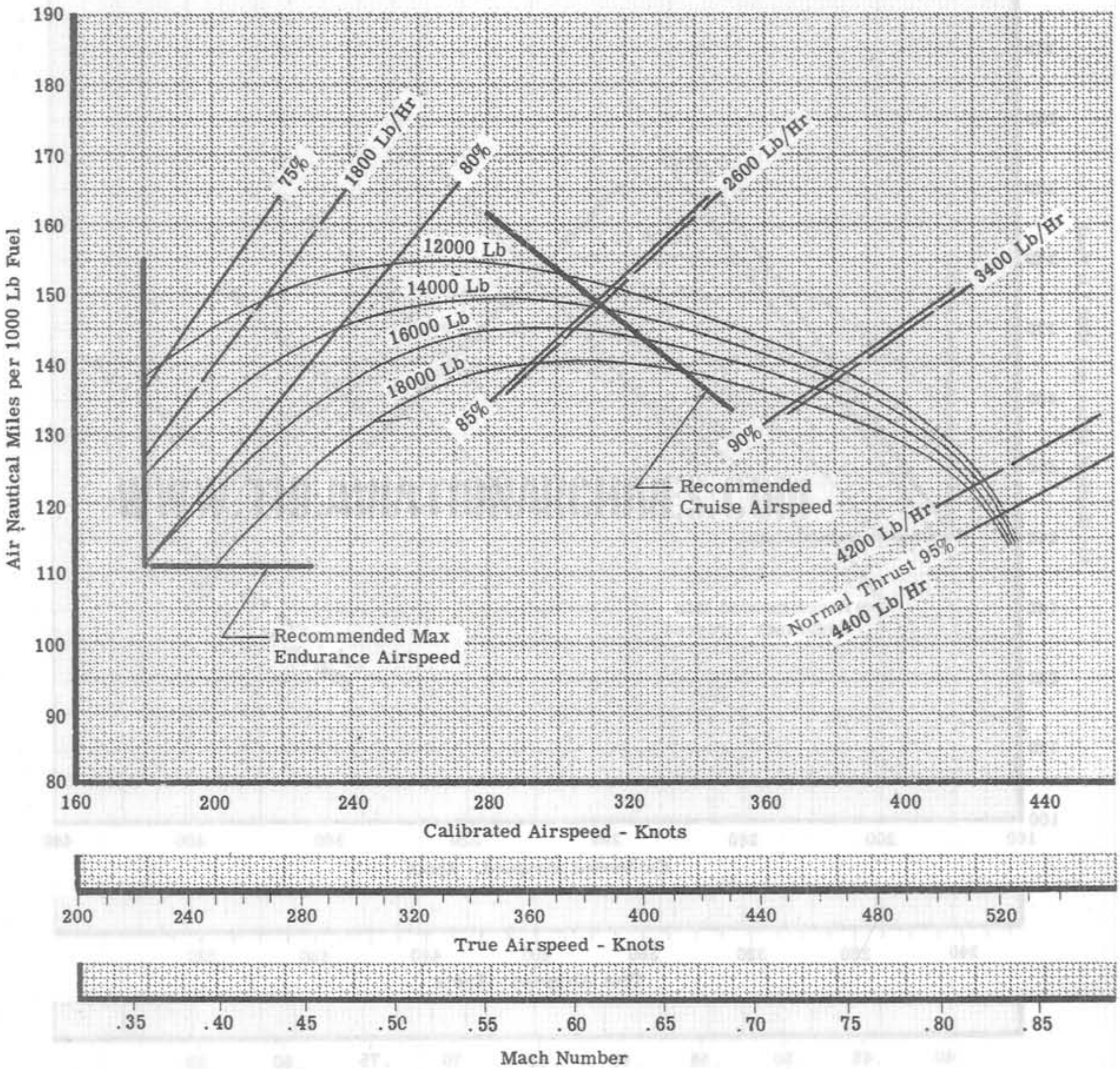
FUEL GRADE AND DENSITY: MIL-F-5624A (JP-3 or JP-4) 6.5 Lb/Gal; MIL-F-5572 (AVGAS) 6.0 Lb/Gal

Figure A-15. Specific Range Curves (Sheet 3 of 9)

SPECIFIC RANGE vs AIRSPEED

STANDARD DAY — CONFIGURATION — 15000 FEET ALTITUDE

MODEL(S): F9F-7 **ENGINE(S):** J33-A-16A



REMARKS:

DATA AS OF 7 May 1952
DATA BASIS: NATC Reports FT31-075, FT31-0107 & GAEC Flight Tests

