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PARTIAL FLIGHT MANUAL

USAF SERIES QF-104A AIRCRAFT

Commanders are responsible for bringing this manual to the attention of all personnel cleared for operation of affected aircraft.

PUBLISHED UNDER AUTHORITY OF THE SECRETARY OF THE AIR FORCE

See Weekly Index T.O. 0-1-1-4A for current status of Operational and Safety Supplements.

THIS PUBLICATION REPLACES SECTION III OF T.O. 1F-104(Q)A-1 DATED 1 JULY 1962

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LIST OF EFFECTIVE PAGES

INSERT LATEST CHANGED PAGES. DESTROY SUPERSEDED PAGES.

NOTE: The portion of the text affected by the changes is indicated by a vertical line in the outer margins of the page.

TOTAL NUMBER OF PAGES IN THIS PUBLICATION IS 164, CONSISTING OF THE FOLLOWING:

Page No.	*Issue*
Title	Original
A	Original
i thru vi	Original
1-1 thru 1-23	Original
1-24 Blank	Original
2-1 thru 2-41	Original
2-42 Blank	Original
3-1 thru 3-6	Original
4-1 thru 4-24	Original
5-1	Original
5-2	Original
6-1 thru 6-4	Original
7-1	Original
7-2 Blank	Original
8-1	Original
8-2 Blank	Original
9-1	Original
9-2 Blank	Original
A-1	Original
A-2 Blank	Original
A1-1	Original
A1-2 Blank	Original
A2-1	Original
A2-2 Blank	Original
A3-1	Original
A3-2 Blank	Original
A4-1 thru A4-13	Original
A4-14 Blank	Original
A5-1 thru A5-8	Original
A10-1 thru A10-10	Original
A11-1	Original
A11-2 Blank	Original
Index-1 thru Index-5	Original
Index-6 Blank	Original

CURRENT FLIGHT CREW CHECKLIST

T.O. 1F-104A-1-3CL-1 30 JUNE 1966

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A
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SUPPLEMENT SUMMARY

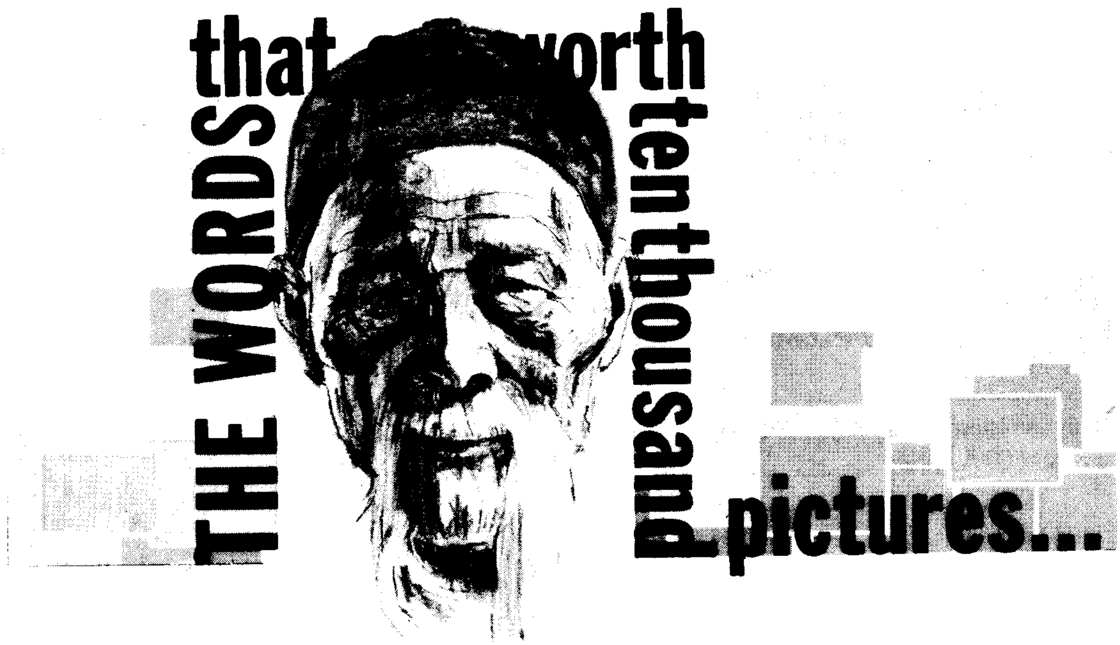
The Operational and Safety Supplements you receive should follow in sequence and if you find you are missing one, check the publication index (T.O. 0-1-1-4A) to see if it was issued and if it is still in effect. It may have been replaced or rescinded before you received your copy. If it is still active, see your Publication Distribution Officer and get your copy. It should be noted that a Supplement number will never be used more than once.

SUPPLEMENTS INCORPORATED IN THIS CHANGE

This revision incorporates all supplements up to and including T.O. 1F-104(Q)A-1S-3 and T.O. 1F-104(Q)A-1SS-5.

SUPPLEMENTS OUTSTANDING

(This portion to be filled in by you when you receive your Flight Manual and to be added to as you receive additional Supplements. Refer to Publications Index (T.O. 0-1-1-4A) for latest information if any questions arise.)



In addition to the information contained in page ii of T.O. 1F-104A-1 the following information is included:

APPLICABILITY. The major systems and equipment described in this manual are listed identically to those of the F-104A Flight Manual. Major systems or equipment common to both the QF-104A and the F-104A are omitted in the QF-104A manual. Information describing systems and/or equipment peculiar only to the QF-104A will appear as additional information using the existing F-104A Flight Manual paragraph heading format or a new paragraph heading as applicable. In this case the statement, "all except the following is contained in T.O. 1F-104A-1," will appear immediately after the main paragraph heading and the applicable subparagraph heading will cover the new or additional information. Systems or equipment applicable only to F-104A aircraft will be noted as, "not applicable," after the paragraph heading.

SECTION I description .... PAGE 1-1

SECTION II normal procedures .... PAGE 2-1

SECTION III emergency procedures .... PAGE 3-1

table of Contents

SECTION IV auxiliary equipment .... PAGE 4-1

SECTION V operating limitations .... PAGE 5-1

SECTION VI flight characteristics .... PAGE 6-1

SECTION VII systems operation .... PAGE 7-1

SECTION VIII crew duties .... PAGE 8-1

SECTION IX all-weather operation .... PAGE 9-1

APPENDIX I performance data .... PAGE A-1

ALPHABETICAL INDEX .... PAGE INDEX-1

GLOSSARY

TERM	DEFINITION
Airspeed on Throttle.	A mode of control during which speed increase-decrease commands vary airspeed reference. Throttle moves to maintain aircraft actual airspeed equal to reference airspeed.
Altitude Control Equipment (ACE)	Equipment that establishes a barometric altitude reference. Circuitry within the drone acts to maintain the drone at the reference altitude as long as ACE is in effect.
ARM	To prepare functions to receive a command.
ATO	Automatic Takeoff Sequence.
Beep Box	Common name for command selector control unit.
Beep Stick	Common name for the control on the command selector which functions as a miniature control stick to initiate turn and pitch commands.
Carrier Failure Sequence	A sequence of programmed commands automatically initiated if radio carrier contact between the director and the drone is interrupted.
Circle Turn	A coordinated turn in which the drone is maintained in a continuous circling attitude until commanded otherwise.
Coded Functions	That group of commands consisting of a combination of two or more channel frequencies being transmitted simultaneously to the drone. Such commands must be routed through the demultiplexer unit of the guidance radio receiver.
Command	An action to obtain a desired response.
Command Radio	A radio system providing voice communication between drone and director installations. Used primarily for training and orientation purposes.
Cruise Reference Airspeed	A mode of drone control that establishes a preset cruise airspeed as the airspeed reference.
Cruise Reference Mach	Same as cruise reference airspeed except in terms of Mach number.
Director Installation	An installation, either ground-based or airborne, of radio, radar, and control equipment from which commands may be transmitted to the drone.
Director Pilot	A rated pilot qualified to perform duties as pilot of the director airplane during all phases of remote control operation.
Direct Pitch	A mode of control in which pitch up and pitch down commands vary pitch attitude.
Direct Throttle	A mode of control during which speed increase or decrease commands vary throttle position directly.
Drone	An airplane, originally intended to be flown by a pilot, which has been converted for pilotless flight by the installation of additional equipment.
Drone Stabilization and Control Equipment (DSCE)	Those components of the drone system that perform the functions of stabilization of flight attitude and control of airplane subsystems and auxiliary equipment.
DSCE Remote Coupling AC	Refers to an ac source that is available when DSCE circuit breaker is closed for either metal stick or nullo flight.
Firing Error Indicator System (FEI)	A system installed in the drone which detects and records the path of an attacking weapon with respect to the drone. Information obtained by this system is used in evaluating the performance of the attacking weapon.

GLOSSARY (Cont)

TERM	DEFINITION
Remote Controller, Ground	A pilot qualified to maintain control of the drone from the ground control station during all takeoff and landing operations.
Guidance Radio or Radar	The radio or radar system that transmits and receives the "beeper" pilot's commands to the drone.
Mach on Throttle	A mode of control during which speed increase-decrease commands vary the Mach reference and the throttle to maintain the actual Mach number of the aircraft equal to the reference Mach number.
Mach on Pitch	A mode of control during which speed increase-decrease commands vary the Mach number reference. Pitch attitude varies automatically to maintain aircraft actual Mach number equal to the referenced Mach number.
Metal Stick	A collective term used to designate a method of drone control used by the safety pilot for system checkout, training, and orientation purposes. Commands are initiated by the safety pilot from the cockpit of the drone. These commands simulate commands from the guidance radio system and are routed directly to the DSCE.
Navigation Turn	A coordinated turn to establish the drone on a new heading. The turn attitude is maintained only as long as the command is held on.
Nullo Flight	An operational flight of the drone with no pilot aboard.
Nullo Setup Flight	A flight made with a pilot aboard, prior to a nullo flight, to determine the necessary adjustment settings required for the nullo flight. The nullo setup flight is made under the conditions that will exist during the nullo flight.
Nullo Switches	A group of switches that are closed prior to nullo flight. The switches bypass certain system circuit breakers.
Override Control	A method of control that allows the pilot to assume manual control of the drone at any time and to stop or alter any remote commands that may be in effect.
Radar Controller	A pilot or navigator with sufficient radar training to position the drone at a known point in space by remotely controlling the drone through the radar command link.
Remote Control Pilot	Commonly called the "beeper pilot." A qualified pilot who controls the drone from the director airplane by use of the remote control system.
Remote dc	Refer to a primary dc source that is available only when the DSCE is engaged for metal-stick or nullo flight position.
Safety Pilot	A qualified pilot in the drone who can take control at any time. The safety pilot also flies the drone through the metal stick function for training and checkout.
Skid Turn	A turn resulting from rudder movement only while the wings are maintained level. Skid turns are possible only during operation with the wing flaps extended and gear down.

Figure 1-1

SECTION I — DESCRIPTION

TABLE OF CONTENTS

	Page
The Airplane	1-1
Engine	1-5
Oil Supply System	1-6
Fuel Supply System	1-6
Electrical Power Supply Systems	1-6
Hydraulic Power Supply Systems	1-12
Flight Control System	1-13
Wing Flap System	1-19
Speed Brake System	1-19
Landing Gear System	1-19
Nosewheel Steering System	1-19
Wheel Brake System	1-22
Drag Chute System	1-23
Instruments	1-23
Warning Light System	1-23
Auxiliary Equipment	1-23

THE AIRPLANE.

All except the following is contained in T.O. 1F-104A-1.

The QF-104A drone is a stabilized, remotely controlled, recoverable pilotless aircraft which is used as a high speed, high altitude target for weapons system evaluation. See figure 1-1.

The QF-104A drone utilizes an Air Force Type F-104A airframe. Remote control is made possible through the addition of the drone stabilization and control equipment (DSCE) and radio and radar guidance equipment in the aircraft. The basic airframe is unchanged except for the removal of unused equipment, the installation of guidance control, other drone equipment, and modifications necessary for these installations. See figure 1-2.

GROSS WEIGHT.

The approximate takeoff gross weights of the airplane (including full internal fuel and pilot) are as follows:

Tip tanks	22,900 pounds
Tip tanks and pylon tanks	26,000 pounds.

Note

- These are approximate gross weights and should not be used for detailed mission planning.
- 100 to 150 pounds of fuel are required for ground operation prior to takeoff.

ARMAMENT.

The drone carries no armament or fire control equipment.

DRONE CONVERSION.

In converting the F-104A aircraft to the QF-104A drone configuration, certain equipment was removed or relocated and other equipment added as indicated by the following:

Major Equipment Items Removed.

1. All nose radome radar fire control system components including:
   - Antenna
   - Amplifiers
   - Duplexer
   - Modulator
   - Power supply
   - Computer
   - Synchronizer
   - Wiring and supports
2. All optical gunsight equipment including:
   - Amplifiers
   - Power supply
3. All armament equipment including:
   - Guns
   - Gun mount
   - Gun purging motors, equipment, and blast tubes
   - Ammunition boxes
   - Ammunition boosters
   - Ammunition feeder case and link ejection chutes
   - Electrical wiring and equipment

GENERAL ARRANGEMENT—QF-104A

1. PARAMI INSTALLATION
2. 2500-VA INVERTER
3. 200A TRANSFORMER - RECTIFIER
4. NIC-CAD BATTERY, 22 AMP HR
5. ARN-31 RECEIVER
6. ELECTRICAL INSTALLATION - NOSE CONE
7. APW-20 ANTENNA - TOP RADOME
8. AILERON SERVO MOTOR
9. STABILIZER SERVO MOTOR
10. INSTRUMENT PANEL
11. ARW-64 CARRIER LIGHT (HIDDEN)
12. TIP TANK AUGMENTATION ANTENNA
13. JUNCTION BOX AND NULLO SWITCHES
14. 200A TRANSFORMER - RECTIFIER
15. REFRIGERATOR
16. VOR LOCALIZER ANTENNA-ARN-56
17. TRIM ADAPTER AND TRANS CARRIER
18. ARC-66 REC - XMTR
19. APW-20 INTEGRATED BOX
20. J-R SERVO AMP
21. APW-20 ANTENNA ELECTRONIC COMPARTMENT COVER
22. ID-251 IND AND STA 310 EQUIPMENT
23. DPN-50 ("C" BEACON) (HIDDEN)
24. ARW-64 ANTENNA - TOP LOCATED
25. ARW-64 REC DECODER INSTALLATION
26. TWT INSTALLATION (RH TANK ONLY)
27. PARAMI ANTENNA (RH TANK ONLY)
28. AUGMENTATION L- BAND HELIX AND X-BAND HORN
29. RIGHT-HAND ELECTRICAL AND FUEL CUTOFF SWITCH
30. THROTTLE SERVO AND LIMIT CONTROL
31. SERVO INSTL - STABILIZER
32. SW INSTL APC
33. FLUXGATE VALVE
34. RUDDER LOCK
35. SMOKE TUBE
36. COMB. NAV & LOW-FUEL WARNING LIGHT
37. DESTRUCTOR KEY SWITCH
38. DRAG CHUTE ACTUATOR
39. AFT VENTRAL FIN
40. DESTRUCTOR SYSTEM INSTALLATION SWITCH (LH FILLET) (HYDRAULIC LG DOOR CUTOFF)
41. DATA LINK ANTENNA AKT-7
42. CAMERA SCORING TIP TANK (LH ONLY)
43. FWD VENTRAL FIN
44. SKID DETECTOR - MLG
45. DSCE ACCELEOMETER
46. DESTRUCT PKG
47. ARC-66 ANTENNA
48. CASE STOWAGE FUEL TANK
49. C-BEACON ANTENNA (DPN 50)
50. GUNBAY FUEL TANK
51. AIR START RELAY
52. J-4 GYRO
53. NOSE WHEEL SCISSORS SWITCH
54. DSCE CONTROL ASSEMBLY
55. 3-AXES DAMPER
56. DSCE FLIGHT COMPUTER
57. ARN-56 RECEIVER
58. MM-2 ATTITUDE GYRO
59. AKT-7 INTEGRATED BOX
60. DRAIN INSTALLATION WATER SEPARATOR

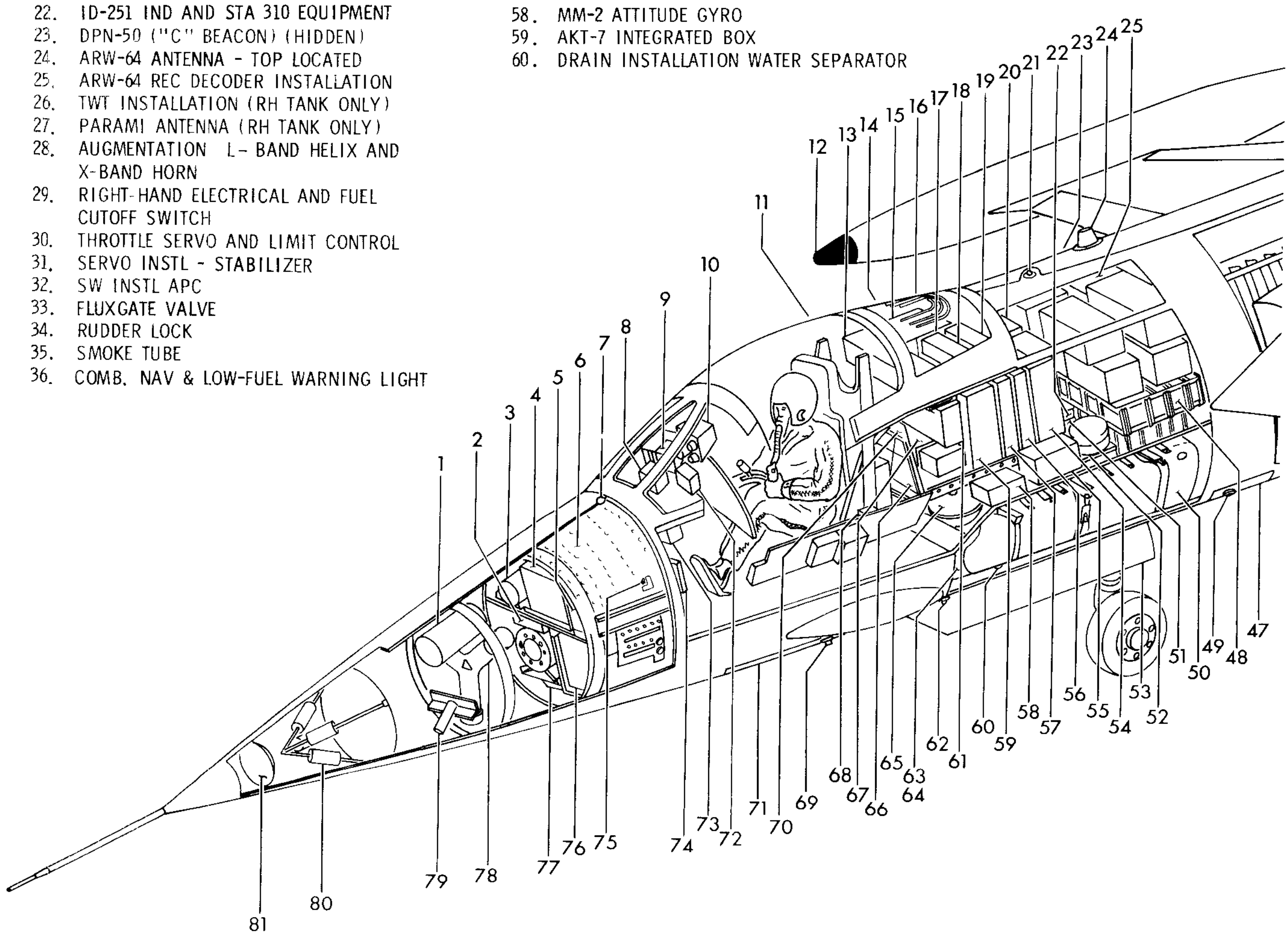
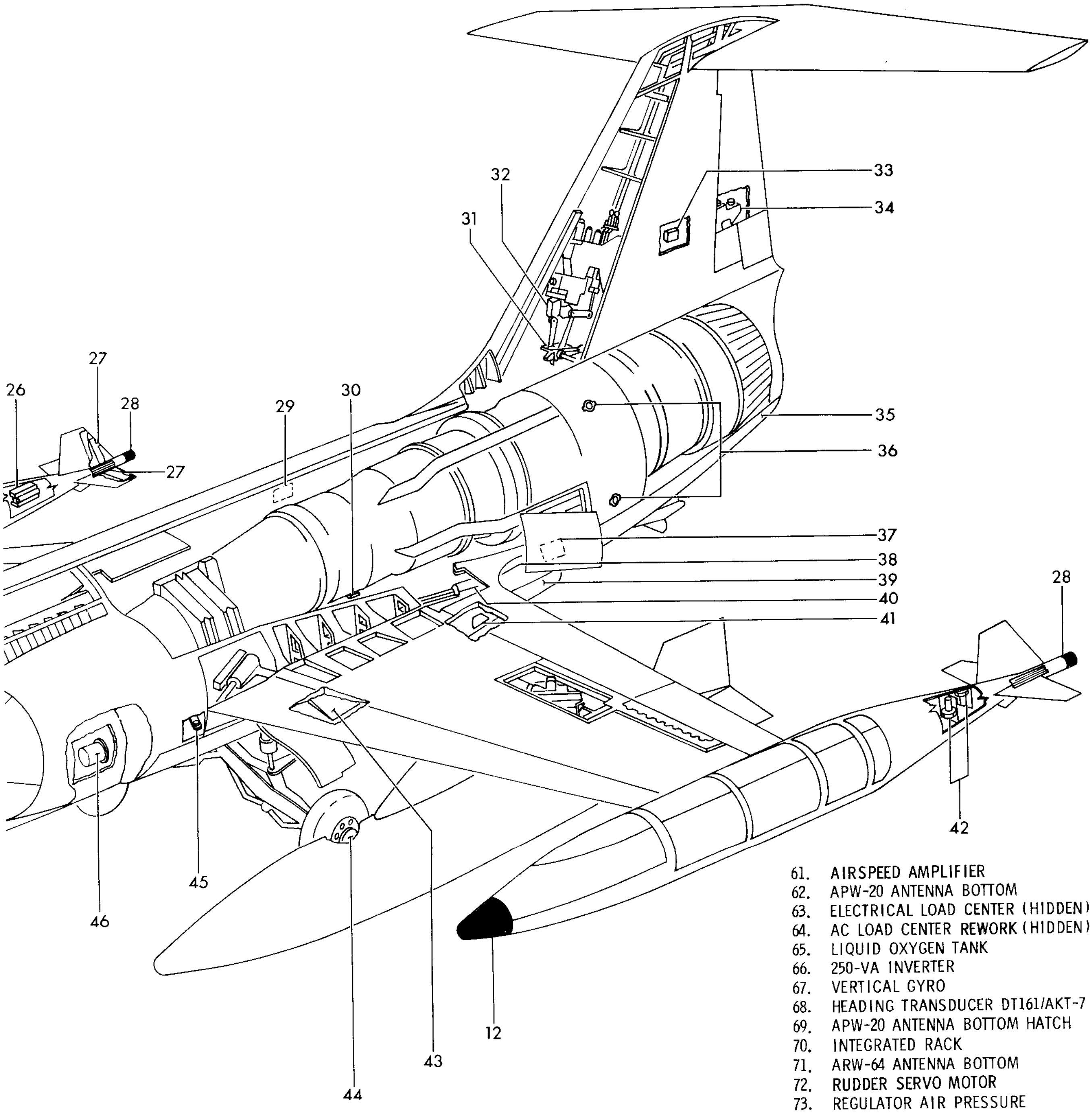


Figure 1-2 (Sheet 1 of 2)



61. AIRSPEED AMPLIFIER
62. APW-20 ANTENNA BOTTOM
63. ELECTRICAL LOAD CENTER (HIDDEN)
64. AC LOAD CENTER REWORK (HIDDEN)
65. LIQUID OXYGEN TANK
66. 250-VA INVERTER
67. VERTICAL GYRO
68. HEADING TRANSDUCER DT161/AKT-7
69. APW-20 ANTENNA BOTTOM HATCH
70. INTEGRATED RACK
71. ARW-64 ANTENNA BOTTOM
72. RUDDER SERVO MOTOR
73. REGULATOR AIR PRESSURE
74. AILERON TRAVEL LIMITER
75. CIRCUIT BREAKER PANEL AND 2 OR 4 EXTERNAL TANK SWITCH
76. AIR DATA COMPUTER
77. AIR PRESSURE OUTFLOW VALVE
78. NOSE CAMERA SCORING
79. GLIDESLOPE ANTENNA ARN-31
80. LAC PARAMI ANTENNA
81. LUNEBERG LENS

F59-B-1-3(2)

Figure 1-2 (Sheet 2 of 2)

4. All cockpit fire control system components including radar range and position indicator, armament control panel, gunsight control and ground test panels.

5. Electronic compartment forward and aft racks, disconnects, and junction boxes.

6. Manual rudder lock installation.

7. Drag chute items.

Relocated Equipment.

1. VHF navigation receiver.
2. Attitude gyro transformer.
3. Inverters.
4. Flasher unit.
5. Gyrosyn compass. Roll gyro.
6. Gyrosyn compass directional gyro.
7. Gyrosyn compass amplifier.
8. Ignition timer.
9. Liquid oxygen equipment.

Added Equipment.

1. AN/ARN-31 glide slope receiving equipment and antenna.

2. AN/AKT-7 telemetering system equipment and antenna.

3. AN/ARW-56 guidance equipment and antennas.

4. AN/APW-20 radar guidance equipment and antennas.

5. DSCE-104 drone stabilization and control equipment including:

   Air data computer.

   Aileron stabilizer and radar servo motors and brackets.

   Throttle servo motors and mounts.

   Amplifiers.

   Accelerometers.

   Power converters.

   Airspeed and Mach reference controls and vertical gyro reference.

6. X- and L-band radar augmentation equipment and antennas.

7. PARAMI miss distance indicator equipment and antennas.

8. "C"-band beacon equipment and antennas.

9. Optical (5) camera scoring system.

10. 200 amp transformer-rectifiers.

11. 2500-VA inverter.

12. 22-AH battery.