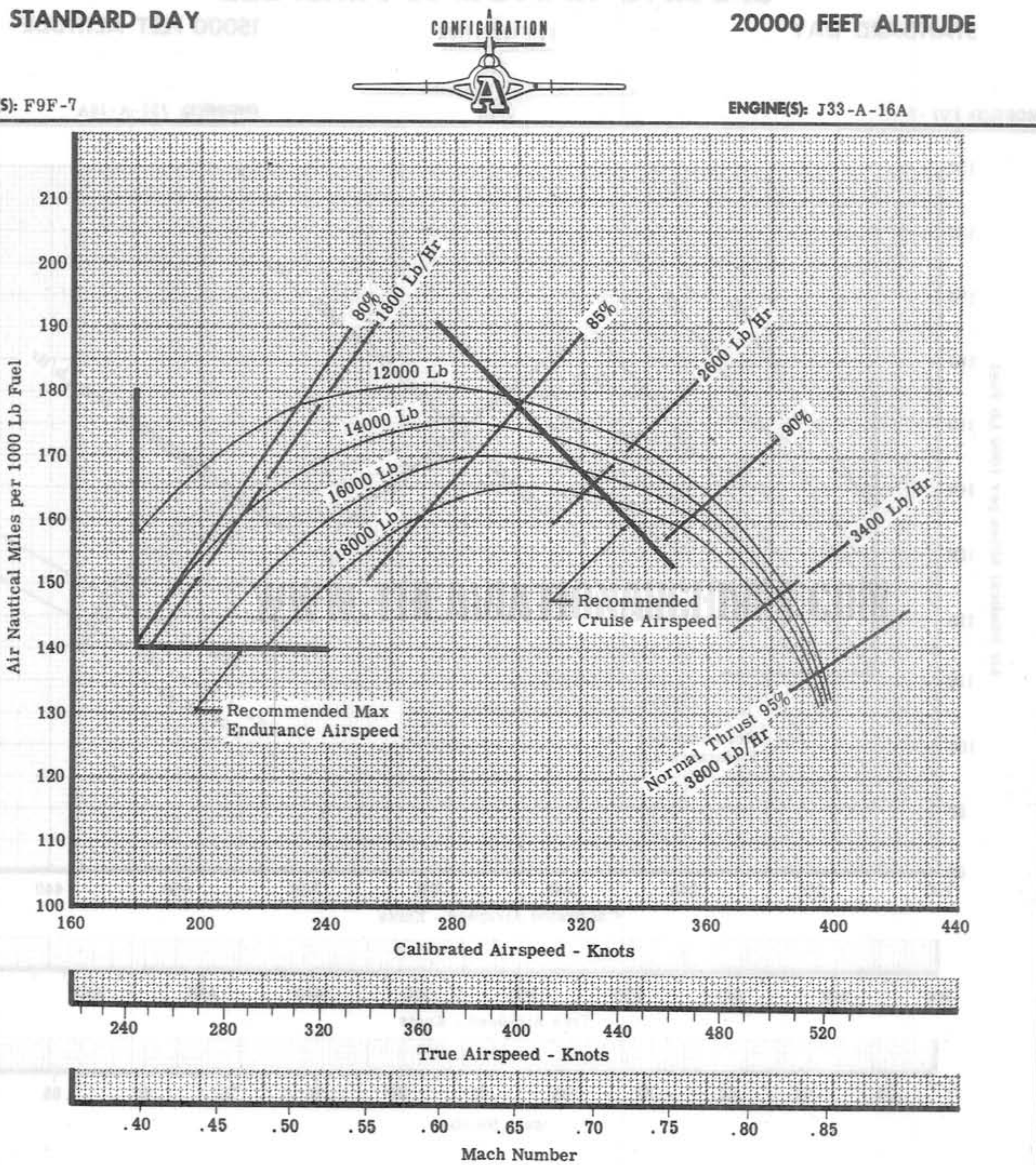
FUEL GRADE AND DENSITY: MIL-F-5624A (JP-3 or JP-4) 6.5 Lb/Gal; MIL-F-5572 (AVGAS) 6.0 Lb/Gal

Figure A-15. Specific Range Curves (Sheet 4 of 9)

SPECIFIC RANGE vs AIRSPEED

STANDARD DAY — CONFIGURATION — 20000 FEET ALTITUDE

MODEL(S): F9F-7 — ENGINE(S): J33-A-16A



REMARKS:

DATA AS OF: 7 May 1952
DATA BASIS: NATC Reports FT31-075, FT31-0107 & GAEC Flight Tests