13. Anti-skid power brake equipment.

14. Range safety destruct system.

15. Additional gun bay and case storage fuel tanks.

Manuals Describing Drone Equipment.

Detailed information on the operating theory, overhaul instructions, and parts breakdown of the special version components may be found in existing manuals describing these components. These manuals are listed below.

1. Maintenance and Repair Manual with Parts Breakdown (T.O. 1F-104(Q)A-2)

2. Handbook Operation and Service Instructions for DSCE-104 System Test Bench

(Sperry—Phoenix, Arizona)

3. Handbook Installation and Operation Sperry Echo Enhancer (SEE) System MOD L-AC

(Sperry—Great Neck, Long Island)

4. Handbook Operation and Maintenance Instructions Transponder Set, AN/DPN-50

(Stromberg-Carlson Div, Gen Dynamics Corp)

5. Manual, PARAMI Instructions, 28-Volt Power Supply

(Ralph M. Parsons Co. Pasadena, California)

6. Manual, PARAMI Instructions Subsystem P/N 413951 incl

   Coupler Calibrator P/N 214333

   Target Antenna Model 9009 A

   Target Transponder Model 9050A

   Calibrate Transponder Model 9052A

(Ralph M. Parsons Co. Pasadena, California)

THROTTLE QUADRANT

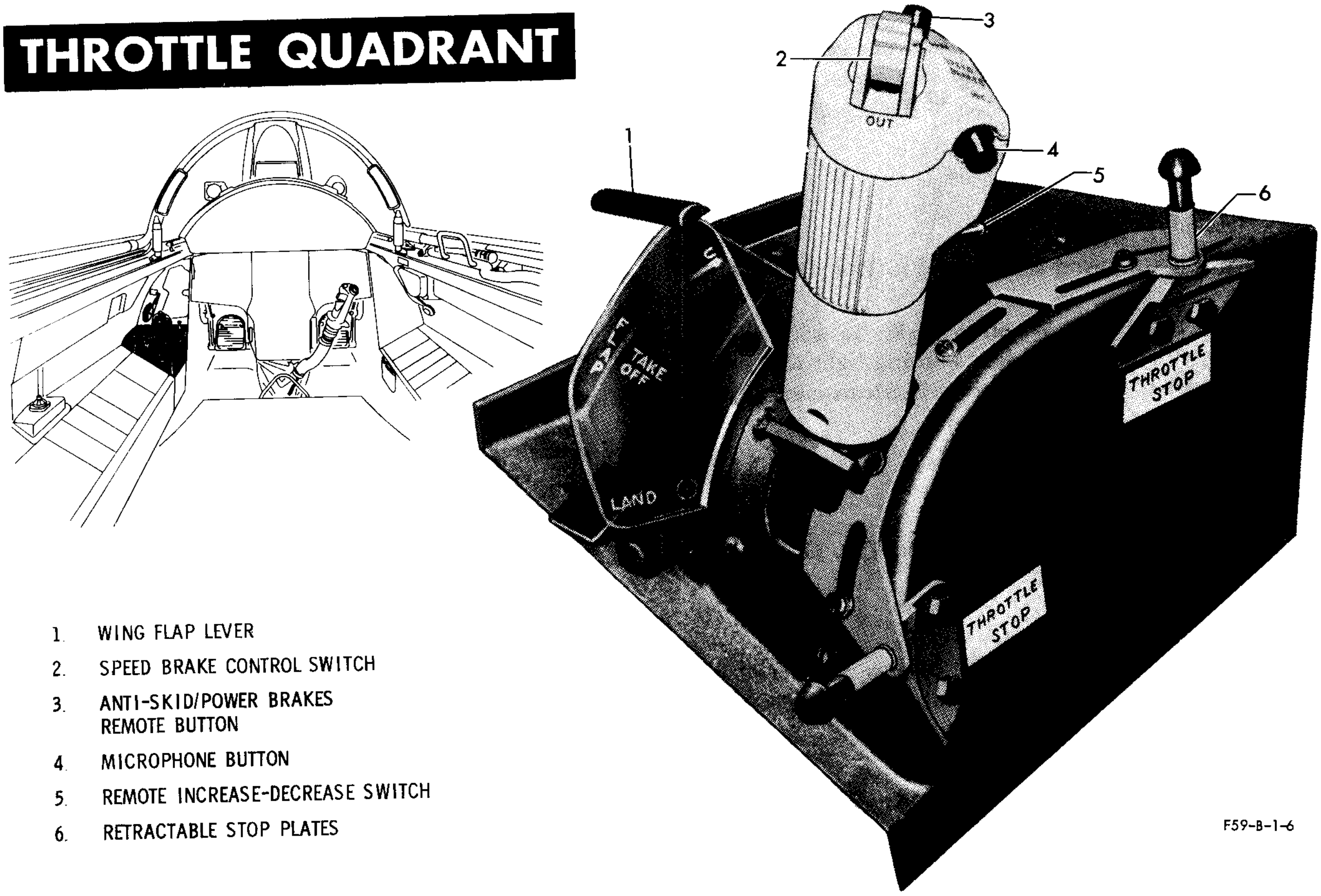


Figure 1-3

ENGINE.

All except the following is contained in T.O. 1F-104A-1.

THROTTLE LINKAGE.

DSCE throttle servo and limit switches are mechanically linked between the throttle and the engine fuel control. Thus, during Nullo or metal stick remote controlled flight the throttle linkage is operated by the servo motor to select power settings. A switch has been added to the nozzle feedback system to signal the throttle servo when the afterburner is on.

THROTTLE.

The potentiometer and switch for gunsight manual range control on the grip assembly have been removed. The former gunsight electrical cage button is now used for controlling the remote brakes (3, figure 1-3). A remote INCREASE-DECREASE control switch (5, figure 1-3) is added to the inboard side of the grip below the microphone button.

Adjustable forward and aft stop plates, with positive latches, are fastened to the side of the throttle quadrant. (6, figure 1-3) During Nullo flight, the stop plates are adjusted to full open. During manned flights, the stop plates are positioned by the pilot to function as detents and as safeguards to prevent inadvertent operation of the throttle to the afterburner or OFF position.

ENGINE IGNITION SYSTEM.

The No. 1 start system receives ignition power through the battery bus from the small (3.6-ampere-hour) battery. The No. 2 start system receives ignition power through the No. 1 dc bus from the large (22-ampere-hour) battery. (See figure 1-11.)

Start Switches. By momentarily operating the No. 1 start switch to START, battery bus power is supplied to energize the ignition circuit and begin the 45-second ignition cycle. By momentarily operating the No. 2 start switch to START, No. 1 dc bus power is supplied to the ignition circuit.

Exhaust Gas Temperature Gage. The exhaust gas temperature gage (EGT) is equipped with a transducer so that EGT can be telemetered to the ground or director aircraft.

Tachometer. An additional tach generator attached to an adapter is mounted on the tachometer generator pad of the engine. This generator furnishes engine rpm information which can be telemetered to the ground or director aircraft.

OIL SUPPLY SYSTEM.

All except the following is contained in T.O. 1F-104A-1.

Engine Oil Level Low Warning Light. In addition to causing the engine oil level low warning light to illuminate, the low oil level information is telemetered to the ground director.

FUEL SUPPLY SYSTEM.

All except the following is contained in T.O. 1F-104A-1.

FORWARD MAIN CELL.

Fuel from the auxiliary fuel cell also enters the main fuel cell through a transfer float valve and flapper-type check valves.

AUXILIARY FUEL CELLS.

The auxiliary fuel cells are located forward of the main fuel cell and consist of the auxiliary tank, the case stowage tank, and gun bay tank. All tanks of the auxiliary fuel cells are interconnected and filled through a separate filler well. A transfer pump is installed in the auxiliary tank and case stowage tank. The gunbay tank feeds by gravity flow into the case storage tank.

Vent Float Valves.

An additional vent float valve has been installed in the auxiliary fuel tank.

EXTERNAL TANKS.

The tip tanks have been modified to contain: scoring cameras in the left tip tank, a parami antenna in the right tank, and augmentation antennas on both tip tanks.

External Stores Release Selector Switch and External Stores Release Button. Either pylon tanks, pylons, or tip tanks may be jettisoned by remote control. For Nullo flights, the selector switch will be set in the PYLON position. In the PYLON position, an initial HOLD TO ARM jettison signal will jettison the pylon tanks; and a second HOLD TO ARM jettison signal will eject the pylons. The control stick external stores jettison button may be used by the pilot for jettisoning tip tanks or pylon tanks.

Fuel Quantity Indicator. A potentiometer is installed in the fuel quantity indicating system to provide telemetering signals.

Fuel Low Level Warning Light. The fuel low level warning light circuit has been modified to illuminate the aft fuselage navigation lights, as well as the fuel low level warning lights, when the fuel level in the main cell drops to approximately 1270 pounds (195 gallons).

ELECTRICAL POWER SUPPLY SYSTEMS.

All except the following is contained in T.O. 1F-104A-1.

AC electric power is supplied by two 20-kva, 120/208-volt, 320-522-cycle, 3-phase, engine-driven ac generators. These generators are not paralleled, each unit powers a separate bus. Emergency ac electric power is supplied by a 5.5-kva, 120/208-volt, 400-cycle, 3-phase, ram air turbine-driven ac generator.

Constant frequency ac power is supplied by a 2500-va, 400-cycle, 120-volt, single-phase rotary inverter supplied from the dc bus system and a 250-va, 400-cycle, 120/200-volt, three-phase instrument inverter.

DC electric power is supplied by two 200-ampere, 28-volt transformer-rectifiers powered by the ac buses.

Emergency dc power is supplied by a 22-ampere-hour, 24-volt nickel-cadmium battery and a 3.6-ampere-hour, 24-volt nickel-cadmium battery.

AC ELECTRICAL POWER SUPPLY.

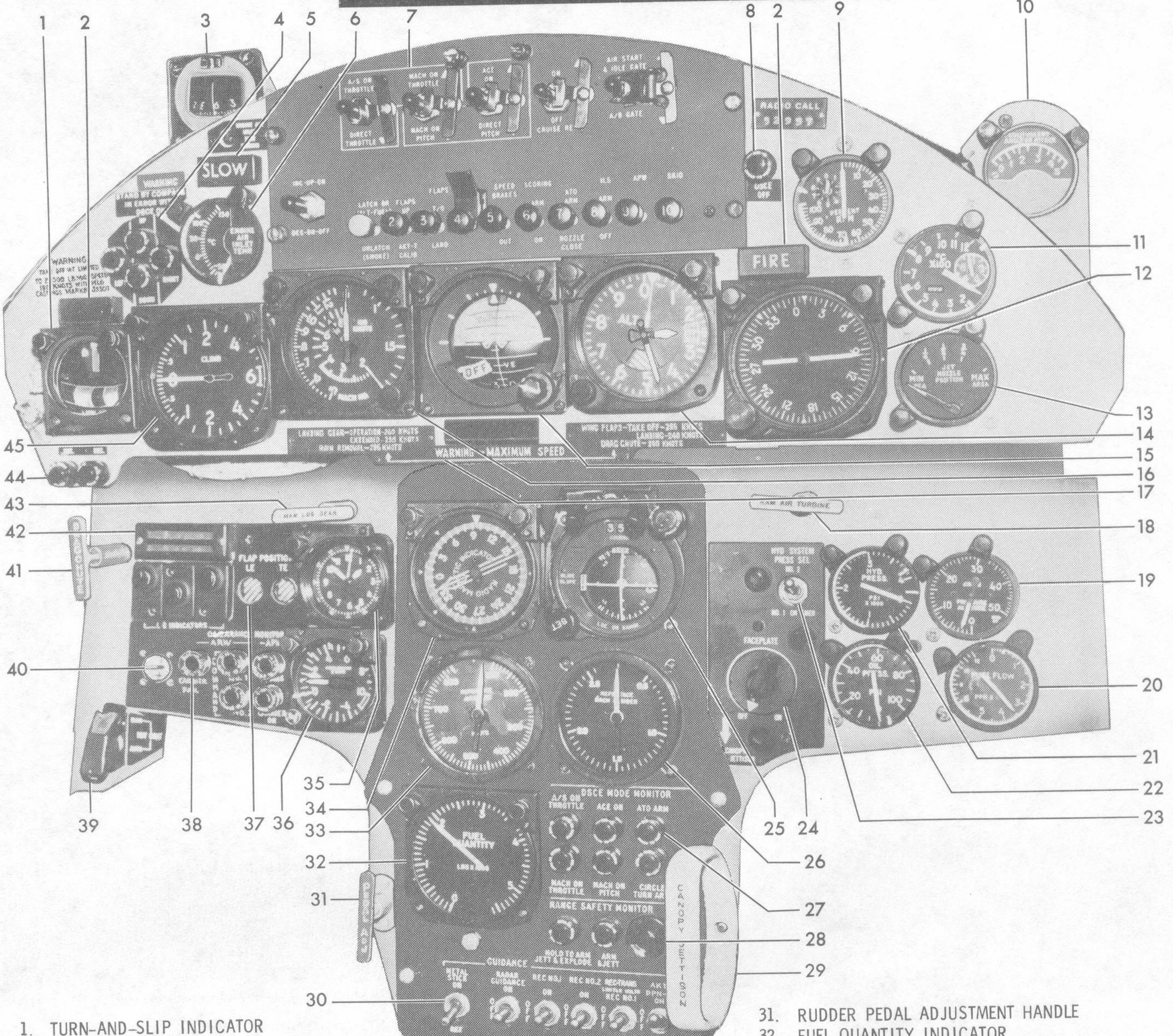
The primary ac electric power system, including the two 20-kva, 120/208-volt, 320-522-cycle, 3-phase engine-driven ac generators, the associated voltage regulators, the control panels, and the bus and bus-transfer systems, is the same as that installed in F-104A airplanes.

Emergency AC Power Supply.

In addition to the emergency ac electric systems peculiar to the QF-104A and described below, the emergency ac system of the F-104A includes the ram air turbine-driven ac generator, the emergency ac bus, emergency instrument transformer, and associated transformer and control circuitry.

The ram air turbine-driven generator is capable of extension by radio command during Nullo flight and manually during manned flight. The loads normally supplied by the 2500-va inverter and the 250-va inverter are automatically transferred to the emergency ac bus and the ram air turbine-driven generator if the latter is extended and both engine-driven ac generators are inoperative.

INSTRUMENT PANEL



1. TURN-AND-SLIP INDICATOR
2. FIRE WARNING LIGHT
3. STANDBY COMPASS
4. COMMAND MONITOR LIGHTS
5. ENGINE AIR INLET TEMPERATURE LIGHT
6. ENGINE AIR INLET TEMPERATURE GAGE
7. METAL STICK REMOTE CONTROL PANEL
8. DSCE-OFF WARNING LIGHT
9. TACHOMETER
10. AUTO PITCH CONTROL INDICATOR
11. EXHAUST GAS TEMPERATURE GAGE
12. DIRECTION INDICATOR
13. EXHAUST NOZZLE POSITION INDICATOR
14. ALTIMETER
15. ATTITUDE INDICATOR
16. AIR SPEED AND MACH INDICATOR
17. MASTER CAUTION LIGHT AND RESET BAR
18. RAM AIR TURBINE EXTENSION HANDLE
19. CABIN ALTIMETER
20. FUEL FLOW INDICATOR
21. HYDRAULIC SYSTEMS PRESSURE GAGE
22. OIL PRESSURE GAGE
23. HYDRAULIC SYSTEM PRESSURE GAGE SELECTOR SWITCH
24. FACE PLATE HEAT RHEOSTAT
25. COURSE INDICATOR
26. MACH NO. REFERENCE UNIT
27. DSCE MODE MONITOR LIGHTS
28. RANGE SAFETY MONITOR LIGHTS
29. CANOPY JETTISON LEVER
30. GUIDANCE SWITCHES
31. RUDDER PEDAL ADJUSTMENT HANDLE
32. FUEL QUANTITY INDICATOR
33. AIRSPEED REFERENCE UNIT
34. RADIO MAGNETIC INDICATOR
35. CLOCK
36. ACCELEROMETER
37. WING FLAP POSITION INDICATOR
38. GUIDANCE MONITOR LIGHTS
39. INLET GUIDE VANES EMERGENCY RESET SWITCH
40. DSCE PITCH TRIM INDICATOR
41. DRAG CHUTE HANDLE
42. STABILIZER AND AILERON TAKE-OFF TRIM INDICATOR LIGHTS
43. MANUAL LANDING GEAR RELEASE HANDLE
44. DSCE INCREASE-DECREASE MONITOR LIGHTS
45. VERTICAL SPEED INDICATOR

– TOUCH AND GO INDICATOR LIGHT (ON LEFT CENTER WINDSHIELD FRAME - NOT SHOWN)

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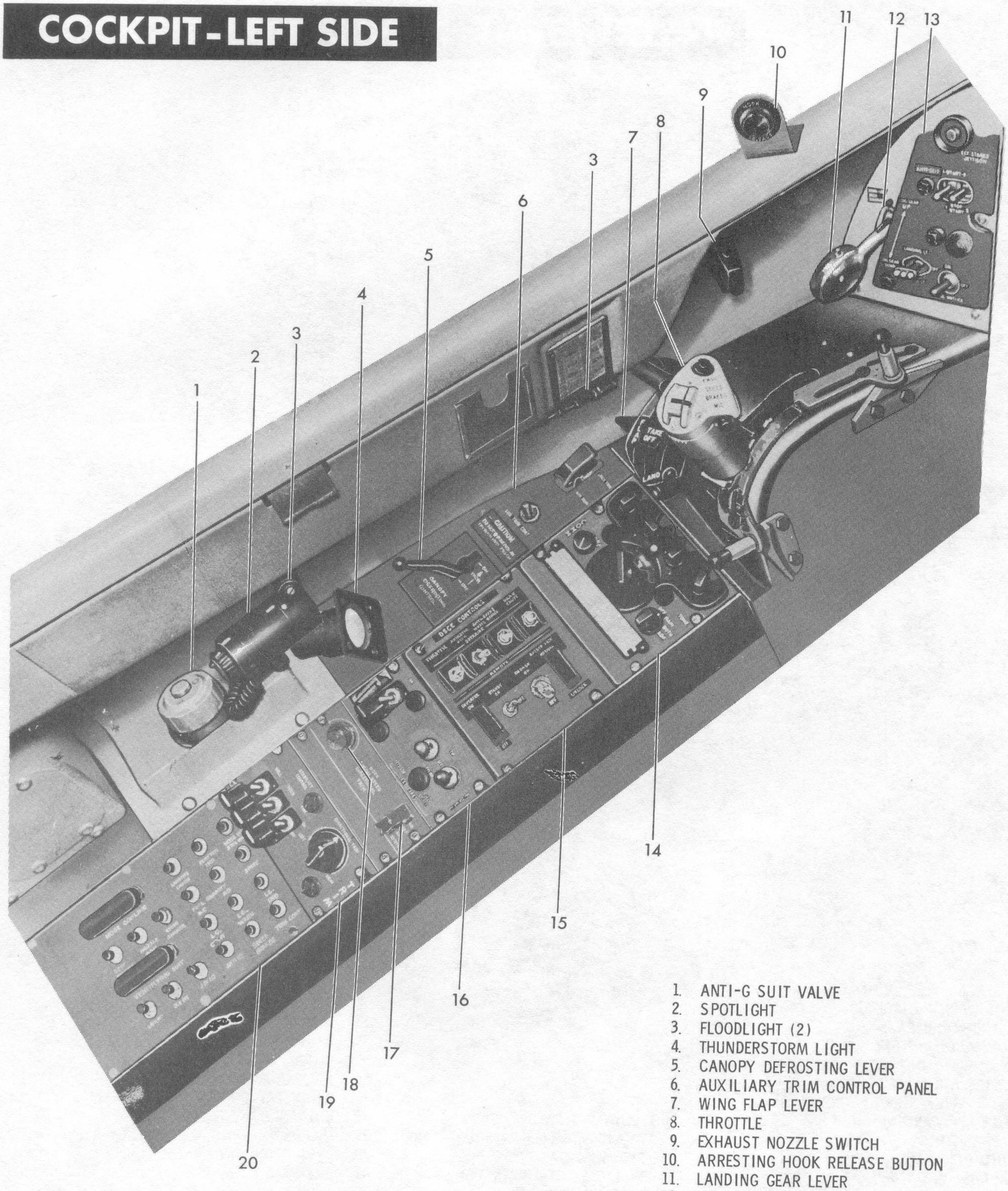
Figure 1-4

COCKPIT - LEFT SIDE

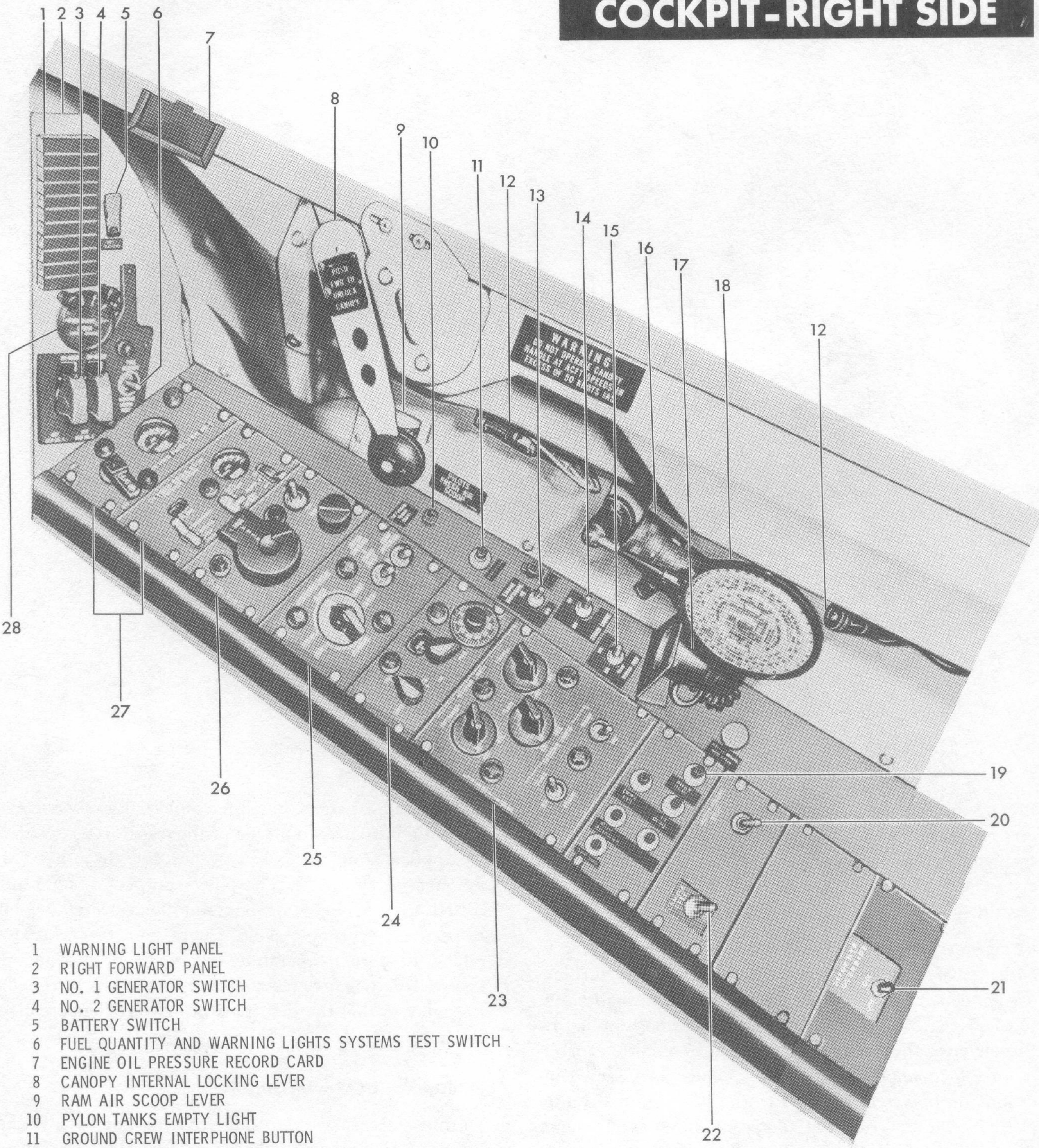


1. ANTI-G SUIT VALVE
2. SPOTLIGHT
3. FLOODLIGHT (2)
4. THUNDERSTORM LIGHT
5. CANOPY DEFROSTING LEVER
6. AUXILIARY TRIM CONTROL PANEL
7. WING FLAP LEVER
8. THROTTLE
9. EXHAUST NOZZLE SWITCH
10. ARRESTING HOOK RELEASE BUTTON
11. LANDING GEAR LEVER
12. LANDING GEAR OVERRIDE BUTTON
13. LEFT FORWARD PANEL
14. UHF COMMAND CONTROL PANEL
15. DSCE CONTROL PANEL
16. FUEL CONTROL PANEL
17. APC SYSTEM CUT-OUT SWITCH
18. DSCE HIGH SPEED DIRECTIONAL TRIM
19. TRIM AND STABILITY CONTROL PANEL
20. LEFT CIRCUIT BREAKER PANEL

F59-B-1-8

Figure 1-5

COCKPIT - RIGHT SIDE



1. WARNING LIGHT PANEL
2. RIGHT FORWARD PANEL
3. NO. 1 GENERATOR SWITCH
4. NO. 2 GENERATOR SWITCH
5. BATTERY SWITCH
6. FUEL QUANTITY AND WARNING LIGHTS SYSTEMS TEST SWITCH
7. ENGINE OIL PRESSURE RECORD CARD
8. CANOPY INTERNAL LOCKING LEVER
9. RAM AIR SCOOP LEVER
10. PYLON TANKS EMPTY LIGHT
11. GROUND CREW INTERPHONE BUTTON
12. FLOODLIGHT (2)
13. ENGINE MOTORING SWITCH
14. THUNDERSTORM LIGHTS SWITCH
15. VENTILATED SUIT BLOWER SWITCH
16. SPOTLIGHT
17. THUNDERSTORM LIGHT
18. COMPUTER
19. RIGHT CIRCUIT BREAKER PANEL
20. AUTO-TRIM TEST SWITCH
21. PITOT HEAT AUTO SWITCH
22. CAMERA OVERRIDE SWITCH
23. LIGHTING CONTROL PANEL
24. J-4 DIRECTIONAL INDICATOR CONTROL PANEL
25. HEATING CONTROL PANEL
26. VHF NAVIGATION CONTROL PANEL (AN/ARN-56)
27. OXYGEN CONTROL PANEL
28. LIQUID OXYGEN QUANTITY GAGE

F59-P-1-9

Figure 1-6

LEFT FORWARD PANEL

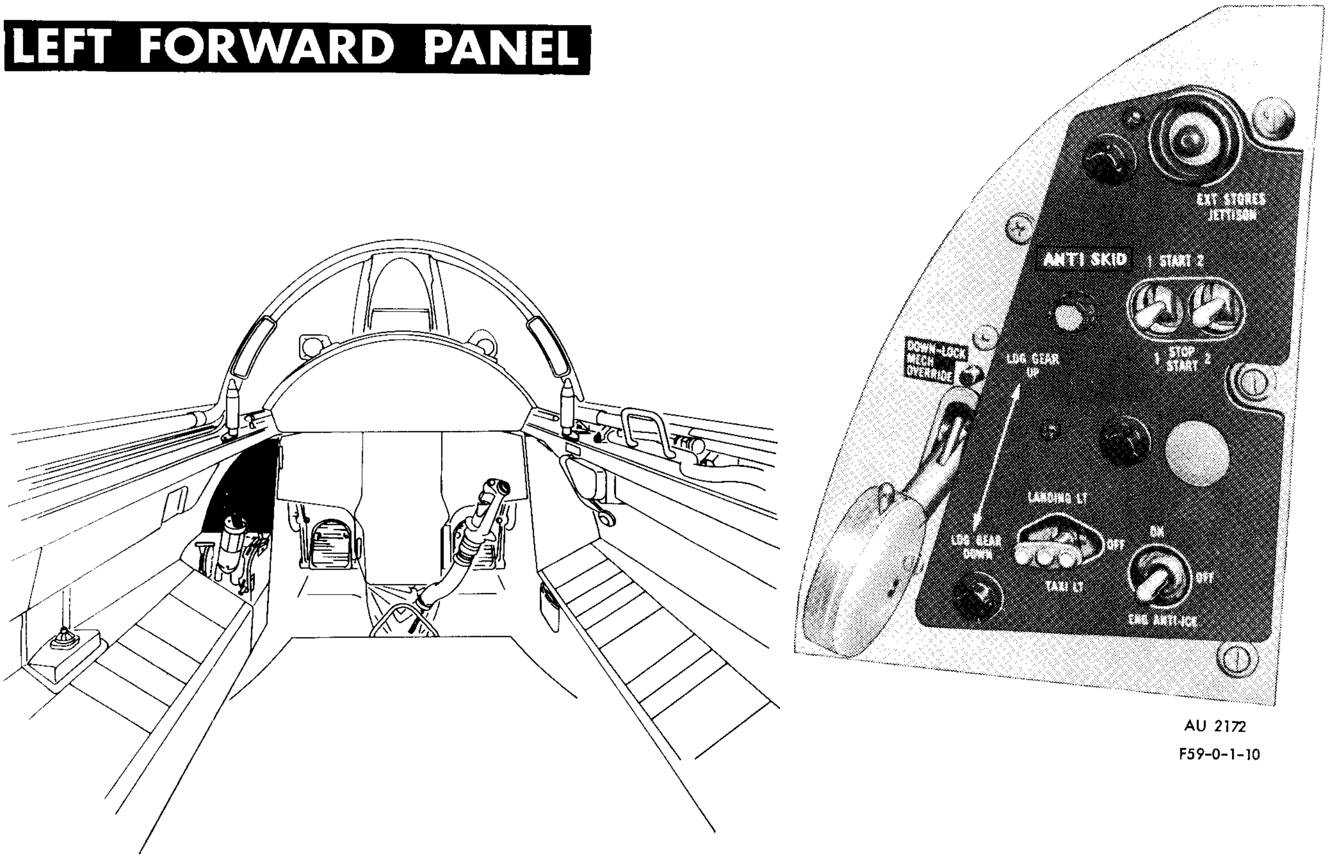


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Figure 1-7

Resumption of operation of the engine-driven ac generators results in return to their normal power source of all ac loads if these sources are operating normally; however, the RAT cannot be retracted when normal power returns.

In an emergency resulting from loss of input power to both transformer-rectifiers while the ram air turbine-driven generator is not extended, loads normally supplied by the 2500-va inverter continue to be supplied by that inverter for a period determined by the life capability of the 22-ampere-hour battery. Under these same conditions no power is supplied to the loads normally supplied by the 250-va inverter except the 3 axes damper and EGT indicator. The 3 axes damper, which is a 3-phase, 120-volt, 400-cycle load, and the EGT indicator which is a single phase, 120-volt, 400-cycle load, is automatically transferred to the phase adaptor which is supplied from the 2500-va inverter.

DC ELECTRICAL POWER SUPPLY.

The dc electric power system includes two 200-ampere, 28-volt transformer-rectifiers. The dc loads are connected to the No. 1 dc bus, the essential dc bus, the emergency dc bus, and a battery bus interconnected as shown schematically in figure 1-11. One of the transformer-rectifiers is supplied from the No. 1 ac bus and the other from the emergency ac bus. The power output of those units is fed to the No. 1 dc bus and the essential dc bus, respectively, through radio filters and reverse-current relays. In normal operation the No. 1 dc bus and the essential dc bus are tied together by the bus sectionalizing relay so that the two transformer-rectifiers are effectively paralleled.

Emergency DC Power Supply.

During emergencies resulting from loss of both engine-driven ac generators, either due to engine flameout or other reasons, emergency dc power is supplied to the No. 1 dc bus by a 22-ampere-hour nickel-cadmium battery located in the nose electric compartment. This battery, when fully charged using the procedure recommended by the manufacturer and when operated in an ambient temperature in excess of 60° F, shall be capable of furnishing the loads normally connected to the No. 1 dc bus in Nullo flight for a period of not less than 4 minutes to a cutoff voltage of 18 volts dc.

RIGHT FORWARD PANEL

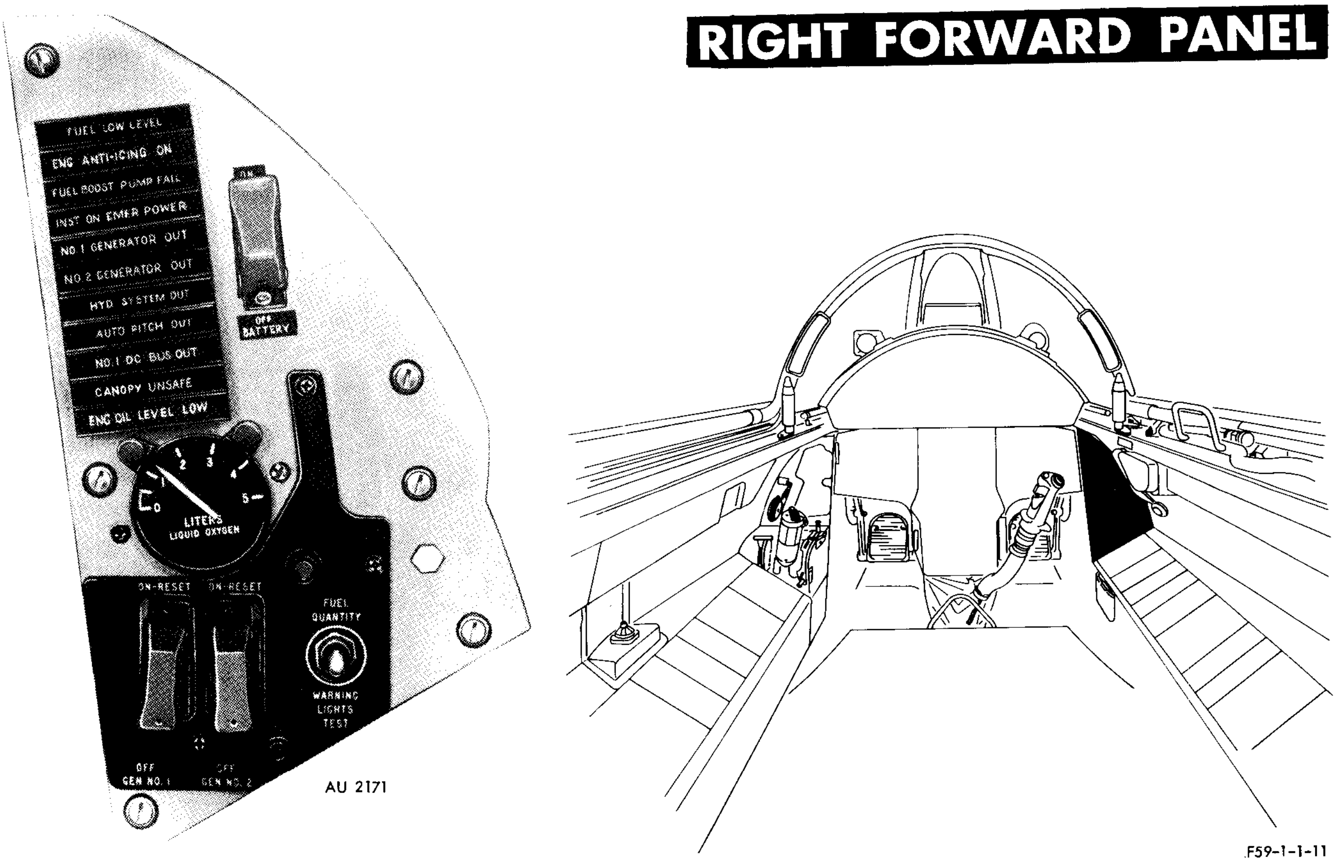


Figure 1-8

The 22-ampere-hour battery is connected to the No. 1 dc bus by a battery relay. A manual control switch is provided to allow disconnecting the battery from the No. 1 dc bus.

In case of loss of both engine-driven ac generators, the No. 1 bus is automatically disconnected (by the bus sectionalizing relay) from the other dc buses for the duration of the emergency period to prevent the battery from furnishing power to the loads on the other buses. If the ram air turbine is extended during such an emergency, the transformer-rectifier connected to the emergency ac bus supplies dc power to the emergency and essential dc buses and the battery bus.

A 3.6-ampere-hour nickel-cadmium battery, battery bus, and blocking diode (the same as used in F-104A airplanes) is installed to furnish emergency electrical power to the battery bus loads. The 3.6-ampere-hour battery is charged from the transformer-rectifier and dc bus system. A blocking diode is used to prevent the 3.6-ampere-hour battery from supplying power to any bus except the battery bus.

INSTRUMENT POWER SUPPLY.

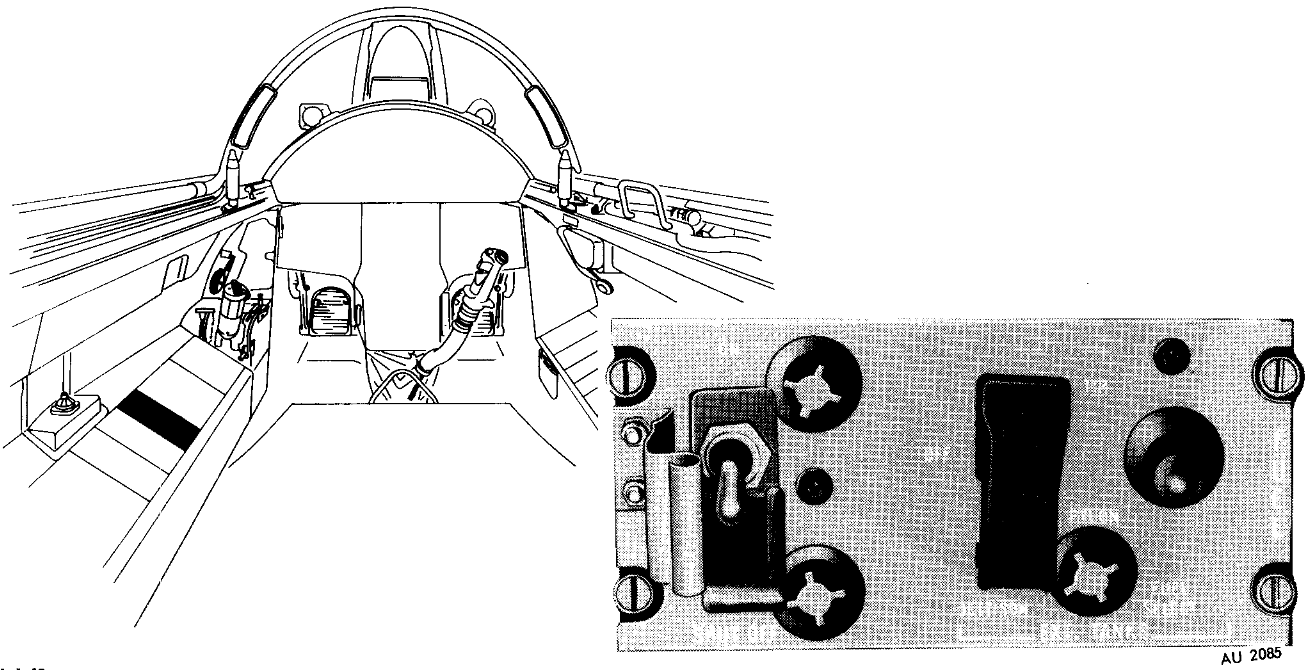
Single phase and three phase 400-cycle electric power is furnished by a 2500-va, 120-volt rotary inverter and a 250-va, 120-volt rotary inverter, respectively. The 2500-va inverter is supplied from the No. 1 dc bus and the 250-va inverter from the emergency dc bus. The power input to the inverters is interlocked to prevent inverter operation when ground power is connected to the airplane, and to allow inverter testing during ground operations. Loads normally energized from the inverters in flight are supplied from the ground power source during ground operations to reduce operational time of the inverters.

CIRCUIT BREAKERS.

All except the following is contained in T.O. 1F-104A-1.

Additional circuit breakers are located on the left side of the nose pressurized can and on the junction box in the electronics compartment.

FUEL CONTROL PANEL



F59-1-1-12

Figure 1-9

Nullo Switches. Nullo switches are located in the forward end of the electronics compartment. They are not accessible to the pilot in flight. In the NULLO flight position, these switches remove the effectiveness of the circuit breakers, fuses, and DSCE engage system for improved reliability for a Nullo mission. In the SAFE FLIGHT position, full circuit wiring protection for pilot safety and DSCE engage system is available.

Ten of the switches are located on the main junction box which contains circuit breakers and fuses. Two switches are located on an auxiliary box just aft of the main "J" box. These Nullo switches are fitted with guard plates labeled SAFE FLIGHT on one side and NULLO FLIGHT on the other. All switches must be positioned correctly for the type of flight before the guard can be positioned with the proper labeling up.

Battery Switch. The battery switch controls the 22-ampere-hour battery by means of a relay. It has two positions, ON and OFF.

Ram Air Turbine Extension Handle. The ram air turbine also may be extended by remote control.

No. 1 Dc Bus Out Warning Light. The No. 1 dc bus out warning light is located on the warning light panel and is energized by the 28-volt dc emergency bus. The light will be illuminated whenever power to the No. 1 dc bus is discontinued during normal operation. The master caution light will also illuminate when the No. 1 dc bus out warning light illuminates. (See figure 1-11 for units which will be inoperative when the No. 1 dc bus out warning light is on.)

HYDRAULIC POWER SUPPLY SYSTEMS.

All except the following is contained in T.O. 1F-104A-1.

NO. 1 HYDRAULIC POWER SUPPLY SYSTEM.

The hydraulically actuated rudder lock is powered also by the No. 1 system.

NO. 2 HYDRAULIC POWER SUPPLY SYSTEM.

A pressure line from the priority valve outlet port carries fluid to the utility hydraulic system, which includes the engine air bypass flaps, landing gear system, nosewheel steering system, drag chute actuator, powered anti-skid brake system, and speed brake selector valve.

FUEL QUANTITY DATA

DATA BASIS:
GROUND TEST; STANDARD DAY CONDITIONS WITH CONVERSION FACTOR 6.5 LB/GAL

REMARKS:
LEVEL FLIGHT ATTITUDE — TOP OF FUSELAGE 3° NOSE UP; STATIC ATTITUDE — TOP OF FUSELAGE 0°.

	USABLE FUEL IN LEVEL FLIGHT ATTITUDE		FULLY SERVICED IN STATIC ATTITUDE	
	US GAL	LB	US GAL	LB
INTERNAL FUEL MAIN CELLS	763	4960	772	5018
INTERNAL FUEL AUXILIARY CELL AND CASE STOWAGE & GUN BAY	240	1560	250	1625
TIP TANKS (EACH)	170	1105	165	1072.5
PYLON TANKS (EACH)	195*	1267	199	1293.5

TOTAL USABLE FUEL IN LEVEL FLIGHT ATTITUDE

INTERNAL FUEL.................................1003 GAL ....6520 LB

WITH TIP TANKS...............................1343 GAL ....8730 LB

WITH TIP TANKS AND PYLONS...................1733 GAL ....11,265 LB

*UNMODIFIED PYLON TANK CAPACITY ....192 GAL EACH

F59-B-1-14

Figure 1-10

FLIGHT CONTROL SYSTEM.

All except the following is contained in T.O. 1F-104A-1.

All systems are controlled also by servo units of the DSCE system during metal stick or remotely controlled flight.

FULL POWER IRREVERSIBLE CONTROL SYSTEM.

A hydraulically actuated rudder lock replaces the former mechanical lock.

The rudder is locked and unlocked automatically by a switch on the landing gear. It is locked when gear is up and unlocked when gear is down. It also may be unlocked by operating the rudder override switch to UNLOCK.

Control Stick.

The connection from the control stick to the aileron and horizontal stabilizer hydraulic control valves is through the DSCE servo units. The control stick grip incorporates the aileron and horizontal stabilizer trim switch which functions as the pitch and directional control for metal stick flight. It also incorporates the nosewheel steering button, the external stores jettison button, and the trigger switch, which in the first detent position, activates the throttle interlock, and in the second detent, disengages the DSCE.

Rudder Pedals.

The rudder pedal cables are connected through the rudder servo unit. The rudder lock has been changed to a hydraulically actuated lock. The normal wheel brakes are applied conventionally by toe action on the rudder pedals.

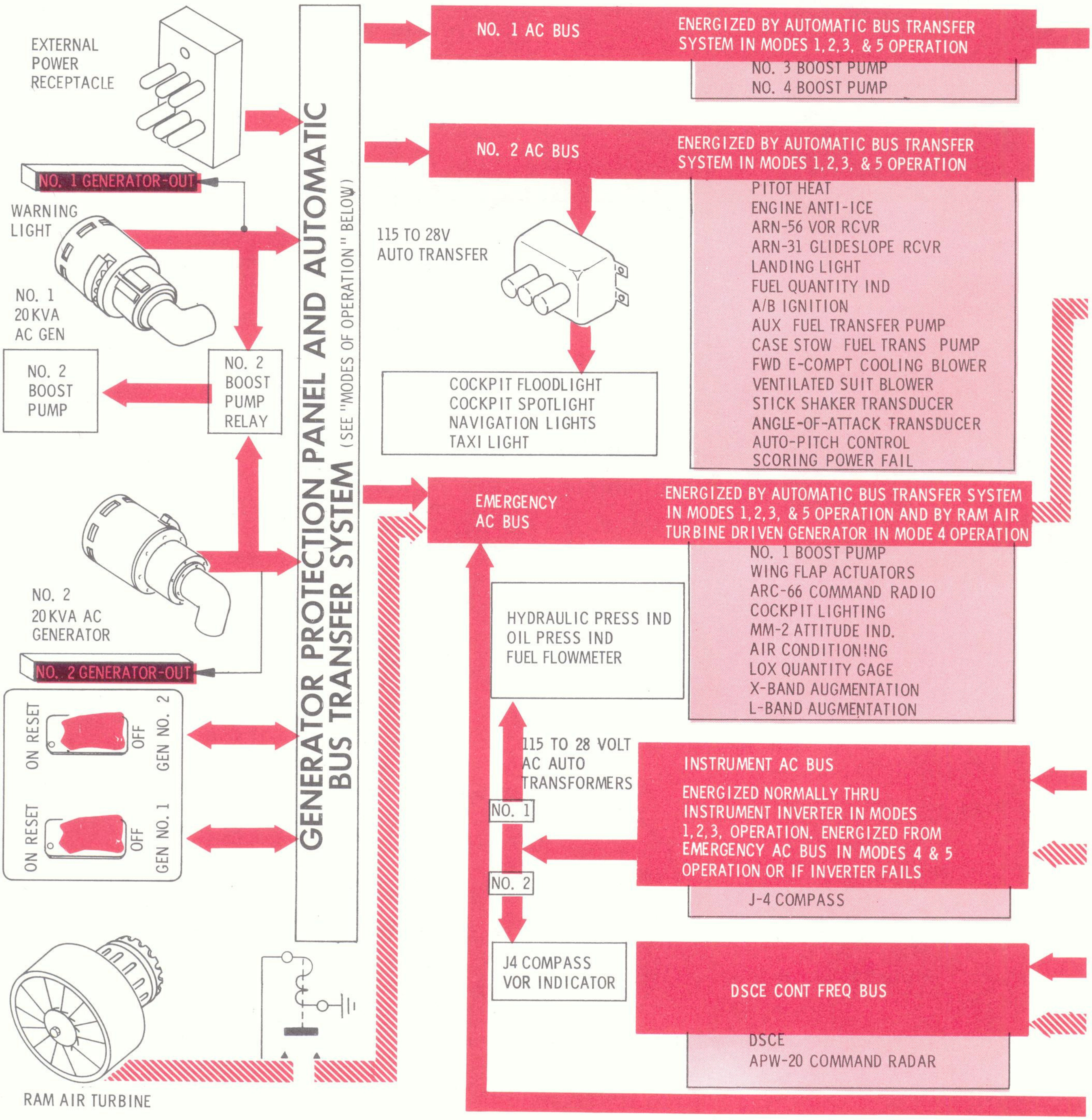
Roll, Pitch, and Yaw.

Electrical power is supplied by the No. 1 dc bus through the instrument inverter.

AUTOMATIC PITCH CONTROL (KICKER) SYSTEM.

During DSCE operation, if conditions warrant, the solenoid valve in the tail actuates a microswitch (remote APC switch) which restricts all UP commands (ATO or radio) and applies a fast rate of pitch to drive the nose of the aircraft down.