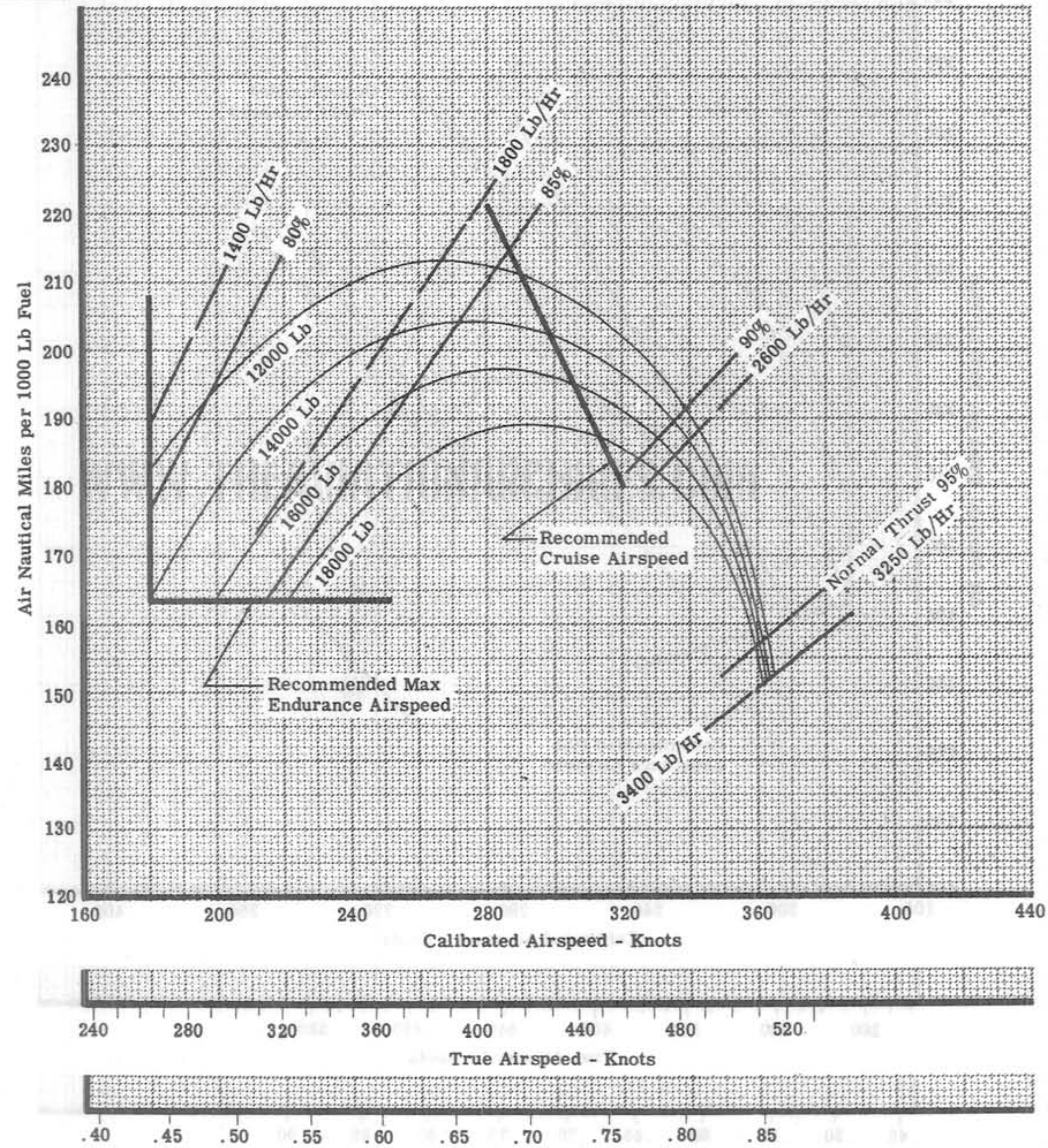
FUEL GRADE AND DENSITY: MIL-F-5624A (JP-3 or JP-4) 6.5 Lb/Gal; MIL-F-5572 (AVGAS) 6.0 Lb/Gal

Figure A-15. Specific Range Curves (Sheet 5 of 9)

SPECIFIC RANGE vs AIRSPEED

STANDARD DAY | **CONFIGURATION A** | **25000 FEET ALTITUDE**

MODEL(S): F9F-7 | **ENGINE(S):** J33-A-16A



DATA AS OF: 7 May 1952
DATA BASIS: NATC Reports FT31-075, FT31-0107 & GAEC Flight Tests

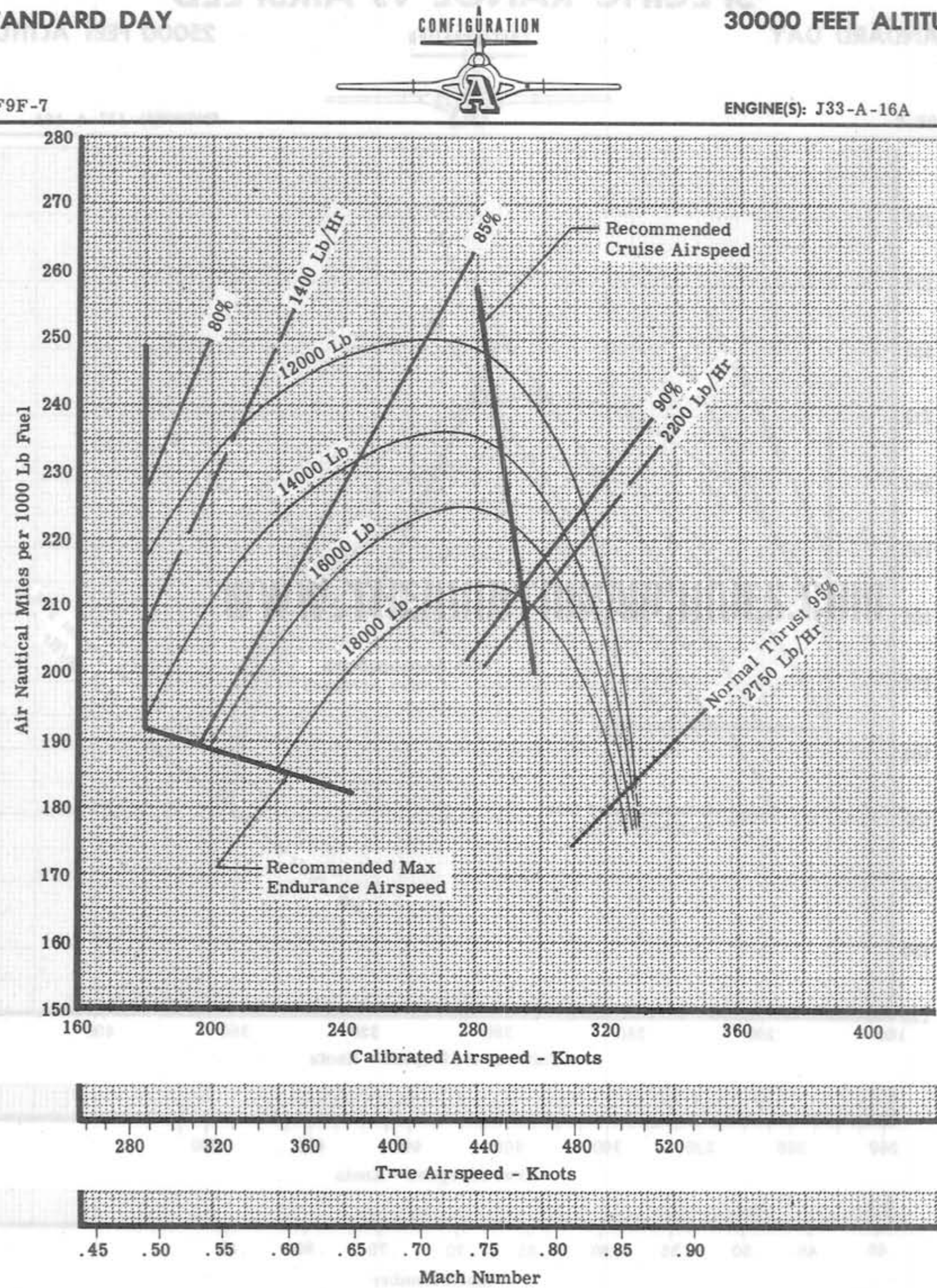
FUEL GRADE AND DENSITY: MIL-F-5624A (JP-3 or JP-4) 6.5 Lb/Gal; MIL-F-5572 (AVGAS) 6.0 Lb/Gal

Figure A-15. Specific Range Curves (Sheet 6 of 9)

SPECIFIC RANGE vs AIRSPEED

STANDARD DAY — 30000 FEET ALTITUDE

MODEL(S): F9F-7 — ENGINE(S): J33-A-16A



DATA AS OF: 7 May 1952
DATA BASIS: NATC Reports FT31-075, FT31-0107 & GAEC Flight Tests

FUEL GRADE AND DENSITY: MIL-F-5624A (JP-3 or JP-4) 6.5 Lb/Gal; MIL-F-5572 (AVGAS) 6.0 Lb/Gal

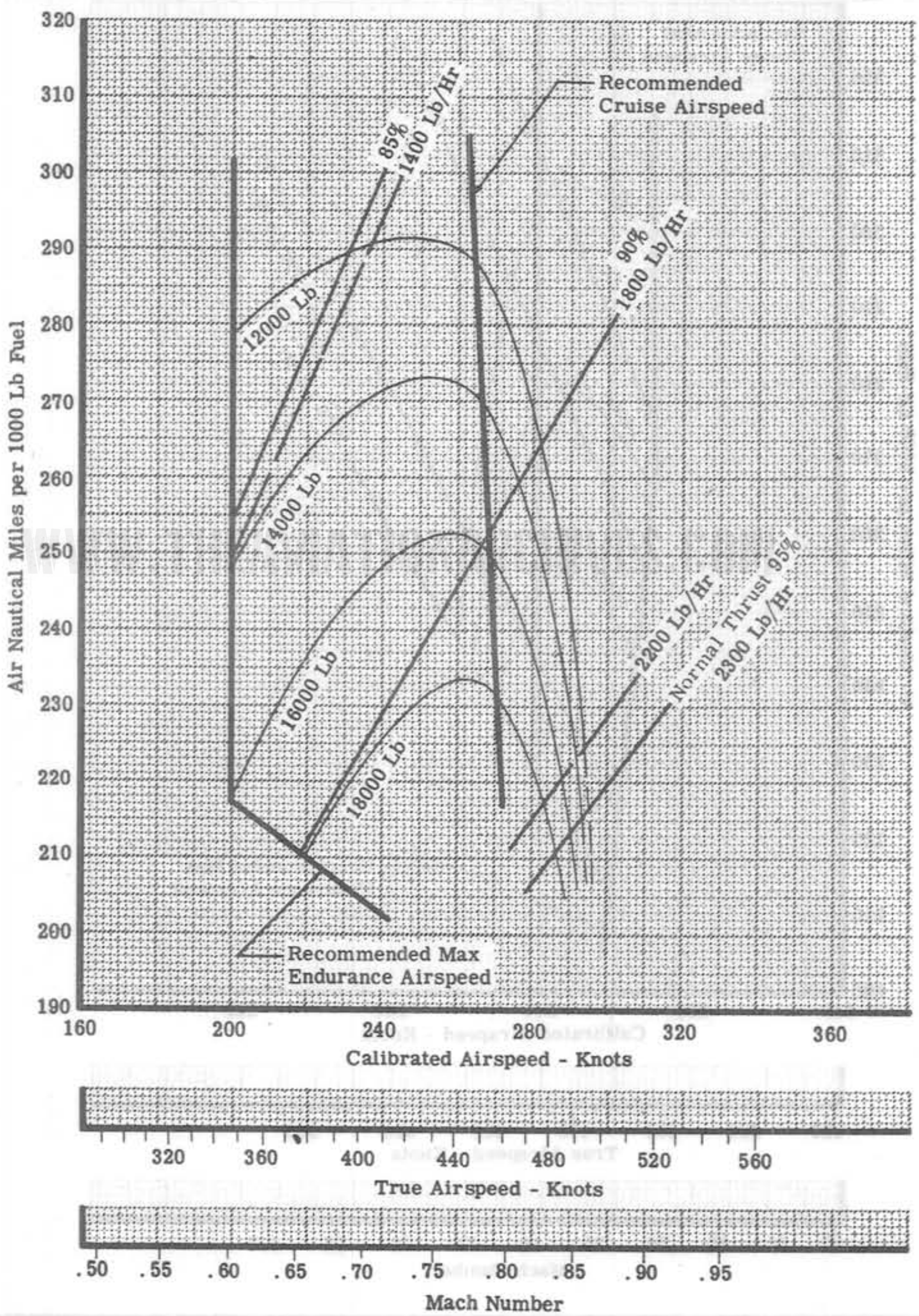
Figure A-15. Specific Range Curves (Sheet 7 of 9)