ELECTRICAL POWER DISTRIBUTION



MODES OF OPERATION

MODE 1-NORMAL OPERATION	MODE 2 - NO. 1 GENERATOR OUT	MODE 3 - NO. 2 GENERATOR OUT	MODE 4 - BOTH GENERATORS OUT	MODE 5 - GROUND POWER OPERATION	MODE 6 - EMERGENCY POWER FROM EXTENSION
NO. 1 GENERATOR ON NO. 1 AC BUS NO. 2 GENERATOR ON NO. 2 AC BUS AND EMERGENCY AC BUS	NO. 2 GENERATOR ON ALL BUSES	NO. 1 GENERATOR ON ALL BUSES	NO. 1 AC AND NO. 2 AC BUSES OUT-EMERGENCY BUS OUT UNLESS RAT IS EXTENDED - NO. 2 BOOST PUMP OUT NO. 1 DC BUS ON BAT	ALL BUSES ENERGIZED BY EXTERNAL POWER SOURCE - TO OPERATE BOTH INVERTERS, SWITCH ON 2500 VA CONTROL IN COCKPIT AND HOLD INVERTER GROUND TEST SWITCH ON.	EMER AC BUS ENERGIZED NO. 1 AC BUS OUT, NO. 2 AC BUS OUT, NO. 1 DC BUS ON BATTERY, BUS SECTIONALIZING EMERGENCY TRANSFORMER SUPPLYING - DC EMER BUS DC, ESSENTIAL BUS AND BATTERY BUS

Figure 1-11 (Sheet 1 of 2)

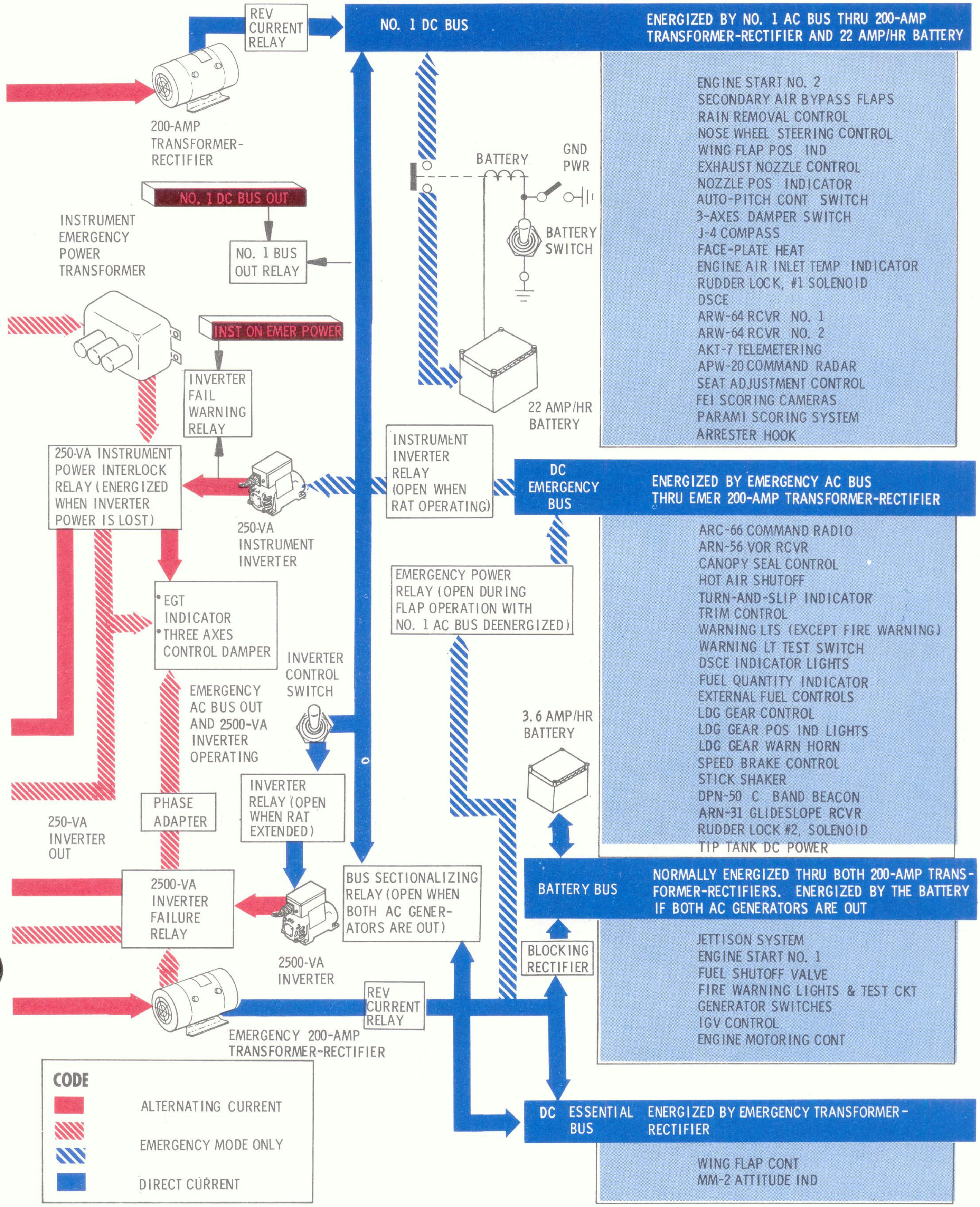


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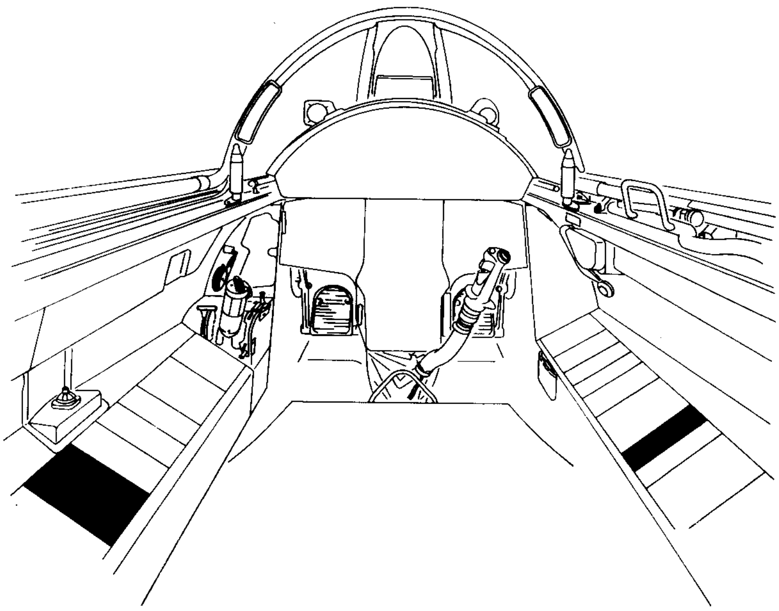
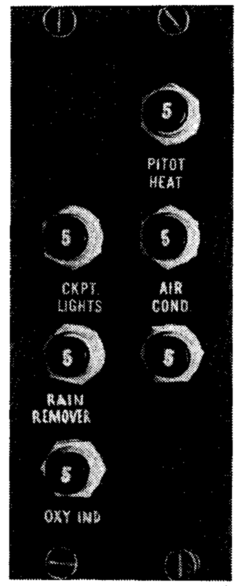
Figure 1-11 (Sheet 2 of 2)

CIRCUIT BREAKER PANELS





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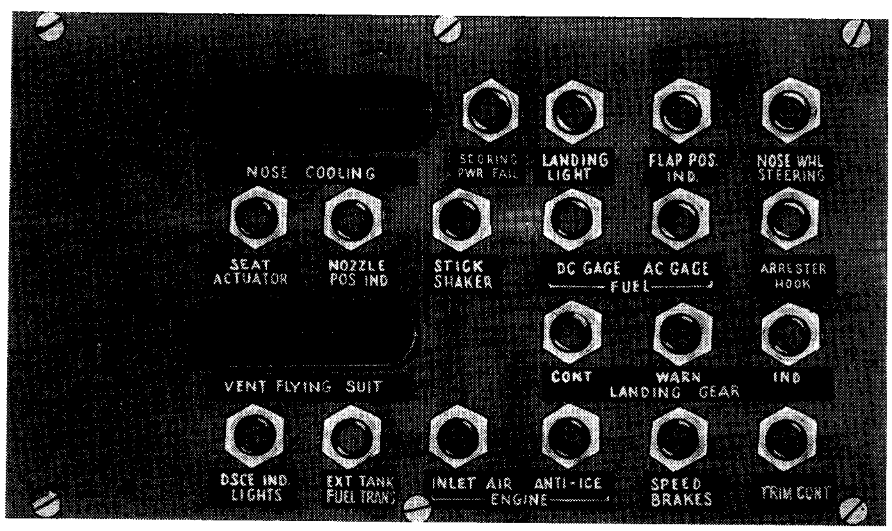

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Figure 1-12 (Sheet 1 of 3)

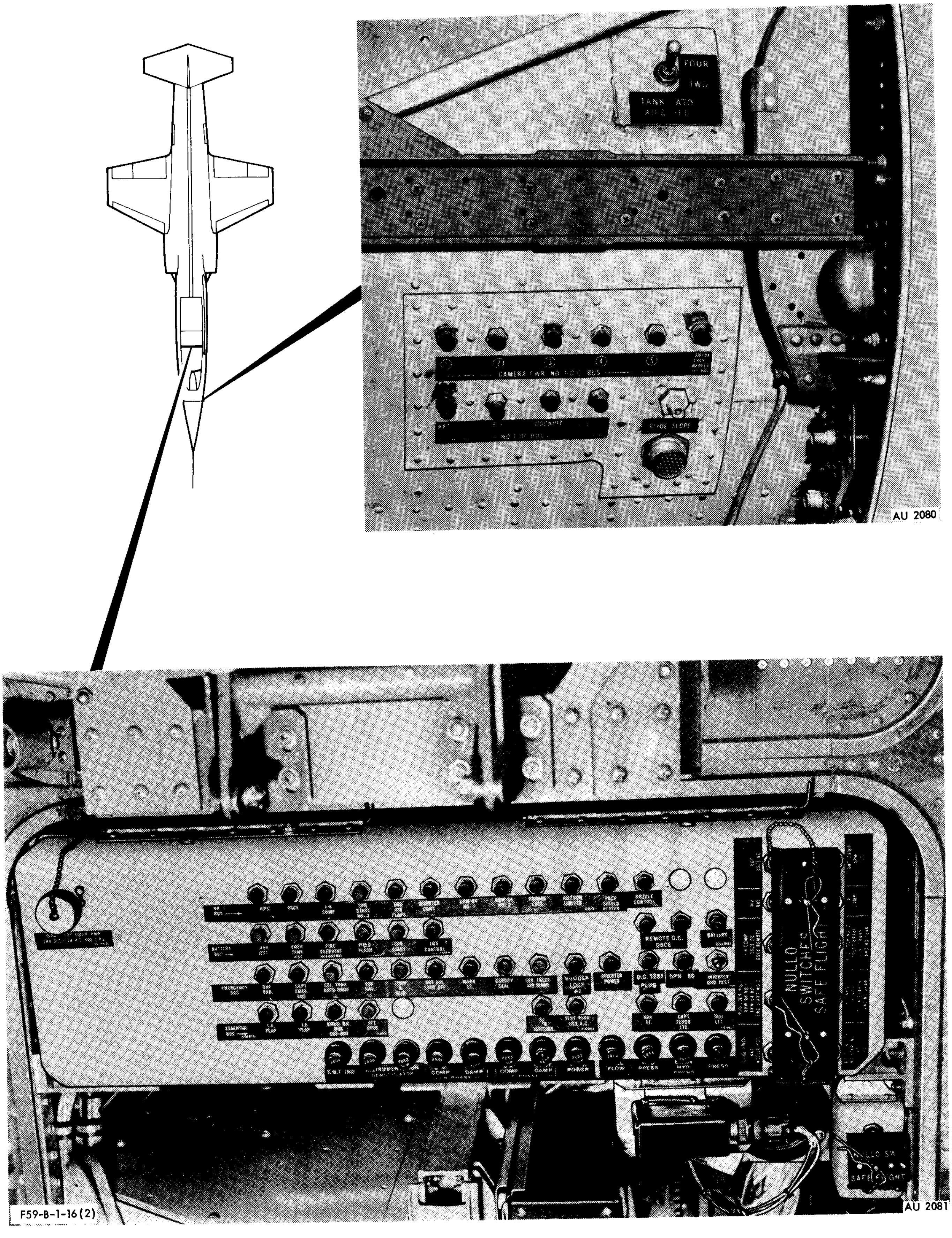


Figure 1-12 (Sheet 2 of 3)

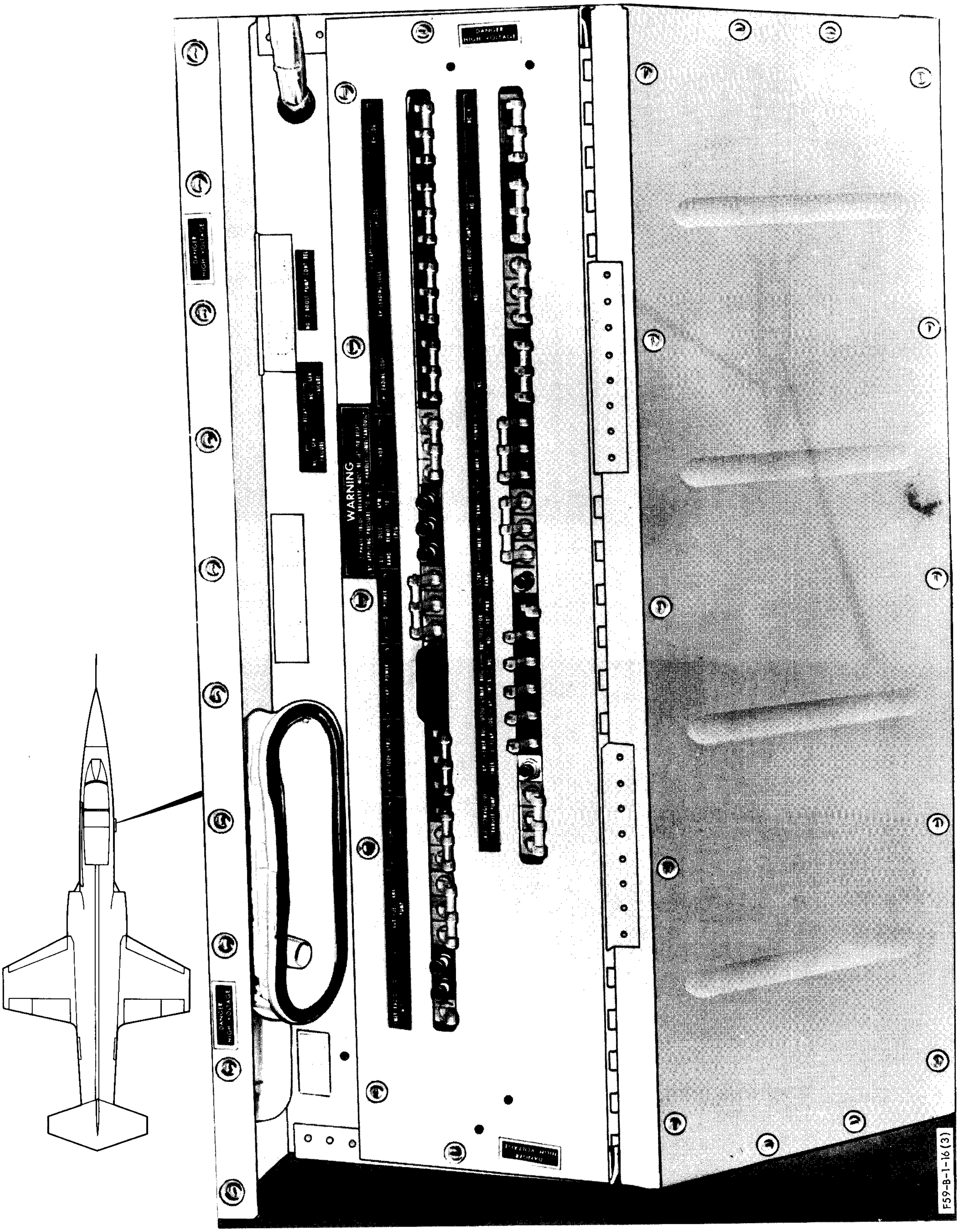


Figure 1-12 (Sheet 3 of 3)

Automatic Pitch Control Kicker Cutout Switch. During metal stick operation, an APC safety relay is in series with the APC cutout switch which will deenergize the system automatically in the event of APC failure.

Aileron and Stabilizer Trim Switch. When the DSCE is engaged, the aileron and stabilizer trim switch controls up and down pitch and right and left turns. The auxiliary trim switch on the left side panel is used to adjust the aileron and stabilizer trim.

Auxiliary Trim Selector Switch. The auxiliary trim selector switch also can be used in the AUX TRIM position when the DSCE is engaged.

Auxiliary Trim Control Switch. When the DSCE system is engaged this switch also is used to adjust or set aileron and stabilizer trim if control switch is in AUX position.

High Speed DSCE Directional Trim Control. (Refer to Section IV.)

Roll, Pitch, and Yaw Damper Switches. All three axes systems can be disconnected without seriously disturbing flight control; however, the systems are especially desirable for aircraft stability during use of the DSCE system. A slight deterioration in control will occur when the dampers are disconnected.

Stabilizer and Aileron Takeoff Trim Indicator Lights. The stabilizer trim light will remain illuminated at any time the stabilizer trim is in TAKEOFF position, and weight is on the gear.

Touch-and-Go Indicator Light. The touch-and-go indicator light (the former radar lockon light) is located on the left windshield frame and is black with an amber center. It is illuminated when the weight of the airplane is on the main landing gear, the control stick is in center and the stabilizer trim is at the TAKEOFF position. It is powered from the No. 1 dc bus.

WING FLAP SYSTEM.

All except the following is contained in T.O. 1F-104A-1.

Wing Flap Lever.

During manned flight with the DSCE on and engaged, the wing flap lever functions also as an override control for the safety of the pilot. The lever must be in the required flap position before the flaps will accept a remote command to travel to that position. During unmanned Nullo flight this override function is bypassed and the flap lever is positioned to the TAKEOFF flap position and remains in that position during the flight.

Wing Flap Position Indicators. The wing flap position indicators are powered by the 28-volt No. 1 dc bus.

SPEED BRAKE SYSTEM.

All except the following is contained in T.O. 1F-104A-1.

The speed brakes can be remotely controlled.

Speed Brakes Switch. The center position of the switch is the REMOTE position for DSCE operation.

LANDING GEAR SYSTEM.

All except the following is contained in T.O. 1F-104A-1.

The landing gear may be remotely controlled and is raised automatically during an ATO (automatic takeoff) sequence.

MAIN LANDING GEAR.

A switch is provided in the lower left wing fillet to shut off hydraulic pressure to the left forward wheel door so that it may be opened with the engine running to install the range safety destruct package for Nullo flights.

NOSE LANDING GEAR.

The nose gear is steerable through use of the rudder pedals or DSCE system.

Landing Gear Lever.

The landing gear lever also functions as an override control during manned DSCE flight. The lever must be in the position commanded before the gear will accept the command. During Nullo flights the landing gear lever remains in the DOWN position.

NOSEWHEEL STEERING SYSTEM.

All except the following is contained in T.O. 1F-104A-1.

During DSCE operation the nose wheel steering is activated (with skid turn on) by the circle turn command when the weight of the aircraft is on the nose gear. An additional restrictor valve reduces the rate of nose wheel steering movement from 16-22 degrees per second to 1-1½ degrees per second.

Nosewheel Steering Button. When the nosewheel steering button is pressed and held, No. 1 dc bus power is directed to the shutoff valve. This button is operable only if No. 1 dc bus power is available and the weight of the aircraft is on the main landing gear. If the DSCE system is on and engaged the button is operable under the above conditions but the steering rate is 1-1½ degrees per second instead of the normal 16-22 degrees per second.

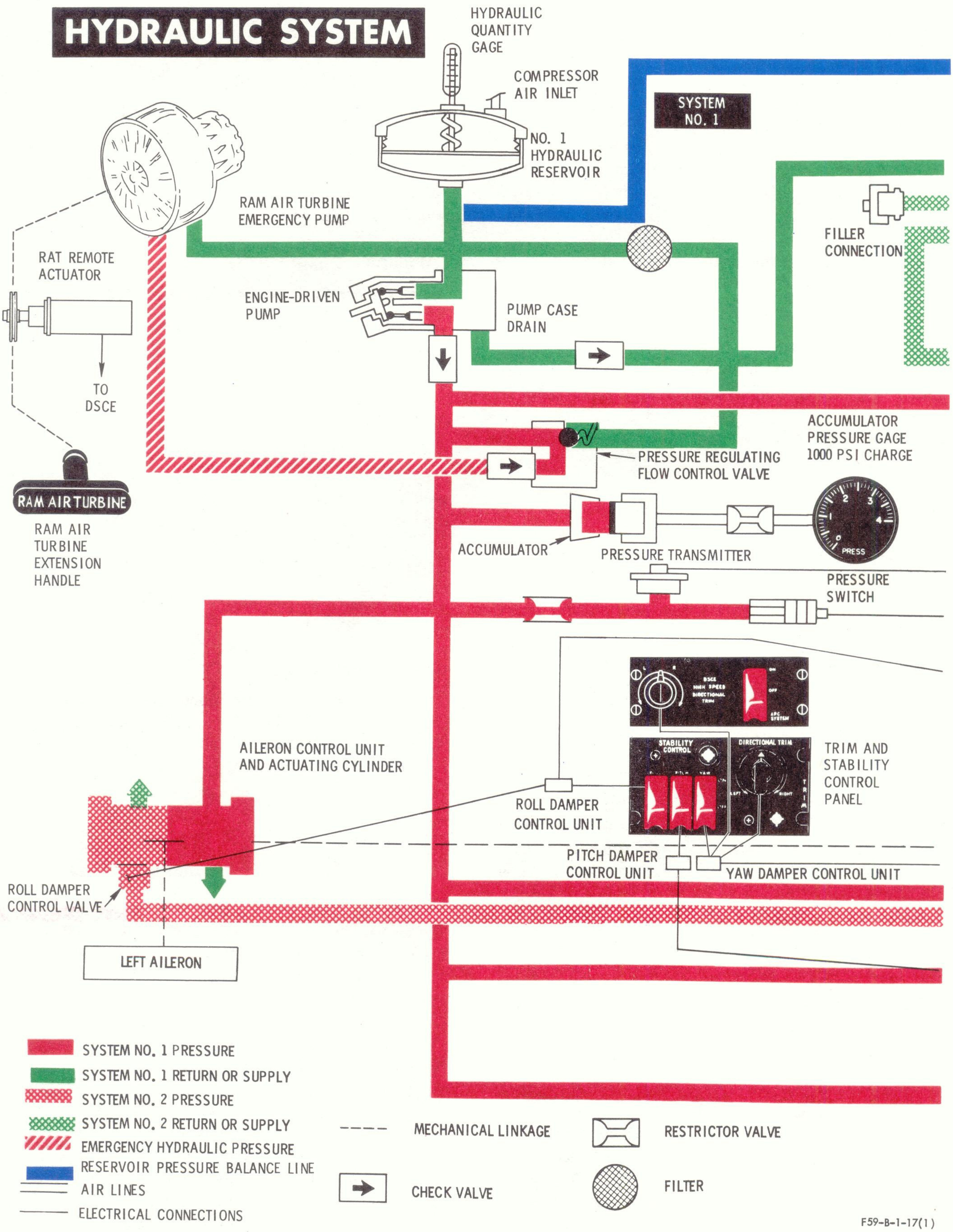


Figure 1-13 (Sheet 1 of 2)

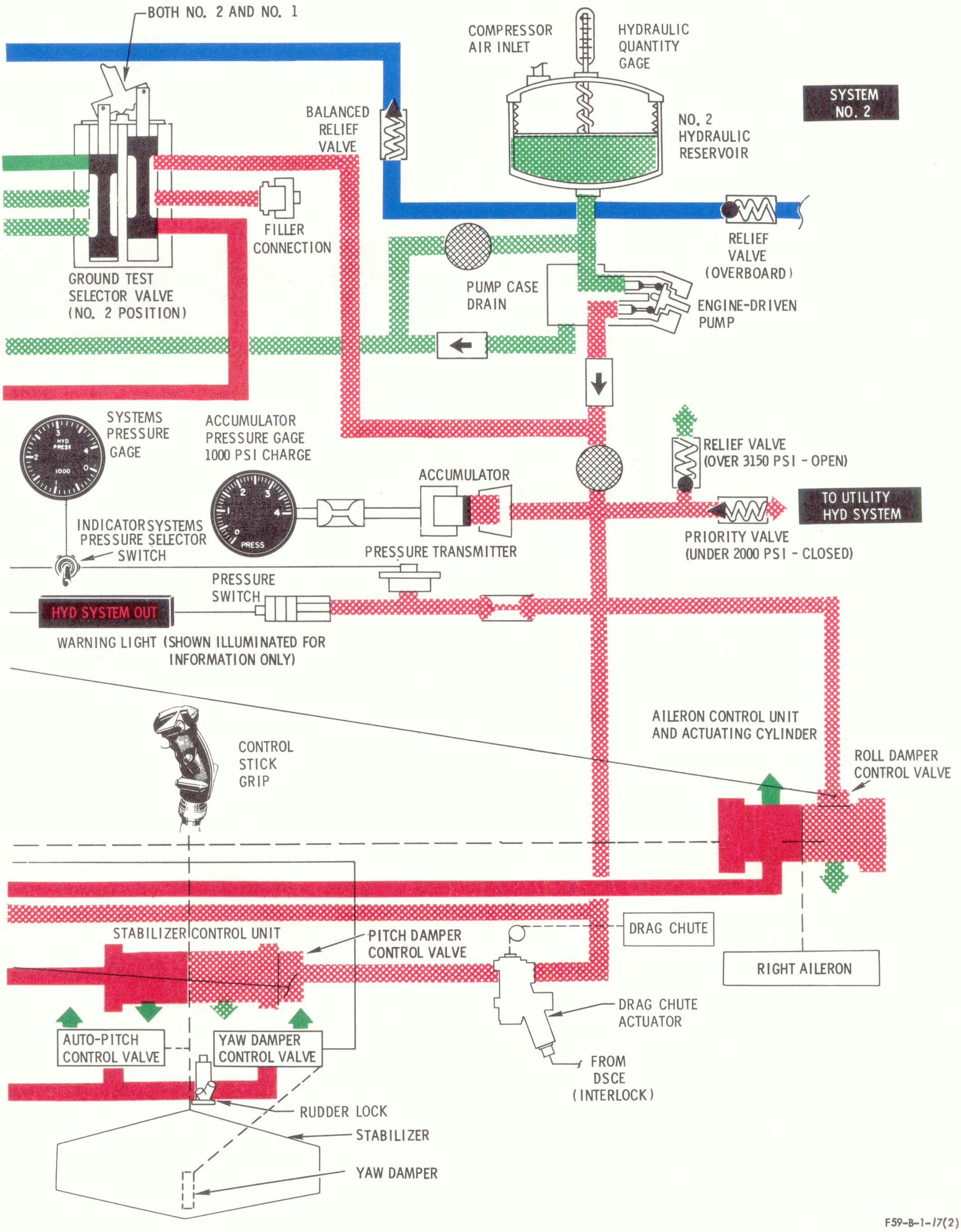


Figure 1-13 (Sheet 2 of 2)

TRIM AND STABILITY CONTROL PANELS

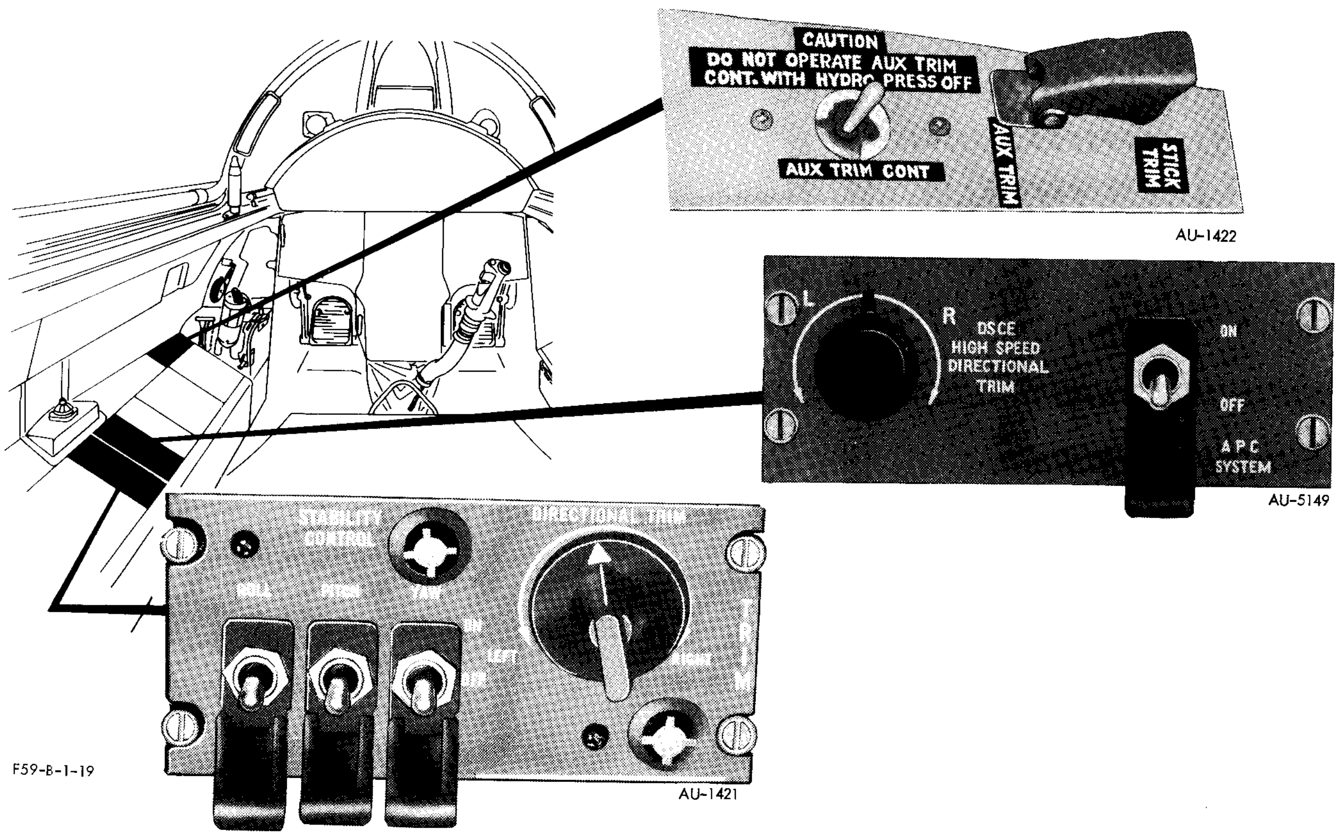


Figure 1-14

WHEEL BRAKE SYSTEM.