SPECIFIC RANGE vs AIRSPEED

STANDARD DAY **35000 FEET ALTITUDE**

CONFIGURATION A

MODEL(S): F9F-7 **ENGINE(S):** J33-A-16A



DATA AS OF: 7 May 1952
DATA BASIS: NATC Reports FT31-075, FT31-0107 & GAEC Flight Tests

FUEL GRADE AND DENSITY: MIL-F-5624A (JP-3 or JP-4) 6.5 Lb/Gal; MIL-F-5572 (AVGAS) 6.0 Lb/Gal

Figure A-15. Specific Range Curves (Sheet 8 of 9)

SPECIFIC RANGE vs AIRSPEED

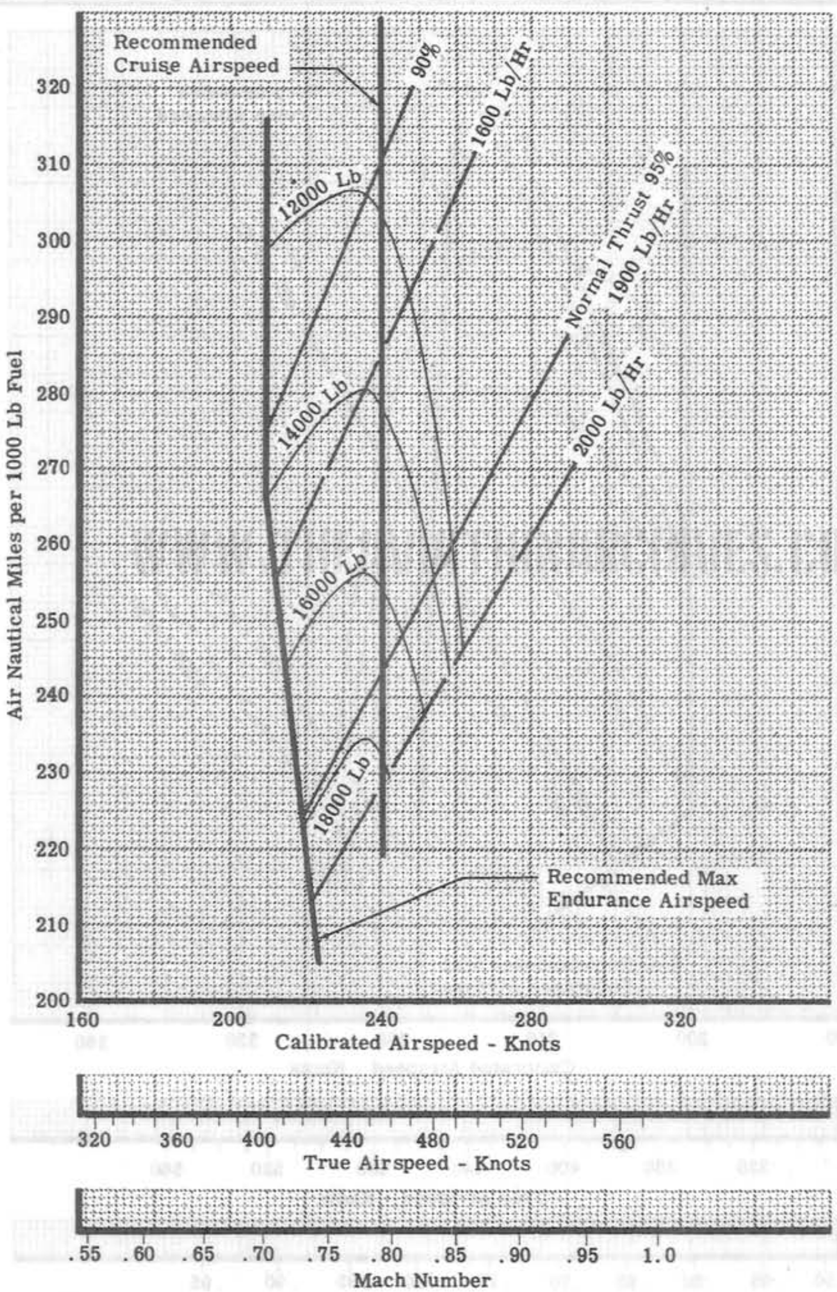
STANDARD DAY

CONFIGURATION A

40000 FEET ALTITUDE

MODEL(S): F9F-7

ENGINE(S): J33-A-16A