All except the following is contained in T.O. 1F-104A-1.

The normal hydraulic brake system is independent of the aircraft hydraulic system and is unchanged. In addition, a power brake and anti-skid sensing system is incorporated and connected to the manual brake system through two shuttle valves and a common "T" connection. Power brake pressure is obtained from the utility hydraulic system aft of the gear up pressure dump valve through a solenoid-operated brake control valve. Brake pressure is applied simultaneously to both brakes by pressing the remote brake button located on the throttle grip. In case of a skid on either wheel the anti-skid sensing system dumps brake hydraulic pressure at both wheel brakes to the hydraulic return system, thus reducing brake pressure to return-line pressure. The anti-skid cycle lasts a maximum of 2.7 seconds for any impending skid. If the remote brake button has been held down, full brake pressure returns to both wheel brakes. Power brakes will take precedence if both brakes are applied simultaneously. If the anti-skid system fails during Nullo flight it will fail in the full ON position. If it fails during manned flight, it will fail in the OFF position and normal brakes must be used.

Note

The DSCE ENGAGE circuit breaker in the main junction box in the electronic compartment must be in and the brake override switch on the left side console must be in REMOTE for the powered anti-skid brakes to be available.

Anti-Skid Brake Indicator Light. The green anti-skid brake indicator light is located on the left-hand auxiliary panel and when airborne is illuminated to indicate the landing gear is down and locked. The light will go off on touchdown unless the anti-skid system fails. Normal brakes will then be necessary.

Note

When the airplane is airborne (landing gear in the up, down, or intermediate position) and the DSCE is disengaged, the green light is illuminated. Operating the anti-skid brake switch to OVERRIDE will turn off the light.

DRAG CHUTE SYSTEM.

All except the following is contained in T.O. 1F-104A-1.

An electrically controlled hydraulic actuator has been added so that the drag chute will deploy when the anti-skid brakes are commanded ON, the nosewheel is on the ground, the drag chute override switch is in the REMOTE position, and the DSCE is engaged.

INSTRUMENTS.

Most of the flight and engine instruments are powered by the electrical system.

Note

For information regarding instruments that are an integral part of a particular system, refer to applicable paragraphs in this Section and Section IV.

PITOT PRESSURE AND STATIC SYSTEMS.

There is no connection to the gunsight pressure transmitter.

The pitot and static systems are also connected to the air data computer of the DSCE system. IAS, Mach number, and altitude information is taken from this source for telemetering to the airborne and ground directors.

STANDBY COMPASS.

The standby compass is unreliable when the DSCE is engaged.

WARNING LIGHT SYSTEM.

All except the following is contained in T.O. 1F-104A-1.

Warning Panel Indicator Lights. The following indicator lights are located on the warning panel:

FUEL LEVEL LOW
FUEL BOOST PUMP FAIL
INST ON EMER POWER
NO. 1 GENERATOR OUT
NO. 2 GENERATOR OUT
HYD SYSTEM OUT
AUTO PITCH OUT
NO. 1 DC BUS OUT
CANOPY UNSAFE
ENGINE ANTI-ICING ON
ENGINE OIL LEVEL LOW

CONTROL STICK GRIP

1. AILERON AND HORIZONTAL STABILIZER TRIM SWITCH AND REMOTE HEADING AND PITCH CONTROL (DSCE)
2. STICK EXTERNAL STORES JETTISON BUTTON
3. THROTTLE INTERLOCK & DSCE DISCONNECT SWITCH
4. CIRCLE TURN ARM BUTTON
5. NOSE WHEEL STEERING BUTTON
6. STICK SHAKER

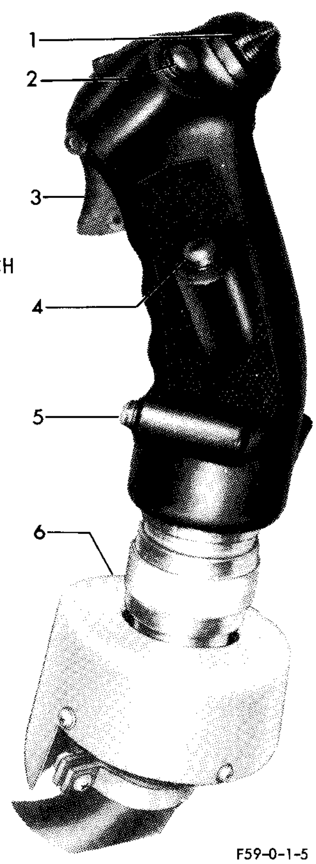


Figure 1-15

Warning Light System Test Switch. A warning light test switch is located on the right forward panel. (The switch also is used to check the fuel quantity indicating system.) When the test switch is moved to WARNING LIGHTS TEST position the fire warning, engine air inlet temperature warning, landing gear warning, landing gear indicator, aileron and stabilizer takeoff trim indicator, master caution, and warning panel lights are energized.

AUXILIARY EQUIPMENT.

Refer to Section IV for information concerning auxiliary equipment.

SERVICING.

Service the aircraft in accordance with the servicing diagram in T.O. 1F-104A-1 and in addition service the 22-ampere hour battery through an access cover on the right side of the nose.

SECTION II — NORMAL PROCEDURES

TABLE OF CONTENTS

	Page
PART 2A—ALL FLIGHTS	
Preparation for Flight	2-1
Preflight Check	2-2
Before Starting Engine	2-6
Starting Engine	2-6
Ground Operation	2-8
PART 2B—MANNED FLIGHTS	
Before Taxiing	2-10
Taxiing	2-10
Before Takeoff	2-10
Takeoff	2-11
After Takeoff Climb	2-12
Climb	2-12
Cruise	2-12
Afterburner Operation	2-13
Flight Characteristics	2-13
Descent	2-13
Before Landing	2-13
Landing	2-14
Touch-and-Go Landings	2-16
Go-Around	2-16
After Landing	2-17
Engine Shutdown	2-17
Before Leaving Aircraft	2-17
Strange Field Procedures	2-17
PART 2C—MANNED DSCE FLIGHTS	
Before Taxiing	2-17
Taxiing	2-18
Before Takeoff	2-19
ATO (Automatic Takeoff)	2-20
Climb From Takeoff to 4000 Feet (After Completion of ATO)	2-21
Military Thrust Climb (4000 Feet to Cruise Altitude)	2-21
Establishing Level Flight	2-24
Cruise	2-24
Afterburner Operation	2-25
Flight Characteristics	2-25
Descent	2-25
Approach	2-26
Touch-and-Go Landing	2-27
Go-Around	2-30
Landing	2-30
After Landing	2-31
Engine Shutdown	2-31
Before Leaving Aircraft	2-31
PART 2D—NULLO FLIGHTS	
Pre-Nullo Flight Check	2-31
Ground Checks	2-31
Engine Start	2-33
After Starting	2-33
Engine Check	2-34
Taxi Check	2-35
Remote Checkout	2-35
Final Cockpit Check	2-36
Launch	2-37
Profile	2-37
Descent	2-38
Drone Recovery	2-40
Engine Shutdown	2-41
Before Leaving the Aircraft	2-41

Part 2A — All Flights

PREPARATION FOR FLIGHT.

FLIGHT RESTRICTIONS.

Refer to Section V for detailed airplane and engine limitations.

FLIGHT PLANNING.

Refer to the Appendix to determine the fuel quantity, engine settings, and airspeeds that are required to complete the mission.

TAKEOFF AND LANDING DATA CARDS.

Refer to the Appendix for the information necessary to fill out the takeoff and landing data cards before each flight.

WEIGHT AND BALANCE.

For weight limitations refer to Section V of this manual and to Section VI of T.O. 1F-104(Q)A-2. For loading information refer to Handbook of Weight and Balance Data, T.O. 1-1B-40.

PREFLIGHT CHECK.

BEFORE EXTERIOR INSPECTION.

Check Form 781 for engineering status and proper servicing.

EXTERIOR INSPECTION.

Perform exterior inspection as outlined in Figure 2-1.

BEFORE ENTERING COCKPIT.

1. Canopy—Check for cracks, cleanliness, and distortion.
2. Manual cable cutter ring—Secured.
3. Ejection ring in position and safety pin installed—Check.

WARNING

Care should be taken to insure that the ejection ring is in the correct position and the pin is correctly installed in the ejection ring housing bracket.

4. Shoulder harness straps over upper tubular cross-member of seat—Check.
5. Ejection seat and seat belt initiator hoses—Inspect general condition.
6. Canopy jettison initiator hose—Condition; quick-disconnect properly seated and safety wired.

WARNING

If the canopy jettison initiator hose quick-disconnect is not properly connected and the pilot pulls the ejection ring without first jettisoning the canopy (with the canopy jettison handle) the pilot will be ejected through the canopy.

7. Personal leads—Check.

WARNING

Do not stow maps, navigation kits, flying clothes, or similar items under or around the ejection seat or under the survival kit cushion because they could interfere with the seat ejection operation; or, after ejection, they could restrict separation of pilot and survival kit from the ejection seat.

INTERIOR CHECK.

CAUTION

All guarded switches not safetied should be positively checked for correct position by raising the guard to determine the switch position.

1. Ignition system—Check as follows:
   a. Battery switch—OFF.
   b. No. 1 ignition switch—Check for audible buzz.
   c. Battery switch—ON.
   d. No. 2 ignition switch—Check for audible buzz.
   e. Battery switch—OFF.
2. Fire warning lights—Check.
3. Landing gear lever—DOWN.
4. Foot retractors—Attach.
5. Seat belt, shoulder harness, and parachute lanyard anchor—Fasten.

WARNING

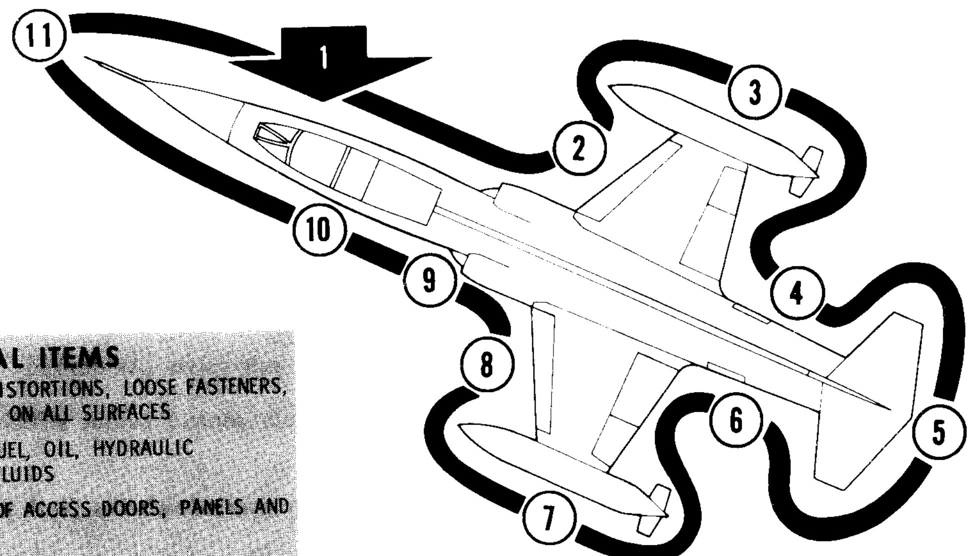
Failure to attach the straps in the following correct sequence may prevent separation from the seat after ejection.

a. Place the right and left shoulder harness loops over the manual-release end of the swivel link.

b. Place the automatic parachute lanyard anchor over the manual-release end of the swivel link.

c. Fasten the seat belt by locking the manual-release lever.

EXTERIOR INSPECTION



GENERAL ITEMS

- CRACKS, DISTORTIONS, LOOSE FASTENERS, OR DAMAGE ON ALL SURFACES
- LEAKS ON FUEL, OIL, HYDRAULIC OR OTHER FLUIDS
- SECURITY OF ACCESS DOORS, PANELS AND COVERS
- REMOVAL OF GROUND SAFETY GUARDS AND COVERS

1 RIGHT FORWARD FUSELAGE

- ELECTRICAL LOAD CENTER-CHECK CIRCUIT BREAKERS, NULLO SWITCHES AND GUARD COVER SECURE.
- ENGINE INTAKE DUCT-UNOBSTRUCTED.
- NAVIGATION AND EXTERNAL LIGHTS-UNDAMAGED.
- ELECTRONIC COMPARTMENT ACCESS DOOR-LOCKED.

2 RIGHT MAIN GEAR

- WHEEL BRAKES-LINES SECURE, NO LEAKAGE.
- TIRES-INFLATION, CONDITION.

3 RIGHT WING

- AILERON AND TRAILING EDGE FLAP-CONDITION.
- ANTENNAS AND CAMERA PORTS-SECURE AND UNDAMAGED.

4 RIGHT AFT FUSELAGE

- POWER CUT-OFF SWITCH-ON. SECURE AND UNDAMAGED.
- ARRESTOR HOOK-RETRACTED AND SECURE.
- DRAG CHUTE-INSTALLED.

5 EMPENNAGE

- GENERAL CONDITION

6 LEFT AFT FUSELAGE

- HYDRAULIC SYSTEM ACCUMULATOR PRESSURES-NORMAL.
- HYDRAULIC SYSTEM MANUAL SELECTOR VALVE-SAFETIED IN NUMBER 2 POSITION.
- HYDRAULIC SYSTEM QUANTITY GAGES-PROPER LEVEL
- ENGINE OIL DIPSTICK-COVER SECURE, FLAG DOWN.
- RANGE SAFETY KEY SWITCH-CHECKED OFF.

7 LEFT WING

SAME AS STEP 3

8 LEFT MAIN GEAR

SAME AS STEP 2 EXCEPT:

- GROUND-AIR SAFETY SWITCH (LEFT GEAR ONLY) CLEAN, UNDAMAGED

9 LEFT FORWARD FUSELAGE

- ENGINE INTAKE DUCT UNOBSTRUCTED.
- GUN BAY TANK DOOR-SECURE.

10 NOSE GEAR

- SCISSORS —PROPERLY CONNECTED
- TIRE— INFLATION, CONDITION

11 NOSE SECTION

- CAMERA PORTS UNDAMAGED, COVERS REMOVED.
- PITOT HEAD-SECURE, COVER REMOVED, OPENINGS CLEAN.

NOTE

THE FLIGHT CREW EXTERIOR INSPECTION PROCEDURES ARE BASED ON THE MAINTENANCE PERSONNEL HAVING COMPLETED ALL POSTFLIGHT AND PREFLIGHT REQUIREMENTS OUTLINED IN SECTION VII; THEREFORE, DUPLICATE INSPECTIONS BY THE FLIGHT CREW HAVE BEEN ELIMINATED EXCEPT FOR CERTAIN ITEMS REQUIRED FOR FLIGHT SAFETY. THE FLIGHT CREW INSPECTION IS TO CHECK THE AIRPLANE FOR GENERAL CONDITION AND SHOULD FOLLOW THE PATH SHOWN ABOVE. IF AIRCRAFT PREFLIGHT IS ACCOMPLISHED AT A STRANGE FIELD, REFER TO THE DETAILED AIRCRAFT PREFLIGHT UNDER STRANGE-FIELD PROCEDURES, THIS SECTION.

F59-P-2-23

Figure 2-1

6. Zero-delay lanyard—Hook.

WARNING

The zero-delay lanyard should not be of such length that it may hang down to the left far enough to catch and release the lap belt.

7. Oxygen hoses to faceplate and pressure suit, other personal leads—Connect.

Note

Connection of personal equipment should be done with the assistance of a personal-equipment man. (Refer to Oxygen System, Section IV of T.O. 1F-104A-1.)

8. If pressure suit is not used, headset, oxygen mask, and G-suit—Connect.

Note

If the pressure suit is not used, the personal leads located on the right rear of the survival kit should be removed and stored on the kit. (Refer to Oxygen Hose Attachment, Section IV of T.O. 1F-104A-1.)

9. MA-2 and MD-3 external power unit—Connected and ON.

Check that nose cooling blower is forcing air out of the outflow valve located on the bottom of the pressurized nose electronic compartment. If not, disconnect external power.

Note

MASTER CAUTION, INST. ON EMERG. POWER, HYD SYSTEM OUT, AUTO PITCH OUT, and No. 1 and No. 2 GENERATOR OUT lights will illuminate until engine is started and external power is disconnected.

10. Attitude indicator—Check.

a. Warning OFF flag retracted within 2½ minutes.

b. Horizon line for proper attitude and freedom from oscillation (energized).

c. Horizon line for proper response to trim knob.

WARNING

If the warning OFF flag requires longer than 2½ minutes to retract, or if any oscillations are noted on the indicator after the OFF flag has retracted, a possible malfunction exists. Either of the above is cause for not using the indicator and should be entered in Form 781.

11. Left console circuit breakers—In.

CAUTION

Circuit breakers should not be pulled or reset without a thorough understanding of all the effects and results of so doing. Pulling circuit breakers indiscriminately can eliminate from the system some related warning system, interlocking circuit, or canceling signal, resulting in an undesirable reaction.

12. Anti-G suit valve—As desired.

13. Autopitch control cutout switch—ON and safetied.

14. Stability control switches (roll, pitch, and yaw)—OFF.

15. Directional trim rheostat—Centered.

16. High speed DSCE directional trim control—Check setting.

17. Fuel shutoff switch—ON (check).

18. External stores release selector switch—As desired.

19. External tank fuel selector switch—As required.

20. Canopy defrosting lever—As required.

21. Override switches—OVERRIDE.

a. Throttle.

b. Arrester hook.

c. Drag chute.

d. Anti-skid and wheel brakes.

Note

Anti-skid brake override must be in REMOTE when using anti-skid brake system.

22. Inverter control switch—ON.

23. DSCE standby switch—ON.

CAUTION

The DSCE Standby switch must be on for all flights even though DSCE will not be used to prevent damage to the non-operating gyros.

Note

In order to ensure erection of the gyro, after turning on the DSCE standby switch, do not interrupt the MA-2 or MD-3 external power source by switching to aircraft electrical power until 3 minutes have elapsed.

24. DSCE engage switch—OFF.
25. Rudder lock switch—NORMAL.
26. Auxiliary trim control switch—Neutral.

CAUTION

Do not use the normal or auxiliary trim control switches without hydraulic pressure as this may damage the trim motor.

Do not attempt to move control stick without hydraulic pressure.

27. Auxiliary trim selector switch—STICK TRIM.
28. UHF Command radio—OFF.
29. Exhaust nozzle control switch—AUTO (guard down).
30. Wing flap lever—UP (check indicator).
31. Throttle—OFF.

CAUTION

To prevent possible damage to the nozzle area control unit do not move throttle when engine is not operating.

32. Throttle retractable stop plates—In place.
33. Speed brake switch—NEUTRAL.
34. Red landing gear warning light—OFF.
35. Green landing gear indicator lights—ON.
36. Landing and taxi lights switch—OFF.
37. Engine anti-ice switch—OFF.
38. IGV switch—Auto (guard down) and safetied.
39. Drag chute handle—Stowed.
40. Manual landing gear release handle—Stowed.
41. Accelerometer—Set.
42. Clock—Check.
43. Airspeed setting index—Set as desired.
44. Altimeter—Set at field elevation.

WARNING

It is possible to rotate the barometric set knob through full travel so that the 10,000-foot pointer is 10,000 feet in error. Special attention should be given the altimeter to ensure that the 10,000-foot pointer is reading correctly.

45. Guidance switches—OFF.
46. Canopy jettison handle—Stowed.
47. Face plate heat rheostat—As required.
48. Hydraulic systems pressure gage selector switch—No. 1.
49. Ram air turbine extension handle—Stowed.
50. No. 1 and No. 2 generator switches—NEUTRAL (guards down).

WARNING

The battery switch must be in the ON position for all manned flights.

51. Battery switch—ON.
52. Fuel quantity and fuel indicating system—Check.
53. Warning light system test switch—WARNING LIGHTS TEST.
54. All DSCE lights—Push to test.
55. Liquid oxygen quantity gage—2 liters minimum.
56. Oxygen system—Preflight check.

(Refer to Oxygen System Preflight Check in T.O. 1F-104A-1.)

Note

If the diluter demand oxygen system is not to be used, the supply lever on the oxygen regulator panel must be in the OFF position. If left in the ON position, the regulator will automatically allow positive pressure oxygen flow above 25,000 feet cockpit altitude, and this will rapidly exhaust the oxygen supply.

57. VHF navigation radio—OFF.

58. J-4 directional indicator control panel—As required.

59. Ram air scoop lever—CLOSED (lever in last aft detent).

Press button on the lever and make sure lever is in the last detent.

CAUTION

It is recommended that the ram air scoop lever be in the CLOSED position during the preflight check and be kept closed for all ground operation. This will provide sufficient cooling air for the electronic equipment. If the ram air scoop is opened on the ground, the supply of cooling air to the electronics compartment is shut off and the electronic equipment may reach overtemperature limits.

60. Cockpit heat rheostat—AUTO (position as desired).

61. Pitch sensor and pitot heat switch—OFF.

62. Rain removal switch—OFF.

63. Interior lights rheostat—As desired.

64. Exterior light switches—As desired.

65. Engine motoring switch—OFF.

66. Thunderstorm light switch—OFF.

67. Ventilated suit blower switch—As desired.

68. Right console circuit breakers—IN.

CAUTION

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

69. Auto trim test switch—Check.

70. Pitot heat auto switch—As Desired.

Note

In the ON position, pitot heat is turned on automatically when weight is off gear.

71. Camera switches—As desired.

72. AB ignition switch (if operational)—ON.

BEFORE STARTING ENGINE.

Before starting engine, make sure the Danger Areas, illustrated in T.O. 1F-104A-1, fore and aft of the aircraft are clear of personnel, aircraft, and vehicles. When the engine is started the boundary layer control outlet for the intake ducts on each side of the lower fuselage will have a suction which may be strong enough to draw articles of clothing or loose equipment into the engine. Start engine with aircraft heading into the wind whenever possible. An external electrical power source will be connected when starting the engine unless an emergency condition exists.

CAUTION

- The starter is limited to 1 minute of continuous operation, after which 2 minutes must be allowed for cooling before using the starter again.
- The auto-start control cable between the aircraft and the auto-start control valve must be connected so that the start switches control starting air. If the auto-start control cable is not connected, the pilot has no control over starting air in the event of starter overspeed. Repeated exposure to overspeed conditions (above 40% rpm) will cause fatigue and subsequent disintegration of the starter. This can result in serious damage to the aircraft.

STARTING ENGINE.

Occasionally during ground operation, it may be necessary to start the engine without the recommended ground starting equipment. Basically there are three types of starts that may be made. The following chart is presented to show the difference between the AUTOMATIC, MANUAL, and BATTERY start, and how existing equipment may be utilized to effect a start.

Type of Start	*Automatic Start Control Cable Connected*	*Air Compressor Connected*	*External Electrical Power Connected*
Automatic	Yes	Yes	Yes
Manual	No	Yes	Yes
Battery	Yes or No	Yes	No

The normal recommended starting procedure is defined as an AUTOMATIC start.

WARNING

- During any start, it is imperative that the pilot and ground crewman coordinate their actions to prevent overspeed of the starter. The pilot must signal the ground crewman at 40% engine rpm to disconnect external air immediately. If air is not shut off immediately, the pilot should stopcock the engine. If engine rpm exceeds 47%, a notation should be made in form 781.
- If positive indication of engine rotation is not apparent within 2 seconds after starting air has been supplied to the aircraft, the start must be discontinued to prevent starter disintegration. Engine rotation is apparent through movement of the control stick or slight buildup of hydraulic pressure.

AUTOMATIC START.

Note

The automatic starting feature shall be used whenever possible. If the automatic start system malfunctions, the mission need not be aborted. However, the malfunction must be corrected prior to the next flight.

1. Ground turbine compressor and automatic start control cable—Connected and ON.

MA-2 or MA-1A ground turbine compressor connected and delivering proper air volume.

2. Start switch—START and release.

If either ignition system is known to be defective the flight should be aborted.

Note

- Successive engine starts should be alternated between ignition systems. This procedure will serve as a check on system operation.
- The maximum allowable starting time should not exceed 60 seconds from the time the start switch is actuated until reaching idle rpm.

3. Throttle—IDLE.

At first indication of engine rotation, advance throttle beyond IDLE detent and then retard to IDLE detent.

4. Fuel flow, 400-800 pounds per hour—Check.

CAUTION

- If fuel flow exceeds 800 pounds per hour, a hot start may result. If fuel flow is less than 400 pounds per hour for ground starts, a hung start may result. If these conditions occur the aircraft must be cleared by maintenance personnel before flight.
- Combustion should occur before reaching 20% rpm or within 20 seconds after fuel flow is established. If no combustion occurs within this rpm or time limit after fuel flow indication, or the engine fails to accelerate to normal idle rpm, or exhaust gas temperature exceeds starting limits, proceed as indicated in False or Hanging Start Procedure, this Section.

5. No. 1 and No. 2 start switches—STOP-START at 40% rpm.

At 40% rpm, simultaneously move the No. 1 and No. 2 start switches to the STOP-START position and signal ground crew to stop airflow.

CAUTION

If the throttle is unintentionally retarded to OFF, a flameout occurs immediately. Do not reopen throttle, in this case, as relight is impossible and the resulting flow of unburned fuel into the engine will create a fire hazard.