DATA AS OF: 7 May 1952

DATA BASIS: NATC Reports FT31-075, FT31-0107 & GAEC Flight Tests

FUEL GRADE AND DENSITY: MIL-F-5624A (JP-3 or JP-4) 6.5 Lb/Gal; MIL-F-5572 (AVGAS) 6.0 Lb/Gal

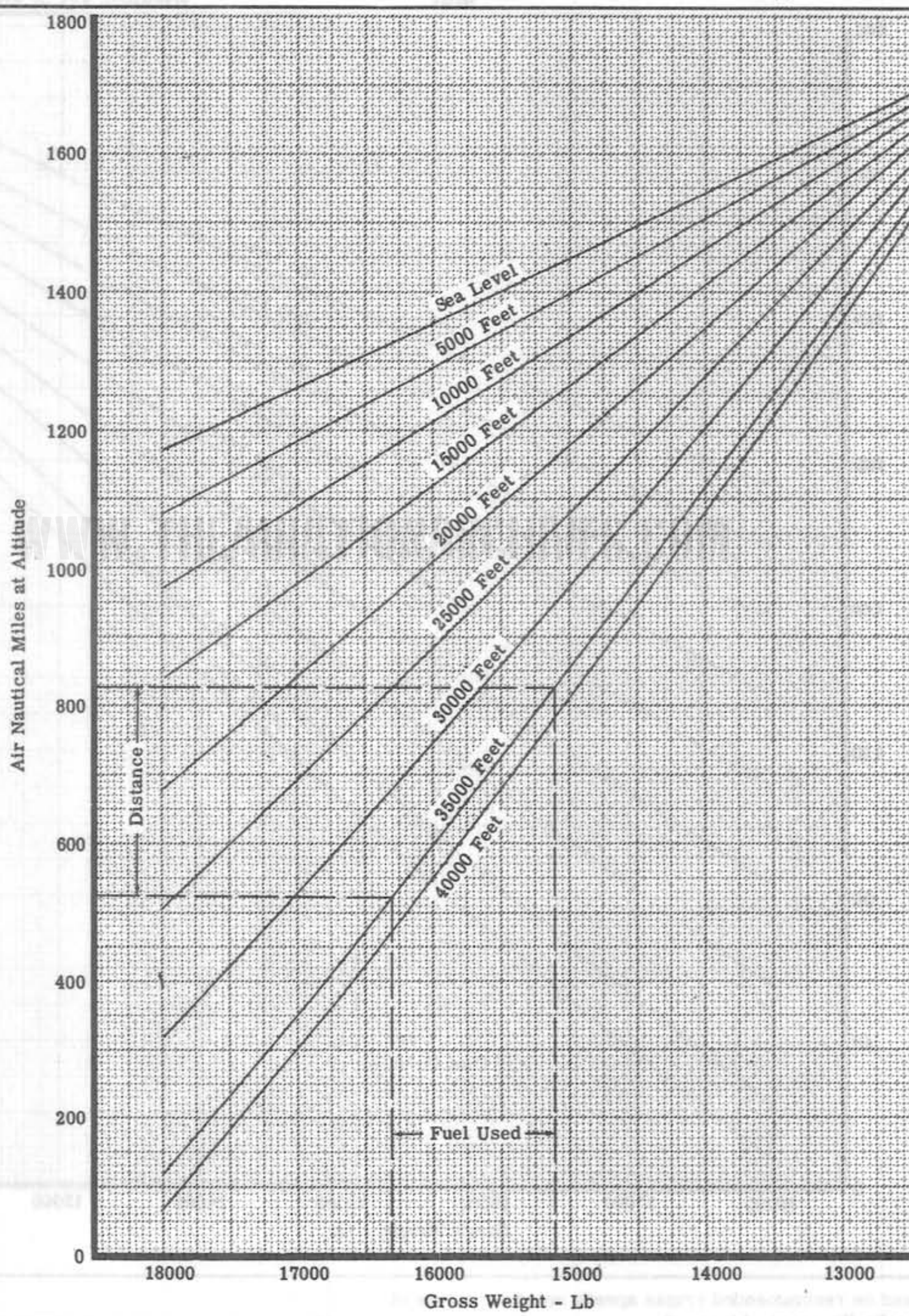
Figure A-15. Specific Range Curves (Sheet 9 of 9)

LONG RANGE PREDICTION - DISTANCE

STANDARD DAY

CONFIGURATION A

MODEL(S): F9F-7 ENGINE(S): J33-A-16A



REMARKS: 1. Based on recommended cruise speeds noted on curves of Specific Range vs. Airspeed.
2. Example from step r., Description of Charts and Tables.