6. External electrical power and ground turbine compressor—Disconnect at idle rpm.

Note

- If the INST ON EMER POWER warning indicator light remains on, ground power unit may still be connected.
- In order to ensure erection of the gyro after turning the DSCE standby switch ON, do not interrupt the MA-2 or MD-3 external power source by switching to aircraft electrical power until 3 minutes have elapsed.

7. Engine instruments for correct indications—Check.
   a. Nozzle position—Approximately ¾ or 7.5.
   b. Tachometer—67% (±1%) rpm minimum.
   c. Exhaust gas temperature—320°-450° C.

Note

In extremely hot weather with ramp temperatures in excess of 100° F, exhaust gas temperature may indicate as high as 500° C.

d. Oil pressure—12 psi minimum.

e. Fuel flow—1000-1400 lb/hr.

MANUAL START.

A manual start is the same as an automatic start, except that starting air should be supplied prior to actuating the start switch. Because the automatic start control cable is not connected, no automatic cockpit control is available to control starting air.

BATTERY START.

A battery start is accomplished with only the air compressor unit connected and with or without the automatic start control cable connected. With the automatic start control cable connected, the starting procedure is the same as an automatic start. Without the automatic start control cable connected, the starting procedure is the same as a manual start.

CAUTION

During a battery start, the only instruments available until the generators reach operating speed will be the exhaust gas temperature gage and the tachometer. Therefore, exhaust gas temperature should be monitored closely to prevent a possible overtemperature condition.

FALSE OR HANGING START PROCEDURE.

1. Throttle—OFF.
2. No. 1 and No. 2 start switches—STOP-START.

Simultaneously move No. 1 and No. 2 start switches to the STOP-START position and signal crew to stop air flow.

3. Check for absence of fuel in tailpipe. Wait until the engine stops rotating before checking for fuel in the tailpipe.
4. If fuel is present—Motor engine.

CAUTION

The starter is limited to 1 minute of continuous operation, after which 2 minutes must be allowed for cooling before using the starter again.

5. Attempt restart.

GROUND OPERATION.

No engine warmup is necessary; however, approximately 30 seconds should be allowed for electronic temperature control warmup and 3 minutes for DSCE warmup if it is to be used. With the assistance of ground crew personnel proceed as follows:

Note

If, for some reason, the DSCE standby switch was not turned ON during the interior check, make sure by waiting at least 1 minute after engine has started that the generators and inverters have reached operating speed, then turn DSCE standby switch ON and allow 3 minutes warmup time.

CAUTION

Do not fly with partially filled tip tanks until it has been determined that they are pressurized. To check tip tanks pressurization, have sniffle valves depressed while engine is running. Air will escape from the tanks if they are pressurized.

1. Generator—Check.

To ensure operation of the generator bus transfer circuits:

a. No. 1 generator—OFF; check warning light and RESET.

b. No. 2 generator—OFF, check warning light and RESET.

2. Boost pump circuit breakers—Checked and ON, electrical load center door—Secure.
3. UHF and VOR—ON and check.
4. Hydraulic systems—Check.

To ensure that the hydraulic systems are operating properly, perform the following checks:

a. At idle rpm, move the stabilizer through a complete cycle. Pressure indications should drop to approximately 2700 psi then rise to 3300 psi maximum and return to normal.

Note

If there are no hydraulic pressure fluctuations during fore and aft movement of the control stick, shut down the engine and investigate.

b. Move ailerons through a complete cycle and same reactions should occur as stabilizer check.

c. Move rudder through maximum travel and check that hydraulic pressure drops, rises, and returns to normal.

d. Hydraulic system pressure gage switch—No. 2.

e. Repeat test (a) and (b) above.

f. Speed brakes—At 75 percent rpm, operate through one complete cycle. Pressure indication on No. 2 gage should drop quickly to approximately 2150 psi, then rise momentarily to approximately 3300 psi and return to normal.

5. Trim system—Check.

CAUTION

It is possible to damage the trim mechanism by operating trim controls with the control stick in a full-throw position. To preclude this possibility, make all trim system checks with the control stick in NEUTRAL.

Make the following checks and have ground crew assure you that control surfaces respond correctly:

a. Normal directional trim control — Operate through full travel and return to neutral.

b. High-speed DSCE directional trim control—Check setting.

Note

This control should have been set and marked on previous flights. It has no effect unless DSCE is engaged and airspeed is above 370 knots IAS.

c. Aileron and horizontal stabilizer trim switch—Test (all four positions).

WARNING

An improperly installed or defective trim switch is subject to sticking in any or all of the actuated positions, resulting in application of extreme trim. If this condition occurs during preflight check and the switch does not return automatically to the center OFF position, enter this fact in the Form 781 with red cross and do not fly the aircraft.

Note

Aileron and stabilizer takeoff trim indicator lights should illuminate as the trim motors pass through the takeoff setting. Stabilizer trim light should remain lighted if stabilizer trim is in TAKEOFF position.

6. Stability augmenters — Check. Turn on YAW-PITCH and ROLL augmenters and have ground crew verify operation.

7. Directional Trim—Check. Operate the directional trim rheostat through full travel each direction and return to center. Have ground crew verify that rudder trim is neutral.

8. Trim—Set for takeoff (verified by ground personnel and indicator lights).

Note

Leading edge of horizontal stabilizer should be alined with black T index painted on the vertical stabilizer.

9. Automatic pitch control system—Check.

a. Wing flap lever—UP.

b. Rotate right vane clockwise until stick shaker operates at approximately 4½.

c. Continue clockwise rotation until stick kicker operates at 5. Check for ability to override stick kicker by aft movement of the control stick.

d. Wing flap lever—LAND. With the flaps in land setting, ground crew will check BLC for proper operation. At idle rpm, expect an EGT rise of approximately 40° C.

e. Wing flap lever—TAKEOFF (Check indicator).

Note

After the flaps have reached the takeoff setting, ground crew will verify flap position, absence of BLC, and that ducts are not crushed.

f. Have right vane rotated clockwise until stick shaker operates. Continue clockwise rotation of vane to stop to check that kicker does not operate.

g. Rotate left vane counter-clockwise until stick shaker operates.

10. Pitot heat check—ON then OFF. Have ground crew verify operation.

11. Rain remover—Verify operation.

Part 2B — Manned Flights

BEFORE TAXIING.

Observe the following instructions:

1. External stores autodrop system safety pins—Remove.
2. Hydraulic door—Closed.
3. Canopy—As desired.
4. Ground crew interphone—Disconnected.
5. Seat safety pin—Remove.
6. Warning lights rheostat—As desired.

CAUTION

Removal of APU may cause warning lights to be reset too bright. During night flying recheck dimming switch if dim setting is desired.

7. Wheel chocks—Removed.

TAXIING.

1. Nosewheel steering—Engage.

The nosewheel and rudder pedals must be alined before the steering mechanism can be engaged.

CAUTION

To prevent possible damage to the main landing gear wheel assemblies from excessive side loads, avoid high-speed taxi turns.

2. Normal and anti-skid brakes—Check.

CAUTION

Do not use remote brakes while normal brakes are depressed as this condition returns the normal brake fluid to the No. 2 hydraulic return system and may deplete the normal brake reservoir.

3. Flight Instruments—Check.

Perform operational check of all flight instruments.

BEFORE TAKEOFF.

AIRPLANE CHECK.

After taxiing to takeoff area, complete the following checks:

1. Canopy—Closed and locked.

Check that CANOPY UNSAFE warning light is out.

CAUTION

- The canopy opening and closing operation is designed to work smoothly and effortlessly. If the canopy is slammed shut or open, the system may be damaged. If any forcing is necessary to obtain hook engagement, the canopy is either out of rig or improperly fitted, and corrective action must be taken before flight.
- The canopy should not be operated in flight because there is no latching mechanism allowing a part-open position.
- Stow rear-view mirror in aft position before closing canopy.

2. Inertia reel lock lever—Locked.
3. Speed brake switch—IN.

To prevent inadvertent extension, switch should be in the IN position when speed brakes are not being used.

4. Trim set for takeoff—Check.
5. Wing flap lever—TAKEOFF (check indicators).
6. Pitot heat, rain removal, and canopy defrost—As required.

Note

Experience has shown that on the ground moisture can collect in the pitot-static tube after exposure to rain or high humidity. Heating the tube helps to eliminate entrapped moisture.

7. Zero-delay lanyard hooked up—CHECK.

ENGINE CHECK.

See the Variation of Engine Speed Temperature and Nozzle Area With Throttle Position illustrated in T.O. 1F-104A-1 and Section V for engine limits. While in the takeoff area, make the following checks:

1. Aline aircraft with runway—Check nosewheel centered.

a. Set attitude indicator 5 degrees nose down.

b. Set the directional indicator pointer under the top index.

2. Brakes—Pump, then hold.

3. Throttle—MILITARY. (Check that engine acceleration is less than 10 seconds and check instruments.)

a. RPM—100% (±1%).

b. Exhaust gas temperature—575° C (±10° C).

Some EGT gages may indicate a momentary fluctuation of ±5° C over normal limits. This indication is allowable provided the fluctuation does not exceed a maximum of ±5° C and does not occur oftener than once every 20 seconds.

c. Nozzle position—⅛ to ¼ or 1 to 3.

d. Fuel flow—Check.

See Military Thrust Fuel Flow illustrated in T.O. 1F-104A-1.

e. Oil pressure—Check.

CAUTION

After oil pressure has stabilized, check indication against oil pressure record card at Military thrust. If the indicated oil pressure varies more than ±5 psi from that listed on the card, or is not within limits of 25 to 55 psi, the flight should be aborted and engine inspected.

4. Throttle—Retard slowly to 80 percent rpm and check for compressor stall.

5. Throttle—Military.

6. Throttle—Rapidly retard to IDLE rpm; check for compressor stall, throttle linkage and fuel flow.

If compressor stall is encountered, abort flight. Make appropriate entry in Form 781.

Note

Fuel flow should momentarily drop to approximately 400-800 pounds per hour. This fuel flow indicates that sufficient minimum fuel flow will be available during idle descents and for air starts. If the fuel flow is not within these limits the flight should be aborted.

TAKEOFF.

Note

The procedures set forth below will produce the results shown in the takeoff charts in the Appendix.

NORMAL TAKEOFF.

Refer to T.O. 1F-104A-1 for complete normal takeoff procedure.

1. Throttle—MILITARY, check acceleration.

2. Brakes—Release.

3. Throttle—Minimum afterburner (ensure light off) then advance to maximum thrust.

Note

- During takeoffs with afterburner, avoid retarding throttle to the sector range.
- Maximum or Military thrust may be used for takeoff. Check the Appendix for differences in takeoff distances. Military thrust takeoff with external stores will result in abnormally long takeoff runs.

4. Engine instruments—Check.

5. Use nosewheel steering as necessary for directional control.

CAUTION

- Nosewheel steering must be disengaged prior to nosewheel lift-off to ensure proper steering clutch release.
- With the steering engaged a large percentage of shimmy damping is lost. Therefore, if nosewheel shimmy is encountered, disengage nosewheel steering.

6. Assume takeoff attitude.

Note

Proper technique is to anticipate the acceleration of the aircraft and rotate the nose so that takeoff attitude and speed are reached smoothly and simultaneously. As external stores are added, an increase in nosewheel lift-off speed can be expected due to the change in weight and center of gravity.

MINIMUM RUN TAKEOFF.

Procedure is the same as for normal takeoff with afterburner except that takeoff airspeed is reduced 10 knots lower than normal. Do not reduce rotation speed.

OBSTACLE CLEARANCE TAKEOFF.

In addition to the procedures for minimum run takeoff, increase the initial climb angle so as to reach the 50-foot height at airspeeds 15 knots less than for a normal takeoff with afterburner. The stick shaker operates intermittently during maximum performance takeoffs and climbouts.

CROSSWIND TAKEOFF.

In addition to the procedures used for normal takeoff, increase nosewheel liftoff and takeoff speed 5-10 knots to compensate for gusts. Nosewheel steering may be required in excess of 100 knots if strong crosswinds are present.

AFTER TAKEOFF CLIMB.

1. Landing gear lever—UP.

When aircraft is definitely airborne, retract gear and check red and green landing gear position indicator lights OFF.

CAUTION

Immediate retraction of the gear is important when making afterburner takeoffs to prevent exceeding the landing gear transient limit airspeed. The landing gear and doors should be completely up and locked before the placard speed is reached; otherwise, excessive airloads may damage the mechanism, or stall gear retraction.

2. Wing flap lever—UP. (Check indicator.)

Note

- Do not retract wing flaps before reaching 250 knots IAS as buffeting will occur. This speed is based on a takeoff gross weight of 22,700 lb. Add 5 knots for each 1000 lb of additional weight.
- Expect an easily controllable nose-up tendency as the flaps retract.

3. Throttle—As desired.

As soon as afterburner thrust is no longer needed, shut down the afterburner by moving throttle aft and inboard. Monitor the nozzle position indicator to check that the nozzles close normally as the throttle is being retarded from maximum afterburning.

4. Engine instruments and fuel quantity indicator—Check.

When carrying external tanks, the fuel quantity indicator should be monitored. A low reading indicates that external tanks are empty or are not feeding properly.

5. Zero-delay lanyard—Disconnect in accordance with Zero-Delay Lanyard Connection Requirements in Section III of T.O. 1F-104A-1.

WARNING

The lanyard must be disconnected whenever operating at high altitudes so that the safety delay provided by the parachute aneroid mechanism will not be overridden.

6. Airspeed—Best climb.

Refer to the Appendix for best climb speed. Take care following takeoff to anticipate the high forward acceleration. As climb speed is approached assume the proper climb attitude to ensure maximum performance.

CLIMB.

The climbing attitude with Maximum thrust is extremely steep, and until experience is gained, some difficulty in holding the climb schedule will be experienced.

See the climb charts in the Appendix for recommended speeds to be used during climb, and for rates and fuel consumption.

CRUISE.

Refer to the Appendix for cruise operating data. The windshield and canopy defrosting system should be operated throughout the flight at the highest flow possible (consistent with pilot comfort) so that a sufficiently high temperature is maintained to preheat the canopy and windshield areas. It is necessary to preheat because there is insufficient time during rapid descents to heat these areas to temperatures which prevent the formation of frost or fog.

The automatic pitch control and stick shaker may be checked in flight as follows: While applying a slow stick deflection, note that the APC indicator reading corresponds to the increase in angle of attack. This indicates satisfactory system operation in respect to sensing of vane angle. Apply a small rapid stick deflection and note that the APC indicator reading increases rapidly, corresponding to the increasing pitch rate. This indicates a satisfactory signal from the pitch-rate gyro. The stick deflection should be great enough to induce a pitch rate sufficient to actuate the stick shaker.

AFTERBURNER OPERATION.

Before moving the throttle into the afterburner range, check that the nozzle position indicator is in its normal range for Military thrust. Move the throttle smoothly outboard and forward into the afterburner range. Check exhaust gas temperature, rpm, and nozzle position.

CAUTION

- If an afterburner light is not obtained within 5 seconds at sea level, or 15 seconds at altitude, after the throttle is moved into the afterburner range, the throttle should be moved inboard to Military thrust and then after 3 to 5 seconds returned to afterburner range to recycle the system. After the initial light is obtained, move the throttle forward with a positive motion if maximum thrust is desired.
- The fuel flow indicator does not indicate afterburner fuel flow.

When shutting the afterburner off, retard the throttle aft and inboard to the Military thrust position. Check engine instruments to ensure that afterburner operation has ceased.

FLIGHT CHARACTERISTICS.

Refer to Section VI for information regarding flight characteristics.

DESCENT.

Refer to the Appendix for recommended descent techniques; accomplish the following steps:

1. Engine anti-ice and pitot heat—As desired.
2. No. 1 and No. 2 hydraulic system pressures—Check.
3. Zero delay lanyard—Hook in accordance with the Zero-Delay Lanyard Connection Requirements in Section III of T.O. 1F-104A-1.

BEFORE LANDING.

Refer to T.O. 1F-104A-1 for a typical landing pattern.

Note

The procedures set forth below will produce the results shown in the landing charts in the Appendix.

WARNING

The airspeeds listed herein are based on a landing gross weight of 15,140 lb or less (1000 lb or less fuel remaining). Increase approach and landing speeds 5 knots for each additional 1000 lb of fuel.

INITIAL.

1. Zero-delay lanyard—Recheck hooked up.

In accordance with the zero-delay lanyard connection requirements in Section III of T.O. 1F-104A-1.

2. Wing flap lever—TAKE OFF (check indicators).

DOWNWIND.

1. Landing gear lever—DOWN below 260 knots IAS and check indicators.
2. Wing flap lever—LAND (below 240 knots IAS and above 210 knots IAS).

Maintain level flight and keep hand on lever until it is determined that the flaps and BLC are functioning normally.

Note

A mild roll transient may be experienced on some aircraft as the flaps move from the TAKEOFF to the LAND position. This is attributed to asymmetric differences in boundary layer control systems and will vary in intensity and direction with individual aircraft but should not exceed 1 inch lateral stick displacement. After the flaps are in the full down position some lateral unbalance may persist. Although not objectionable, this unbalance can be trimmed out, if desired.

Note

A slight EGT rise may occur during BLC operation; however, this rise will not exceed the limit temperature.

CAUTION

If a boundary layer control system malfunction is experienced, as manifested by a strong rolling moment as the wing flaps travel to the land position, proceed as follows:

a. Immediately return the wing flap lever to TAKE-OFF position.

b. Fly final approach at not less than 190 knots IAS.

c. Touch down at 160 knots IAS.

BASE LEG.

1. Landing gear down and locked—Check.
2. Brakes—Pump.
3. Airspeed—200 knots IAS minimum.

FINAL.

1. Roll out on final approach minimum distance from end of runway—6000 feet; recommended airspeed, 190 knots IAS.
2. Engine speed—87%-90% rpm.
3. Airspeed—170 knots IAS recommended.

Note

The recommended final approach speed includes sufficient margin to cover most operating conditions such as turbulent air, instrument conditions, normal landing weight variation, etc. This margin makes additional allowances for such factors unnecessary.

WARNING

Under various conditions of heavy gross weight or high ambient temperatures, with flaps in the LAND position, sufficient thrust may not be available at military to maintain proper rate of descent and airspeed during turn from downwind to final. Refer to Heavy Weight Landing paragraph, this Section.

LANDING.

BOUNDARY LAYER CONTROL.

The installation of boundary layer control to effect low landing approach and touchdown speeds has resulted in some new flight characteristics and changes in required piloting technique. The pilot should remember at all times when using LAND flaps that the additional lift afforded by BLC is dependent on engine airflow. This lift, therefore, varies with airspeed, altitude, and engine rpm. The greatest effect is realized at low airspeed, low altitude, and engine speeds above 82%. The significance of this is that under the landing condition, especially as touchdown is approached, proper use of the throttle is mandatory to accomplish a smooth reduction in engine rpm so that a smooth reduction in the effects of BLC on lift will result.

LANDING TECHNIQUE.

The recommended landing pattern results in a flat powered approach similar to that used for ILS and radar approach patterns carrying approximately 88% rpm until touchdown is approached. A straight-in approach of 6000 feet, minimum, is recommended to simplify the technique and judgment involved in the landing flare. Thrust should be controlled to hold airspeed and sink rate to the recommended values on the final approach. (Use of the recommended speeds provides ample speed margin from the back side of the thrust-required curve.) Airspeed response to throttle adjustments is extremely positive and rapid, aiding considerably in establishing a good approach. The high drag of the aircraft in the landing configuration makes it unnecessary to use speed brakes in the landing pattern (especially on the approach). Speed brakes may be used during round-out to aid in controlling touchdown point. The approach should be maintained to establish a flareout just short of the runway. As the touchdown point is approached, flareout rotation should be started, followed by a smooth reduction of thrust to 82%-83%. The gradual rpm reduction induces a right rolloff which is associated with thrust reduction and not BLC, since a similar rolloff is experienced accompanying a thrust reduction with TAKE OFF flaps. An abrupt thrust reduction results in an abrupt rolloff tendency and a rapid increase in rate of sink. These characteristics make it necessary to approach touchdown carrying thrust and reduce thrust to idle as the main gear contacts the runway. The smooth thrust reduction reduces the rolloff tendency, thereby making it easy to maintain wings-level flight throughout the flare as well as provide positive control of rate of sink. It may seem unnatural to touch down with more than idle thrust; however with the drag of the landing flaps, it is possible to slow down rapidly enough so that idle thrust need not be used. Adhere to recommended approach and touchdown speeds. If the aircraft is held off to lower speeds lateral stability and control will deteriorate and wing drop tendencies will be experienced. In addition, the high pitch angle required for flight at these low airspeeds will be excessive and can result in tail dragging.

NORMAL LANDING.

1. Throttle—Retard to IDLE (after touchdown).
2. Nosewheel—Lower.
3. Nosewheel steering—Engage. Engage nosewheel steering as soon as nosewheel is on the ground.

Note

If severe nosewheel shimmy is encountered, release nosewheel steering and attempt to hold weight off nosewheel.

4. Drag chute—Deploy. To obtain maximum aerodynamic braking, deploy drag chute as soon as nosewheel is on the ground.

CAUTION

Because the location of the drag chute will cause a nosedown pitching moment when deployed, to prevent damage to the aircraft do not deploy the chute until all three gears are on the ground.

CROSSWIND LANDING.

Wind drift may be compensated for by crabbing or the wing down method, or a combination of both. In strong crosswinds the wing down method or a combination of the two methods is more suitable. The most important things to remember are to lower the nose immediately after touchdown and engage nosewheel steering before deploying the drag chute. The drag chute may be deployed in 90-degree crosswinds of 20 knots, or 45-degree crosswinds of 30 knots provided nosewheel steering is engaged. The airplane tends to weather-vane, but directional control can be maintained with nosewheel steering. After landing, some difficulty may be encountered releasing the drag chute; however, turning the airplane directly into the wind should alleviate the difficulty.

HEAVYWEIGHT LANDING.

The use of anti-skid brakes is recommended if a heavyweight landing must be made. Adjust the approach and touchdown airspeed for gross weight (see the landing charts in the Appendix for the airspeed at any landing gross weight) and fly a larger than normal pattern or make a straight-in approach. This is especially important on approaches under hot or high-altitude landing conditions. Rate of descent should be monitored closely and not allowed to become excessive. Be prepared to use afterburning thrust if necessary. See Section VI and the Appendix for charts showing the variation in flight performance to expect. Under marginal conditions, a straight-in approach is recommended. In addition, minimize drag by using a TAKE OFF flap or gear up configuration for approach, changing to the final landing configuration when landing is assured. Under certain conditions at forward center of gravity, TAKE OFF flaps must be used for the landing. Refer to Heavyweight Landing in Section VI. If landing roll distance is a major consideration and center of gravity is not, use LAND flaps to reduce the touchdown speed and delay gear extension until the flare is assured.

WARNING

Under these conditions, afterburner will have to be used if a go-around is attempted after the landing gear has been extended.

CAUTION

If a hard landing is made, the aircraft should be inspected for signs of structural damage before being flown again.

MINIMUM RUN LANDING.

The use of anti-skid brakes is recommended for landing with minimum ground roll. Fly the approach so that close control can be exercised over touchdown point and airspeed. Land as near to the end of the runway as possible, touching down at 140 knots for normal landing gross weight. Use speed brakes to aid in controlling touchdown point and speed as well as for maximum drag during the rollout. Plan chute deployment so that it blossoms as the nosewheel touches down. Apply heavy braking but do not skid the tires if on manual brakes. Hold heavy braking action until the aircraft stops. Be prepared to use nosewheel steering in the event of a blown tire.

LANDING ON SLIPPERY RUNWAYS.

Wet Runway.

The use of anti-skid brakes is recommended when landing on a wet runway. Use the same procedure as for minimum run landing. Leave the flaps at LAND throughout the landing roll for maximum aerodynamic drag. Above 110 knots, if anti-skid brakes are not available, use light braking only to preclude skidding on the wet surface. Normal braking may be used below 100 knots; remain alert for the possibility of skidding. No difficulty in control should be experienced during a wet runway landing. If a yaw is encountered, release both brakes and regain directional control with nosewheel steering and only a light application of brakes. See the landing charts in the Appendix for information on variation of stopping distance with runway surface condition.

Icy Runway.

Use anti-skid brakes when landing on icy runways. Landing on icy runways is very hazardous and should be attempted only by experienced pilots and only when absolutely necessary to complete operational requirements. Landing on packed snow or icy runways will require a ground roll distance up to 2.3 times that required on a dry runway. Follow approach and landing procedures as outlined for wet runways except to avoid wheel braking if anti-skid brakes are not available. When runway conditions are such that patches of ice are present, avoid normal braking if possible. If normal braking is necessary, use short and intermittent braking action to avoid skidding.

TOUCH-AND-GO LANDINGS.

No special technique is required during touch-and-go landings.

After touchdown, proceed as follows:

1. Wing flap lever—TAKE OFF.
2. Throttle—Military thrust.
3. Speed brakes switch—IN.
4. TRIM—Set for takeoff.
5. Use normal take-off technique.

GO-AROUND.

Make decision to go around as soon as possible and using the procedures listed in T.O. 1F-104A-1.

CAUTION

The use of excessive nose-up trim during final approach will appreciably reduce the effect of forward stick; therefore, as throttle is advanced, the aircraft should be trimmed toward neutral.

1. Throttle—Military thrust (Maximum thrust if necessary).

CAUTION

The available excess thrust to perform a go-around varies with airspeed, gross weight, aircraft configuration, field elevation, and ambient temperature. As extremes of these variables are approached the ability to perform a successful go-around with Military thrust decreases, thus requiring afterburning thrust. See Section VI and the Appendix for illustrations and charts showing the variation in performance to expect with changes in these operating conditions.

2. Speed brake switch—IN.
3. Landing gear lever—UP.

When rate of descent is checked.

4. Wing flap lever—TAKE OFF.

At not less than 170 knots IAS.

Note

Expect a definite nose-up trim change when raising the wing flaps to TAKE OFF.

WARNING

When making a go-around, leave the wing flap lever in the TAKE OFF position for 30 to 60 seconds. This action will cool the BLC ramp and keep the retracting flaps from pinching the ramp. Pinched BLC ramps can cause undesirable rolling moments when the BLC system is operating.

5. Wing flap lever—UP.

At not less than 240 KIAS.

AFTER LANDING.

Maintain directional control with nosewheel steering and brakes and proceed as follows:

1. Speed brake switch—IN.
2. Wing flap lever—TAKE OFF.
3. Rain remover—OFF.

If rain remover has been OFF during descent, the rain remover switch should be turned ON for not more than 20 seconds, then OFF. This procedure is necessary to free the line of condensation in order to protect the rain removal shutoff valve from corrosion.

4. Engine anti-ice and pitot heat—OFF.
5. Drag chute—Jettison in appropriate area.
6. Trim—Takeoff.

ENGINE SHUTDOWN.

1. Wing flap lever—UP.
2. UHF—OFF.
3. Run engines for 3 minutes at IDLE rpm for proper engine cooling.

Note

Operation during taxiing can be considered as part of this time if performed at less than 82% rpm.

4. Throttle—OFF.

Note

Check that engine decelerates freely. Listen for any excessive noise during shutdown.

5. Fuel shutoff switch—OFF.
6. Battery switch—OFF.

BEFORE LEAVING AIRCRAFT.

1. Ejection seat safety pin—Installed.
2. Pressure suit oxygen supply lever—OFF.
3. Diluter demand oxygen supply lever—ON.
4. Radio equipment—OFF.
5. Wheels—Chocked.
6. Landing gear ground safety pins—Installed.
7. External stores automatic drop system—Safetied.
8. Form 781—Complete.

CAUTION

In addition to established requirements for reporting any system defects and unusual and excessive operations, the flight crew will also make entries in Form 781 to indicate when any limits listed in the Flight Manual have been exceeded.

STRANGE FIELD PROCEDURES.

Refer to T.O. 1F-104A-1 for Strange Field Procedures.

Note

Make sure the 22 ampere hour battery is properly serviced.

Part 2C — Manned DSCE Flights

Note

Manned DSCE flight includes metal stick flight and remote-controlled flight with safety pilot.

WARNING

- DSCE shall not be engaged for any flight operations when tip tanks are not installed.
- For a manned DSCE flight, the pilot shall determine that all Nullo switches are in a safe flight position and guard is installed correctly.

BEFORE TAXIING.

1. Metal stick switch—ON.
2. ARW, APW, and telemetering switch—As required.
3. Receiver/Transmitter switches—OFF.
4. Observe the following:
   a. DSCE OFF light is on.
   b. Pitch trim indicator is centered.

5. Override switches positioned as follows:

a. Throttle—OVERRIDE.

b. Drag chute—OVERRIDE.

c. Anti-skid and wheel brakes—REMOTE.

d. Rudder lock—NORMAL (guard down).

e. Hook override switch—OVERRIDE (if installed).

6. External stores autodrop system safety pins—Remove.

7. Pitot heat and camera override switches—As desired.

8. Hydraulic door—Closed.

9. DSCE Ramp Check.

a. DSCE engage switch—ENGAGE.

b. Switch to No. 2 receiver then back to No. 1.

c. Brakes—LATCH.

d. Up and down pitch—COMMAND, then recenter stick and check that touch and go light is on.

e. Left and right navigation turn—COMMAND.

f. Skid arm—LEFT and RIGHT.

g. Circle turn—ON and OFF.

h. Airspeed on throttle—COMMAND, check light on.

i. Direct throttle—COMMAND, check airspeed light off.

j. Mach on throttle—COMMAND, check light on.

k. Direct throttle—COMMAND, check mach on throttle light off.

l. Mach on pitch—COMMAND, check light on.

m. ACE—COMMAND, check light on, mach on pitch light off.

n. ATO—ARM, check light on, ACE light off.

o. Nose up—COMMAND, check ATO light off—recenter stick and check that touch and go light is on.

p. Throttle override switch—REMOTE.

q. Throttle—Increase and Decrease.

r. Throttle in override.

s. Speed brakes switch—OUT and IN, return speed brake switch to IN position.

t. Telemetry—CALIBRATE.

u. DSCE—DISENGAGE.

10. Canopy—As desired.

11. Ground crew interphone—Disconnected.

12. Seat safety pin—Remove.

13. Wheel chocks—Removed.

TAXIING.

1. Nosewheel steering—Engage.

The nosewheel and rudder pedals must be alined before the steering mechanism can be engaged.

CAUTION

To eliminate possible damage to the main landing gear wheel assemblies (caused by excessive side loads), avoid high speed taxi turns.

2. Flight indicators—Check.

Perform operational check of all flight indicators.

3. DSCE engage switch—Engage with rudder centered.

a. DSCE OFF light—OFF.

Note

DSCE engage switch is a solenoid-held switch. Check that switch remains engaged.

b. All DSCE mode monitor lights OFF.

Note

If circle turn light is on, depress circle turn switch once, circle turn light should extinguish.

c. There should be no stick or pedal motion upon engagement.

4. Skid—ARM.

Command skid.

5. Left and right turn—COMMAND.

a. Rudder pedals should move hard over.

b. Upon release of command, rudder pedals should return to neutral.

c. Stick should not move.

6. Develop heading error (by allowing aircraft to drift or with manual brakes).

a. Rudder pedals deflect to oppose error.

7. Circle turn—ARM (while rudder pedals are deflected).

a. Rudder pedals return to neutral for approximately 2 seconds to pick up nosewheel steering.

8. Left and right turn—COMMAND.

a. Check that nosewheel turns in correct direction.

9. Brake—Check.

a. Drag chute override switch—OVERRIDE.

CAUTION

Drag chute override switch must be in OVERRIDE or drag chute will deploy.

b. Brake override switch—OVERRIDE.

c. Remote brakes—COMMAND.

Brakes should not come on.

d. Brake override switch—REMOTE.

e. Remote Brakes—COMMAND.

Command momentarily and release. Brakes should apply during Command.

10. Circle turn—OFF.

11. DSCE trigger switch—Disengaged (second detent).

a. DSCE engage switch should drop out.

b. DSCE off light illuminates.

c. Control forces reduce to normal.

BEFORE TAKEOFF.

PREFLIGHT AIRCRAFT CHECK.

After taxiing to takeoff area, complete the following checks:

1. Canopy—Closed and locked.

Check that CANOPY UNSAFE warning light is out.

CAUTION

- The canopy opening and closing operation is designed to work smoothly and effortlessly. If the canopy is slammed shut or open, the system may be damaged. If any forcing is necessary to obtain hook engagement, the canopy is either out of rig or improperly fitted, and corrective action must be taken before flight.
- The canopy should not be operated in flight because there is no latching mechanism allowing a part-open position.
- Stow rear-view mirror to aft position before closing canopy.

2. Inertia reel lock lever—LOCKED.

3. Speed brake switch—IN.

To prevent inadvertent extension, switch should be in the IN position when speed brakes are not being used.

4. Trim set for takeoff—CHECK.

5. Wing flap lever—TAKE OFF. (Check indicators).

6. Pitot heat, rain removal, and canopy defrost—As required.

Note

Experience has shown that on the ground moisture can collect in the pitot-static tube after exposure to rain or high humidity. Heating the tube helps to eliminate entrapped moisture.

WARNING

Pitot heat operation is limited to 4 minutes on the ground.

7. Zero-delay lanyard hooked up—CHECK.

PREFLIGHT ENGINE CHECK.

See the Variation of Engine Speed, Temperature and Nozzle Area with Throttle Position illustrated in T.O. 1F-104A-1 and Section V for engine limits. While in the takeoff area, make the following checks:

1. Aline aircraft with runway—Check nosewheel centered.

a. Set attitude indicator 5 degrees nose down.

b. Set the directional indicator pointer under the top index.

2. Brakes—Pump, then hold.

3. Throttle—MILITARY. (Check that engine acceleration is less than 10 seconds and check instruments.)

a. RPM—100% (±1%).

b. Exhaust gas temperature—575° C (±10° C).

Some EGT gages may indicate a momentary fluctuation of ±5° C over normal limits. This indication is allowable provided the fluctuation does not exceed a maximum of ±5° C and does not occur oftener than once every 20 seconds.

c. Nozzle position—1/8 to 1/4 or 1 to 3.

d. See Military Thrust Fuel Flow illustrated in T.O. 1F-104A-1.

(Refer to T.O. 1F-104A-1.)

e. Oil pressure—Check.

CAUTION

After oil pressure has stabilized, check indication against oil pressure record card at Military thrust. If the indicated oil pressure varies more than ±5 psi from that listed on the card, or is not within limits of 25 to 55 psi, the flight should be aborted and engine inspected.

4. Throttle—Retard slowly to 80 percent rpm and check for compressor stall.

5. Throttle—Military.

6. Throttle—Rapidly retard to IDLE rpm; check for compressor stall, throttle linkage and fuel flow.

If compressor stall is encountered, abort flight. Make appropriate entry in Form 781.

Note

Fuel flow should momentarily drop to approximately 400-800 pounds per hour. This fuel flow indicates that sufficient minimum fuel flow will be available during idle descents and for air starts. If the fuel flow is not within these limits the flight should be aborted.

DSCE RUNWAY CHECK.

Note

For metal stick flight the pilot will make the following checks. For remote controlled flight the ground station or director aircraft will make the checks with the QF-104A pilot calling the checklist.

1. DSCE engage switch—ENGAGE.

2. J-4 synchronizing indicator—CENTER.

3. Override switches as follows:

a. Throttle—REMOTE.

b. Arrestor hook—OVERRIDE.

c. Anti-skid brakes—REMOTE.

d. Drag chute—OVERRIDE.

e. Pitot and camera—AS DESIRED.

4. Afterburner stop—REMOVE.

5. Brakes—LATCH.

6. Skid—ARM, LEFT and RIGHT.

7. Circle turn—ON.

8. ATO—ARM, check light ON.

9. Depress button No. 1 in preparation for brakes release.

ATO (AUTOMATIC TAKEOFF).

(See Figure 2-2.)

1. Throttle—INCREASE and HOLD—Check that throttle advances to full military but does not advance into minimum afterburner (check acceleration).

2. As throttle increase is still held, brakes unlatch—COMMAND before afterburner lights.

3. Ground roll—Correct heading as necessary.

During ground roll it may be necessary to correct heading. This is accomplished by commanding left and right skid as required. If nosewheel shimmy develops, it may be desirable to disengage nosewheel steering by disarming circle turn.

4. Check instruments.

ATO LIFT-OFF AND COMPLETION.

With full tip tanks only, the climb reference attitude will engage at 160 ±5 knots IAS and the aircraft will lift off at 195 knots IAS. With full tip and pylon tanks the climb reference will engage at 170 ±5 knots IAS and the aircraft will lift off at 205 knots IAS.

Note

At this point ILS (localizer), if used, is automatically disengaged.

Automatic pitch trim is activated at lift off.

1. Landing gear lever—UP.

The landing gear retracts automatically at 227 knots IAS.

WARNING

If the landing gear lever override button must be used to operate the gear handle from DOWN to UP, the DSCE will not operate to raise the gear either by command or automatically at gear limit speed. The DSCE must be disengaged to raise the gear.

Gear retraction turns off the skid turn mode and causes the rudder lock to engage. Note also that the ATO arm monitor light extinguishes. Disengagement of the skid mode activates either the navigation turn mode or the circle turn mode, depending on selection made prior to or during takeoff. The aircraft is now airborne, accelerating, and climbing (pitch attitude approximately 14 degrees) in full afterburner with flaps at TAKE OFF.

AFTER TAKEOFF CLIMB.

Refer to the Appendix for best climb speed. Care should be taken following takeoff to anticipate the high forward acceleration. As climb speed is approached assume the proper climb attitude to ensure maximum performance.

1. Engine instruments and fuel quantity indicator—Check.

When carrying external tanks, the fuel quantity indicator should be monitored. A low reading indicates that external tanks are empty or are not feeding properly.

2. Zero delay lanyard—Disconnect in accordance with the Zero Delay Lanyard Connection Requirements in Section III of T.O. 1F-104A-1.

CLIMB FROM TAKEOFF TO 4000 FEET (AFTER COMPLETION OF ATO).

Slow Speed—Climb.

1. Airspeed on throttle—COMMAND (A/S cannot be commanded until completion of ATO).
2. Cruise reference—ON.
3. Afterburner gate—COMMAND—hold until engine is out of afterburner.
4. Nose UP or DOWN—Command to maintain desired climb attitude.
5. ACE ON—Command.

MILITARY THRUST CLIMB (4000 FEET TO CRUISE ALTITUDE).

1. Flap lever—UP.
2. Flaps up—COMMAND, check flaps and gear up light, illuminated when flaps are full up.
3. Direct throttle—COMMAND.
4. Mach on throttle—COMMAND.
5. Throttle decrease—HOLD, Mach reference will drive to minimum Mach reference pre-set in the drone and stop. Observe power increase to full military.
6. Airspeed on throttle—COMMAND when drone has accelerated to reference Mach setting and throttle modulates.
7. Airspeed reference—INCREASE until power is full military.
8. Direct throttle—COMMAND.
9. Direct pitch—COMMAND.
10. Mach on pitch—COMMAND.

WARNING

Prior to a Mach-on-pitch command actual Mach number should agree with the Mach reference indicator. It is important to remember that the aircraft will nose down if the actual speed is less than the commanded speed. The aircraft will nose up if the actual speed is greater than the commanded speed.

AFTERBURNER CLIMB.

1. Direct throttle—Command.
2. Throttle increase—Command until throttle is at full afterburner.
3. Mach on pitch—Command, at desired Mach number.

Mach reference indicator should agree with actual Mach number.

TYPICAL AUTOMATIC TAKEOFF (ATO)

BASED ON A TAKEOFF GROSS
WEIGHT OF 22,770 LB WITH
TIP TANKS INSTALLED

REFER TO PART 10 FOR
TAKEOFF DISTANCE AND
SPEED AT OTHER GROSS WEIGHTS

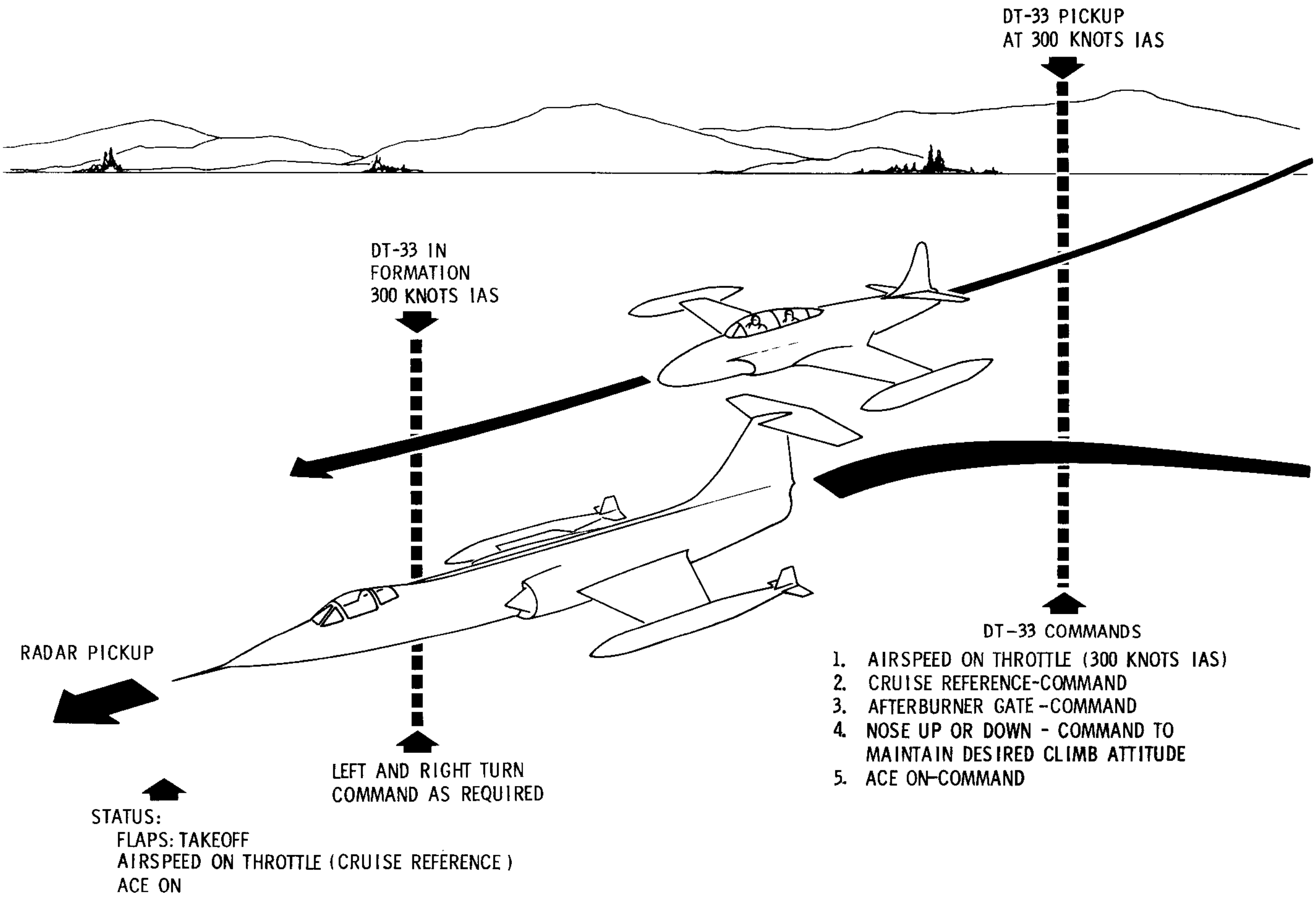


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Figure 2-2 (Sheet 1 of 2)

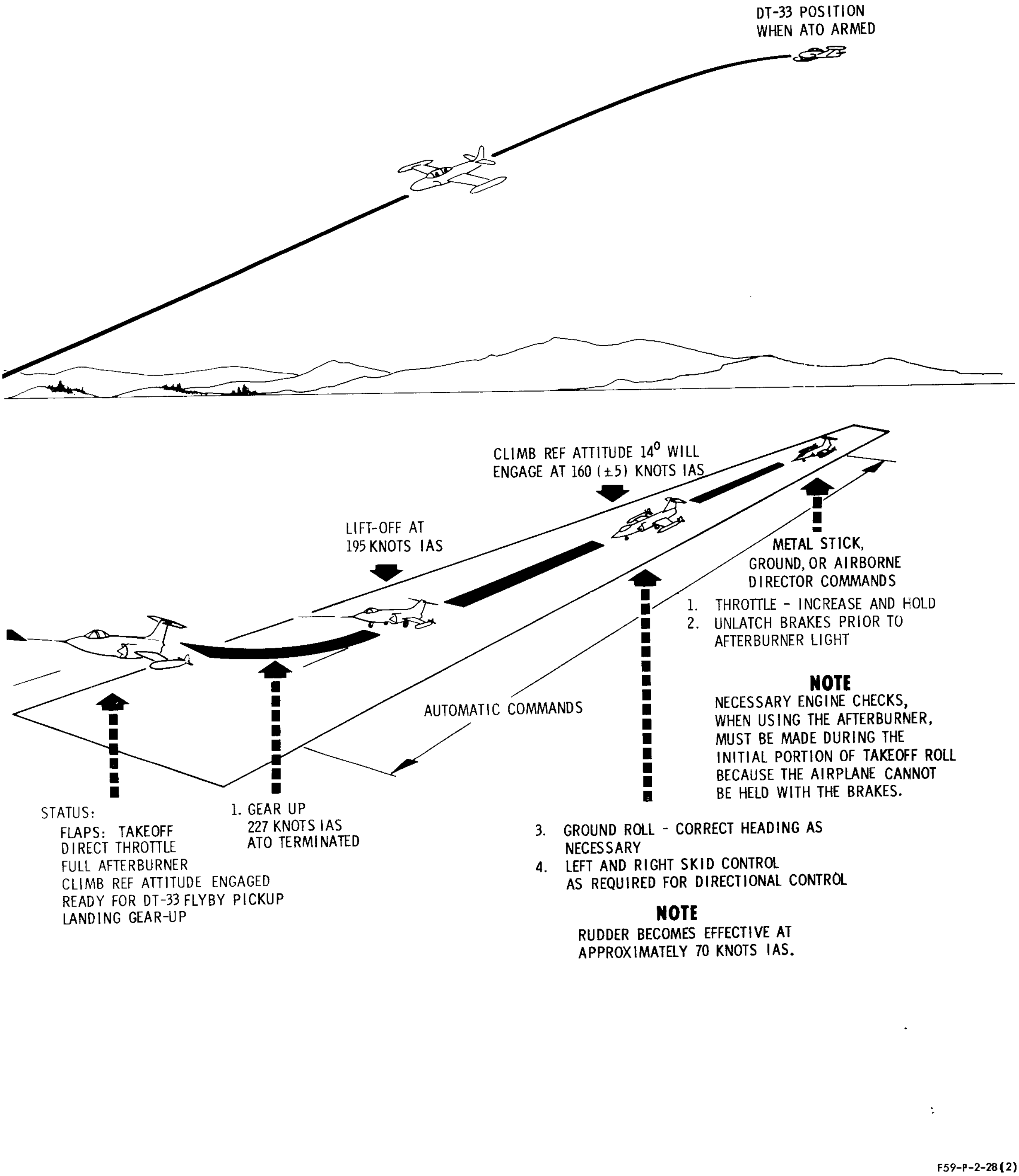


Figure 2-2 (Sheet 2 of 2)

Note

If Mach on pitch engagement is made slightly at variance with the intended Mach number or throttle setting (or it is desired to alter these items) change Mach on pitch reference by commanding speed increase or decrease and alter throttle by commanding THROTTLE INTERLOCK and simultaneously commanding speed increase or decrease. It is necessary to disengage cruise reference before speed increase or decrease commands are effective in altering Mach reference.

Note

Mach on pitch operation is not recommended in transonic region. Refer to Section VI.

ESTABLISHING LEVEL FLIGHT.

1. DIRECT PITCH—Command.

2. Nose UP or DOWN—Command to establish level flight.

3. ACE—Command.

G SWITCH AND STABILIZER RATE DISCONNECT CHECK.

G Limit Disconnect Check.

1. Overpower the stabilizer servo unit by slowly pushing or pulling the control stick and releasing. The stick deflection and time of deflection should be just sufficient to obtain 0G or 3G respectively on the accelerometer during the recovery. At these limits the system should disengage.

2. Re-engage DSCE.

Rate Disconnect Check.

1. Overpower the stabilizer servo by quickly pushing or pulling the control stick and releasing. The system should disengage but above 0G or less than 3G.

2. Re-engage DSCE.

CRUISE.

Refer to the Appendix for cruise operating data.

Operation of the Airstart and Idle Gate.

The airstart and idle gate toggle switch provides airstart ignition, direct pitch, direct throttle and removes the idle cutoff and inflight idle gates to facilitate an airstart. Without the throttle stop plates in place, if the airstart and idle gate switch were actuated either remotely or by metal stick and a throttle decrease command were held, the throttle would drive to cut off.

WARNING

Do not make a manned inflight check of the idle gate while holding a decrease throttle command. The accumulation of play in the throttle linkage and the throttle servo could result in a flameout even though that removable stop plate is in place.

MACH ON THROTTLE.

1. Mach on throttle—Command.

Note

Mode must be in direct-throttle or Mach-on-pitch to acquire Mach-on-throttle mode.

2. Speed increase or decrease—Command as desired to establish the desired Mach reference.

Note

- The Mach reference unit displays the commanded Mach number. If it is desired to establish the cruise value, command cruise reference. If the throttle regime is not compatible with the commanded Mach number (that is, the throttle must move into or out of the afterburner region to ultimately stabilize the aircraft at the commanded Mach number) then the afterburner gate command must be given to permit throttle advance into afterburner.
- Afterburner gate is always open in the direct-throttle mode.

AIRSPEED ON THROTTLE.

1. ACE—Command.

2. Airspeed on throttle—Command.

MACH ON PITCH (Cruise-Climb).

1. Direct throttle—Command to desired rpm.

2. Direct pitch—Command.

3. Mach on pitch—Command.

Actual Mach number should agree with Mach reference indicator.

Note

Mach on pitch operation is not recommended in transonic region. Refer to Section IV.

IN-FLIGHT ENGAGEMENT, DSCE.

1. Trim aircraft in all three axes to center controls.

Note

Above 370 knots IAS with DSCE engaged, directional yaw trim will transfer to the high speed DSCE direction trim rheostat.

2. DSCE engage switch—ENGAGE with no pressure on the controls.

System should be engaged when wings are level and pitch attitude is as near zero as the flight condition permits.

3. If directional trim above 370 knots IAS is not satisfactory, set the high speed DSCE directional trim control for correct trim.

AFTERBURNER OPERATION.

DIRECT THROTTLE.

1. Direct throttle—Command.

2. Increase throttle—Command, throttle will pause at minimum afterburner until afterburner light-off then will increase to full afterburner if increase command is held long enough.

3. Decrease throttle—Command.

Throttle will retard out of afterburner range and continue to in-flight IDLE if decrease command is held.

AIRSPEED ON THROTTLE.

1. Airspeed on throttle—Command.

Note

Airspeed reference will agree with actual airspeed.

2. Increase—Command (to increase airspeed reference).

3. Afterburner gate—Command until throttle moves into afterburner range.

Throttle will pause at minimum afterburner until afterburner light-off and then will increase to full afterburner.

4. Decrease—Command (to decrease airspeed reference).

5. Afterburner gate—Command until throttle moves out of afterburner range.

MACH ON THROTTLE.

1. Mach on throttle—Command.

2. Increase—Command.

3. Afterburner gate—Command until throttle moves into afterburner range.

Note

If afterburner does not light off, throttle will not advance beyond minimum afterburner.

4. Decrease—Command (to decrease Mach reference).

5. Afterburner gate—Command until throttle moves out of afterburner range.

CAUTION

If afterburner light-off is not obtained within 5 seconds at sea level, or 15 seconds at altitude, after the throttle is moved into the afterburner range, the throttle should be retarded to military thrust and then, after 3 to 5 seconds, returned to afterburner range to recycle the system. After the initial light-off is obtained check exhaust gas temperature, rpm, and nozzle position.

Note

The fuel flow indicator does not indicate afterburner fuel flow.