DATA AS OF: 7 May 1952
DATA BASIS: NATC Reports FT31-075, FT31-0107 & GAEC Flight Tests

FUEL GRADE AND DENSITY: MIL-F-5624A (JP-3 or JP-4) 6.5 Lb/Gal; MIL-F-5572 (AVGAS) 6.0 Lb/Gal

Figure A-16. Long Range Prediction—Distance Curves

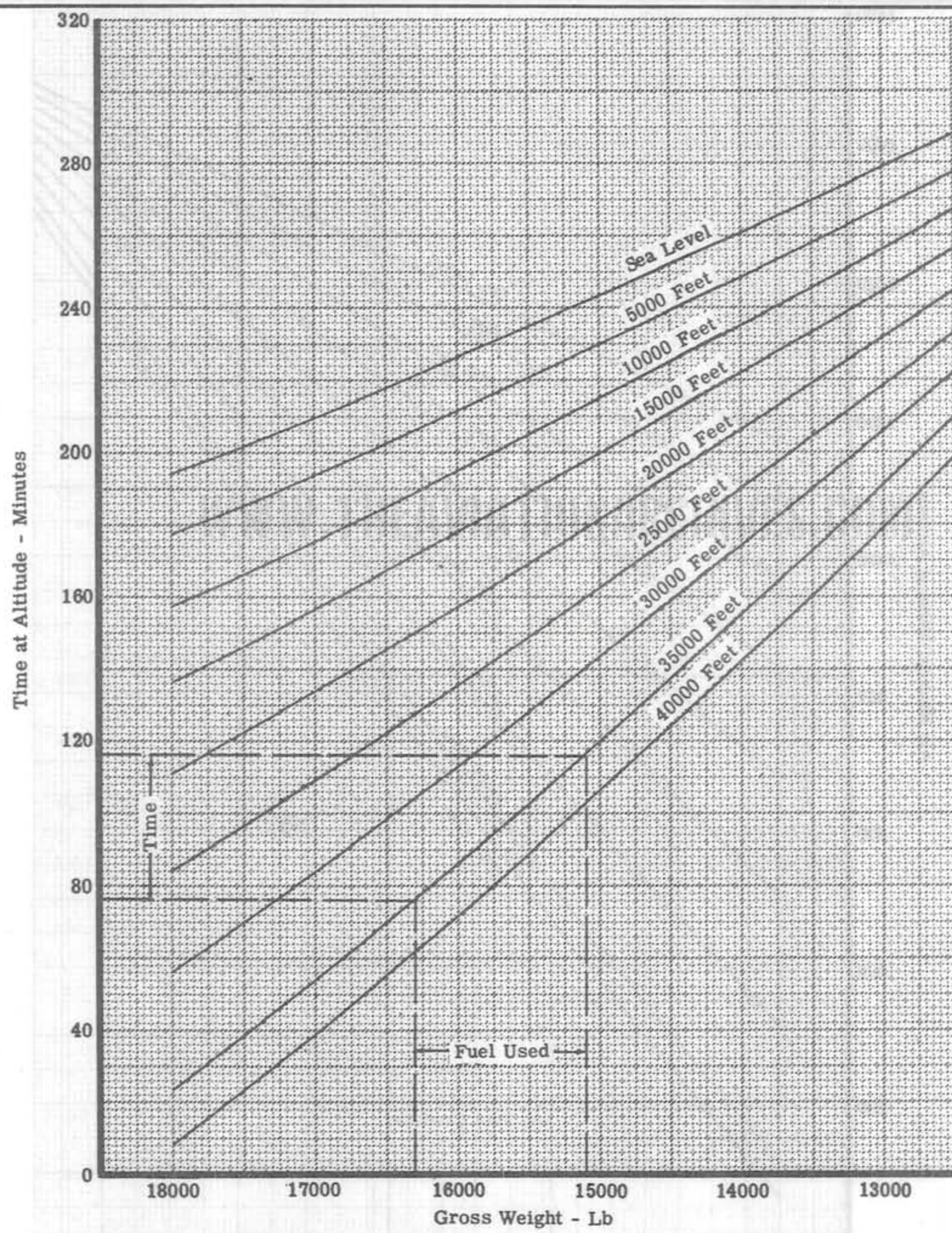
Appendix I of this publication shall not be carried in aircraft on combat missions or when there is a reasonable chance of its falling into the hands of an unfriendly nation.

LONG RANGE PREDICTION - TIME

STANDARD DAY

CONFIGURATION

MODEL(S): F9F-7 ENGINE(S): J33-A-16A



REMARKS: 1. Based on recommended cruise speeds noted on curves of Specific Range vs. Airspeed.
2. Example from step t., Description of Charts and Tables.

DATA AS OF: 7 May 1952
DATA BASIS: NATC Reports FT31-075, FT31-0107 & GAEC Flight Tests

FUEL GRADE AND DENSITY: MIL-F-5624A (JP-3 or JP-4) 6.5 Lb/Gal
MIL-F-5572 (AVGAS) 6.0 Lb/Gal

Figure A-17. Long Range Prediction—Time Curves

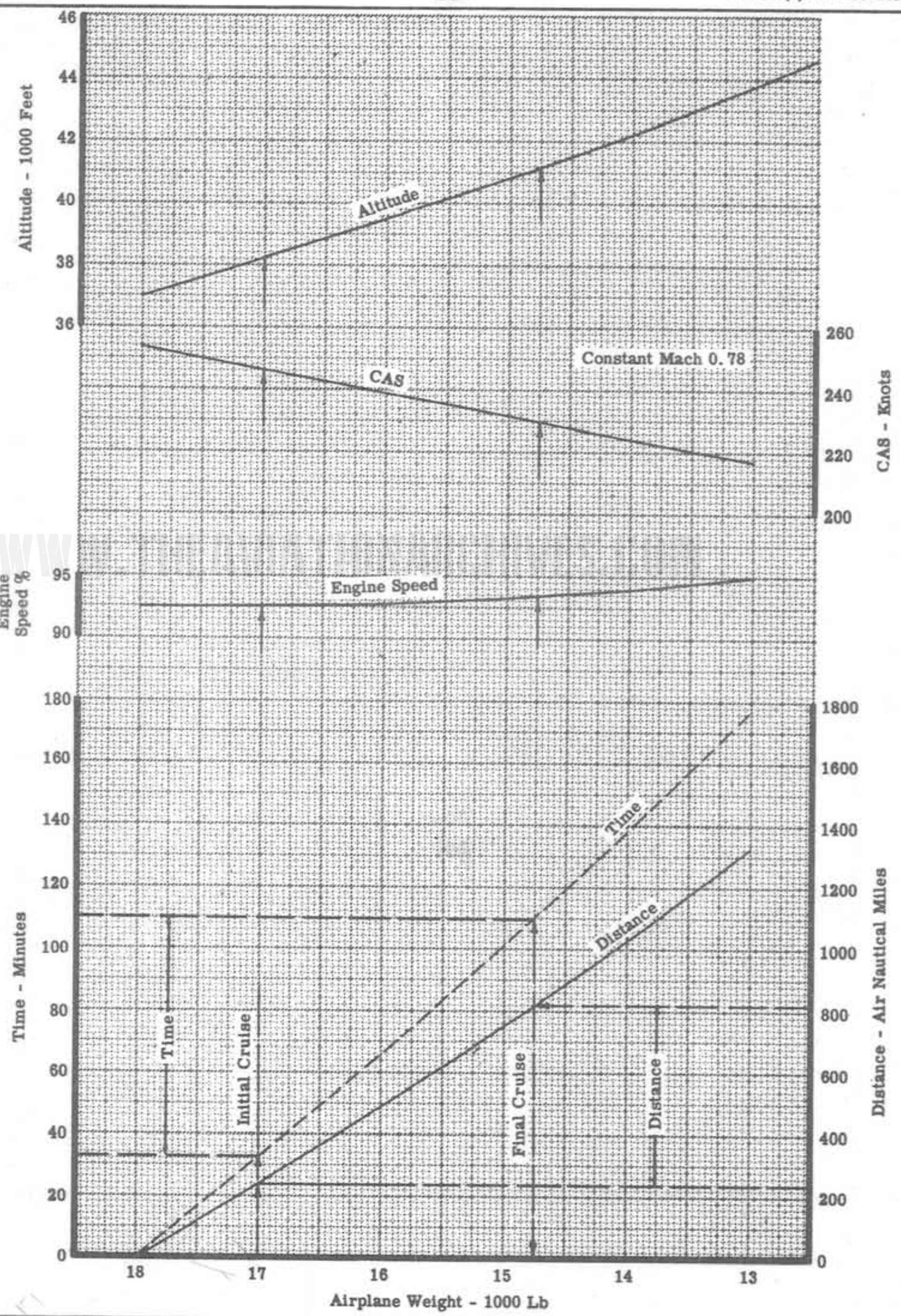
MAXIMUM RANGE -VARIABLE ALTITUDE

STANDARD DAY

CONFIGURATION

MODEL(S): F9F-7

ENGINE(S): J33-A-16A



REMARKS:
1. Climb at 100% to initial cruise altitude.
2. Vary airspeed & altitude, as shown, as weight decreases.
3. Rate of climb will be approximately 40 FPM.
4. Engine speed and time are for Standard Day only.
5. See step v., for example.

DATA AS OF: 7 May 1952
DATA BASIS: NATC Reports FT31-075, FT31-0107 & GAEC Flight Tests

FUEL GRADE AND DENSITY: MIL-F-5624A (JP-3 or JP-4) 6.5 Lb/Gal; MIL-F-5572 (AVGAS) 6.0 Lb/Gal

Figure A-18. Maximum Range—Variable Altitude Curves

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