FLIGHT CHARACTERISTICS.

Refer to Section VI for information regarding flight characteristics.

DESCENT.

Refer to the Appendix for recommended descent techniques and accomplish the following steps:

1. Defrost—ON (preheat 10 minutes before descending).

2. Engine anti-ice and pitot heat—Climatic.

3. No. 1 and No. 2 hydraulic system pressures—Check.

4. Airspeed throttle—Command.

5. Direct pitch—Command, after speed is stabilized.

6. Down pitch—Command, to start the descent (throttle should retard to INFLIGHT IDLE unless in afterburner).

CAUTION

Pitch-down beeping will result in throttle retardation to INFLIGHT IDLE. Excessive pitch-down commands will create excessive airspeeds.

7. Afterburner gate—Command as necessary if engine is in afterburner to allow throttle to retard into military range.

8. Adjust pitch to maintain 300 knots IAS.

Note

As long as the throttle is free to modulate (without being restricted by the idle or military power stops) the commanded airspeed will be automatically maintained.

APPROACH. (See Figure 2-3.)

WARNING

The airspeeds listed herein are based on a landing gross weight of 15,140 lb or less (1000 lb or less fuel remaining). Increase approach and landing speeds 5 knots for each additional 1000 lb of fuel.

Note

The procedures set forth below will produce the results in the landing charts in the Appendix.

DESCENT TO PATTERN ALTITUDE.

1. Airspeed throttle—Command, set reference at 230 knots.

2. Zero-delay lanyard—Connect in accordance with the Zero Delay Lanyard Connection Requirements in Section III of T.O. 1F-104A-1.

3. Wing flap lever—Takeoff.

4. TAKE OFF flaps—Command.

5. Establish 300 knots IAS.

6. Direct Pitch—Command.

7. Circle turn as desired.

8. Descend to pattern altitude.

DOWNWIND.

1. ACE—Command.

2. Check that airspeed on throttle is ON and reference is set at 230 knots.

3. Fuel—Check.

BASE.

1. Landing gear lever—DOWN.

Warning light and horn will be on until gear is down and locked.

2. Landing gear down—Command.

Check indicator.

3. Decrease command airspeed reference to 215 knots IAS.

4. Drag chute and anti-skid brakes override switch—REMOTE if full-stop landing is to be made.

FINAL.

1. ILS arm—Command (if to be used). Wings must be level.

Note

Do not arm ILS if above glide-path plane. It is absolutely essential that range and altitude are such that aircraft is below glide-path plane when ILS is armed. As range reduces aircraft will intercept and automatically engage glide path. As this occurs ACE disengages automatically. If a crosswind condition creates unreasonable localizer standoff errors, command left and right navigation turns as necessary to reduce same. However, such commands will disarm ILS.

2. Wing flap lever—LAND.

3. Land flaps—Command.

Note

- A mild roll transient may be experienced on some aircraft as the flaps move from the TAKE OFF to the LAND position. This is attributed to asymmetric differences in boundary layer control systems and will vary in intensity and direction with individual aircraft but should not exceed 1 inch lateral stick displacement. After the flaps are in the full-down position some lateral unbalance may persist.
- A slight EGT rise may occur during BLC operation; however, this rise will not exceed the limit temperature.

CAUTION

If a boundary layer control system malfunction is experienced, as manifested by a strong rolling moment as the wing flaps travel to the LAND position, proceed as follows:

(a) DSCE—Disengage.

(b) Immediately return the wing flap lever to TAKE OFF.

(c) Fly final approach at not less than 190 knots IAS.

(d) Touch down at 160 knots IAS.

4. Decrease command airspeed reference to 190 knots IAS.

5. Localizer will engage when beam error becomes less than 2½ degrees.

Note

Glide-path will not engage unless localizer has first engaged. After engagement, UP or DOWN commands will disarm glide-path. To re-engage, ILS must be disarmed, then re-armed.

6. If ILS is not used, ACE-off command and down-command to start final approach.

7. Decrease—Command to decrease aircraft speed reference to final approach speed. (170 knots IAS minimum).

Note

- Increase approach and landing speeds 5 knots for each additional 1000 lb of fuel.
- Refer to landing distance charts in the Appendix for final approach and touchdown speeds at other gross weights.

8. ILS—Off command or L-R turns to disengage.

9. Direct throttle—Command.

10. Skid on—Command.

WARNING

Do not command skid-on and direct throttle simultaneously on landing approach as this combination can result in ACE and cruise reference on.

11. Circle turn—Arm, to obtain nosewheel steering.

12. Nose up—Command as necessary for flaring.

Note

Glide-path automatically disengages on nose up or down commands.

13. Speed decrease—Command to approach rpm during flare.

14. Left or right skid turn—Command as necessary to de-crab.

TOUCH-AND-GO LANDING.

If a touch-and-go landing is desired, make a normal approach and landing. As main gear contacts runway proceed as follows:

1. Nose down—Command (approximately 1 second).

This will place the nose gear on the runway and command a pitch attitude close to zero. As nosewheel touches down with flaps still at LAND, the trim will automatically go to 5° nose up and the stabilizer takeoff trim light will come on and remain lighted. Once started, the trim sequence will continue to completion.

CAUTION

It is essential that excessive nose-up stabilizer angles be avoided, especially below takeoff speed. If excessive stabilizer angles are established below APC takeoff speed, the aircraft may rotate sharply as takeoff speed is reached. The nose-up attitude that can be attained is excessive and recovery could be difficult. The stick-shaker boundary would be penetrated during this maneuver which would block any further nose-up commands; however, this action would probably occur too late to prevent further rotation.

2. Wing flap lever—TAKE OFF.

3. Takeoff flaps—Command.

4. Airspeed on throttle—Command.

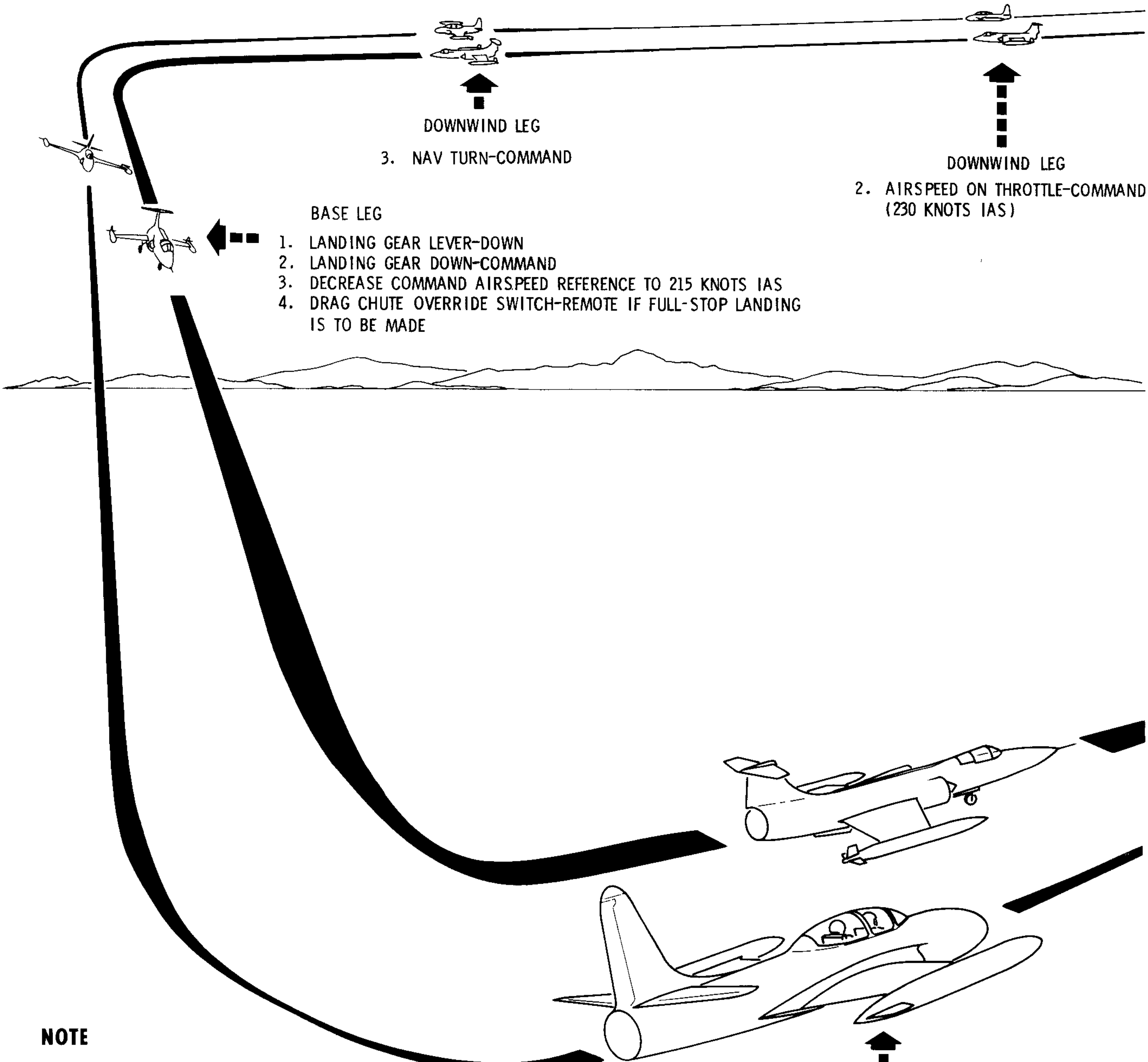
5. Touch-and-go light—Check ON.

This indicates that stabilizer trim is at takeoff, control stick is at neutral, and normal DSCE takeoff can be made.

If touch-and-go light does not come on, command nose up or down to obtain light or note that the control stick is in neutral.

DSCE APPROACH AND LAND PATTERN - TYPICAL

Based on a normal landing gross weight of 15,140 lb or less (1000 lb or less fuel remaining).



NOTE

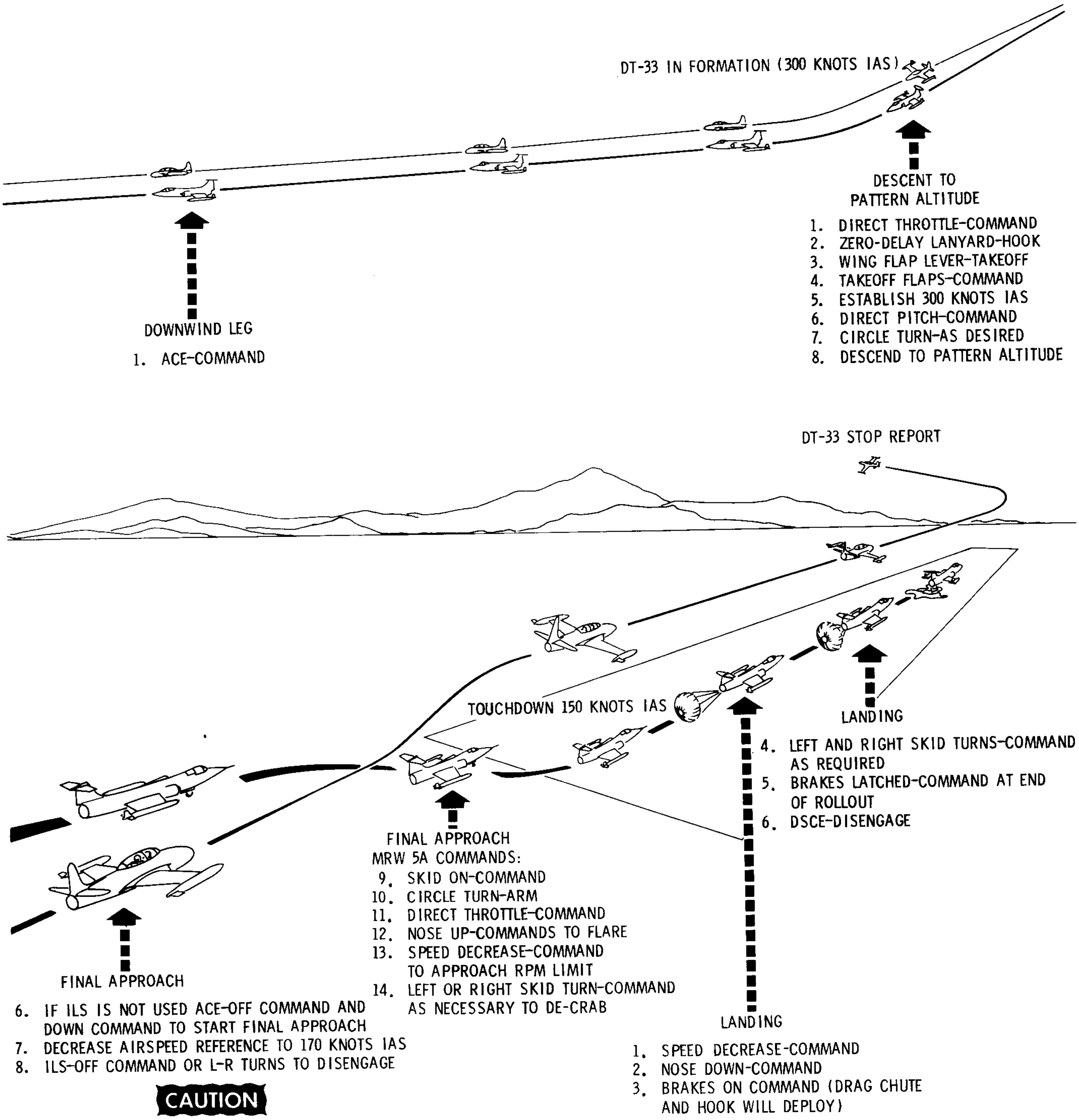
- Increase approach and landing speeds 5 knots for each additional 1000 lb of fuel remaining.
- Refer to landing distance charts in PART 10 for final approach and touchdown speeds at other gross weights.

FINAL APPROACH

1. ILS ARM-COMMAND (IF USED) WINGS MUST BE LEVEL
2. WING FLAP LEVER-LAND
3. LANDING FLAPS-COMMAND
4. DECREASE COMMAND AIRSPEED REFERENCE TO 190 KNOTS IAS
5. LOCALIZER WILL ENGAGE WHEN ERROR BECOMES LESS THAN 2-1/2 DEGREES

F59-B-2-29(1)

Figure 2-3 (Sheet 1 of 2)



CAUTION

- Steep final approaches can be hazardous if the airspeed drops below normal, turns are made, or gusty winds prevail. These factors may cause an excessive rate of sink which will not be recognized and corrected before contact with the ground.
- All final approaches should be made with power and on a glide slope similar to that for ILS approach.

CAUTION

Do not chop power while airborne as abrupt loss of lift will accompany the decrease in boundary layer control airflow.

F59-B-2-29(2)

Figure 2-3 (Sheet 2 of 2)

6. Speed increase—Command. Airspeed reference to 250 knots IAS minimum.

WARNING

ATO cannot be used for touch-and-go landings as pitch integrator output may prevent the aircraft from attaining the 14° climb reference attitude.

7. Turn and pitch commands as required to complete takeoff.

8. Landing gear lever—UP, when airborne.

9. Gear up—Command.

Note

The procedure for a remote operation is identical except that following touch-down the elevator remote operator must visually determine that the stabilizer is in a satisfactory position to takeoff. If not, pitch—Command to position stabilizer. The 1-second down command in conjunction with the automatic trim will provide this condition in a normal landing.

GO-AROUND.

If aircraft has already touched down when a go-around is necessary proceed as above for touch-and-go landing.

If go-around is necessary prior to touchdown:

1. Airspeed on throttle—Command.

2. Speed increase—Command.

Airspeed reference to 250 knots IAS minimum.

3. Speed brakes—IN (if extended).

4. Nose up—Command to establish a shallow climbout.

5. Landing gear lever—UP.

6. Landing gear up—Command at 170 knots IAS.

7. Flap lever—TAKE OFF.

8. Takeoff flaps—Command at 185 knots IAS.

9. Nose up—Command as required to counteract any tendency to sink during flap retraction.

10. Afterburner gate—Command if required.

WARNING

ATO sequence cannot be used for a go-around as the pitch integrator output may prevent the aircraft from attaining the 14° climb reference attitude.

LANDING. (See Figure 2-3.)

NORMAL LANDING.

1. Speed decrease—Command to bring throttle to IDLE after weight is on main gear.

2. Nose down—Command to place nosewheel on ground. Note that rudder centers momentarily to pick up nosewheel steering.

3. Brakes on—Command after touchdown (and nosewheel is on ground).

Note

Drag chute and hook will deploy with first application of brakes if override switches are in REMOTE position.

4. Left and right skid turns—Command as required during rollout.

5. Brakes latched—Command at end of rollout.

6. Trigger—Pull to second detent to disengage DSCE.

AIR-TO-AIR LANDINGS.

Air-to-air landings are performed without the use of a ground station where the director airplane performs all functions that the ground station would normally do. An air-to-air landing is an emergency method of landing the drone when an MRW-5 is not available or operational. Since successful completion of an air-to-air landing demands outstanding judgment and faultless manipulation of the remote controls, the following procedure will apply:

1. Practice air-to-air landings will be performed only by highly qualified safety pilots and only when specifically scheduled.

2. If a touch-and-go landing is planned from an air-to-air pattern, the safety pilot will disengage after touchdown and complete the touch-and-go landing. He may re-engage after the drone is safely airborne.

3. Full stop landings may be completed by the remote control pilot.

AFTER LANDING.

Maintain directional control with nosewheel steering and brakes and proceed as follows:

1. Speed brake switch—IN.
2. Wing flap lever—TAKEOFF.
3. Rain remover—OFF.

If rain remover has been OFF during descent, the rain remover switch should be turned ON for not more than 20 seconds then OFF. This procedure is necessary to free the line of condensation in order to protect the rain removal shutoff valve from corrosion.

4. Engine anti-ice and pitot heat—OFF.
5. Drag chute—Jettison in appropriate area.
6. Check stabilizer and aileron trim—TAKEOFF.

ENGINE SHUTDOWN.

1. Wing flap lever—UP.

If no malfunction or warping has occurred, return wing flaps to the UP position with ground crew checking to ensure ducts are not crushed during flap movement.

2. Run engines for 3 minutes at IDLE rpm for proper engine cooling.

Note

Operation during taxiing can be considered as part of this time if performed at less than 82% rpm.

3. Throttle—OFF.

Note

Check that engine decelerates freely. Listen for any excessive noise during shutdown.

4. Airstart idle gate—Hold.
5. Hold throttle outboard while commanding a decrease until throttle is OFF.

Note

Check that engine decelerates freely. Listen for any excessive noise during shutdown.

6. Fuel shutoff switch—OFF.
7. Battery switch—OFF.

BEFORE LEAVING AIRCRAFT.

1. Ejection seat safety pin—Installed.
2. Pressure suit oxygen supply lever—OFF.
3. Diluter demand oxygen supply lever—ON.
4. Radio equipment—OFF.
5. Wheels—Chocked.
6. Landing gear ground safety pins—Installed.
7. External stores autodrop system—Safetied.
8. All override switches—OVERRIDE.
9. Throttle stop plates—Check in place.
10. ARW receiver switches—OFF.
11. Radar guidance switch—OFF.
12. Receiver limiter switch—OFF.
13. Metal stick switch—OFF.
14. Telemetry switch—OFF.
15. Form 781—Complete.

CAUTION

In addition to established requirements for reporting any system defects and unusual and excessive operations, the flight crew also will make entries in Form 781 to indicate when any limits listed in the Flight Manual have been exceeded.

Part 2D — Nullo Flights

PRE-NULLO FLIGHT CHECK.

A manned pre-Nullo flight is made to operationally check all DSCE functions and flight characteristics.

GROUND CHECKS.

DSCE PRE-NULLO CHECK.

The DSCE pre-Nullo ground checks allow the electronics maintenance personnel to ground check all DSCE and augmentation equipment.

EXTERIOR INSPECTION.

The Nullo check pilot will conduct a normal aircraft exterior inspection plus the following drone-peculiar items:

1. Airspeed and Mach reference—Set.
2. Electronics compartment—All circuit breakers IN.
3. Nullo switches—Safe flight.
4. Electrical load center—Check all circuit breakers and set X and L band circuit breakers in accordance with the mission profile.
5. Electrical and engine cutoff switch—On and cover closed.
6. Landing gear and takeoff flap up-and-locked light—Secure.
7. Smoke nozzle—Secure.
8. Range safety key—OFF and chain attached.
9. Wheel door hydraulic cutoff switch—ON (cover closed).
10. Camera lenses, left tip—Undamaged.
11. Nose gear scissors switch—Secure and safetied.
12. Nose gear electrical connection on—Secure and safetied.
13. Nose camera lenses—Undamaged.

INTERIOR CHECK.

1. Remove survival kit.
2. Seat belt, shoulder harness, tie-down strap, pressure suit, and oxygen hose—Attached and secured.
3. Seat safety pin—Installed.
4. Canopy jettison safety pin—Installed.
5. Left console circuit breakers—IN.
6. Auto-pitch control cutout switch—ON (cover down).
7. High speed DSCE directional trim control—Set for 1.5.
8. Stability control switches (roll, pitch, and yaw)—OFF.
9. Directional trim rheostat—Set on mark.
10. Fuel shutoff switch—ON.
11. External stores release selector switch—OFF.
12. External tank fuel selector switch—OFF.

Note

If pylon tanks are installed switch must be in PYLON position for fuel to feed automatically. If tip tanks only are installed, switch must be in TIP position.

13. Override switches—OVERRIDE.
14. DSCE inverter control switch—ON.
15. DSCE standby switch—ON.
16. DSCE engage switch—OFF.
17. Rudder lock—Normal.
18. Canopy defrost lever—Slightly open.
19. Auxiliary trim control switch—NEUTRAL.
20. Auxiliary trim selector switch—STICK TRIM.
21. UHF radio—As required.
22. Wing flap lever—UP (check indicator).
23. Throttle retractable stop plates—In place.
24. Throttle—OFF.
25. Speed brakes switch—NEUTRAL.
26. Exhaust nozzle control switch—AUTO (guard down).
27. Landing gear lever—DOWN.
28. Red landing gear warning light—OFF.
29. Green landing gear indicator light—ON.
30. Landing and taxi lights—OFF.
31. Engine anti-ice switch—OFF.
32. Anti-skid override switch—REMOTE.
33. Anti-skid fail light—Push to test.
34. IGV switch—AUTO (guard down and safetied).
35. Drag chute handle—Stowed.
36. Manual landing gear release handle—Stowed.
37. DSCE guidance and function lights—Push to test.
38. Accelerometer—Centered.
39. DSCE mode monitor and range safety monitor lights—Push to test.
40. Altimeter—Set at field elevation.
41. Airspeed and Mach reference—Check at zero.
42. Metal switch stick—ON.
43. Radar guidance switch—ON.

44. Receiver No. 1 and No. 2—ON.

45. Receiver transfer switch—OFF (centered).

46. Telemetry switch—ON.

47. Ram air turbine and extension handle—Stowed.

48. Canopy jettison handle—Stowed.

49. Hydraulic system pressure gage switch—NO. 1.

50. DSCE off-light—ON.

51. Battery switch—ON.

52. Fuel quantity and fuel indicating system—Check.

53. Warning light system test switch—WARNING LIGHTS TEST.

54. Oxygen system—Check.

Note

If diluter demand oxygen system is not to be used, the supply lever on the oxygen regulator panel must be placed in the OFF position. If left in the ON position, the regulator will automatically allow positive pressure oxygen flow above 25,000 feet altitude, which will rapidly exhaust the oxygen supply.

55. VHF navigation radio—ON and ILS frequency—SET.

56. J-4 latitude correction controller—Set for proper latitude.

57. J-4 synchronizing indicator—Centered and function selector switch—MAG.

58. Ram air scoop—Closed.

59. Cockpit heat control—AUTO (slightly hot).

60. Pitch sensor and pitot heat switch—OFF.

61. Rain removal switch—OFF.

62. Interior lights rheostat—OFF.

63. Exterior lights switch—OFF.

64. Engine motoring switch—OFF.

65. Thunderstorm light switch—OFF.

66. Ventilated suit blower switch—OFF.

67. Right console circuit breakers—IN.

68. Automatic pitot heat switch—OVERRIDE.

69. Camera switch—OFF.

70. Check that DSCE will engage then disengage.

ENGINE START.

1. Start MA-1 two minutes prior to scheduled engine start.

2. Recheck A/B ignition circuit breaker—IN.

3. Follow normal engine start procedure.

AFTER STARTING.

No engine warmup is necessary; however, approximately 30 seconds should be allowed for electronic temperature control warmup and 3 minutes for DSCE warmup if it is to be used. With the assistance of ground crew personnel proceed as follows:

1. Generator—Check.

To ensure operation of the generator bus transfer circuits:

a. No. 1 generator—OFF; check warning light and RESET.

b. No. 2 generator—OFF, check warning light and RESET.

2. Boost pump circuit breakers—Checked and ON, electrical load center door—Secure.

3. UHF and VOR—ON and check.

4. Hydraulic systems—Check.

To ensure that the hydraulic systems are operating properly, perform the following checks:

a. At idle rpm, move the stabilizer through a complete cycle. Pressure indications should drop to approximately 2700 psi then rise to 3300 psi maximum and return to normal.

Note

If there are no hydraulic pressure fluctuations during fore and aft movement of the control stick, shut down the engine and investigate.

b. Move ailerons through a complete cycle, same reactions should occur as stabilizer check.

c. Move rudder through maximum travel and check that hydraulic pressure drops, rises, and returns to normal.

d. Hydraulic system pressure gage switch—No. 2.

e. Repeat test (a) and (b) above.

f. Speed brakes—At 75 percent rpm, operate through one complete cycle. Pressure indication on No. 2 gage should drop quickly to approximately 2150 psi, then rise momentarily to approximately 3300 psi and return to normal.

5. Trim system—Check.

CAUTION

It is possible to damage the trim mechanism by operating trim controls with the control stick in a full-throw position. To preclude this possibility, make all trim system checks with the control stick in NEUTRAL.

Make the following checks and have ground crew assure you that control surfaces respond correctly:

a. Normal directional trim control — Operate through full travel and return to neutral.

b. High-speed DSCE directional trim control—Check setting.

Note

This control should have been set and marked on previous flights. It has no effect unless DSCE is engaged and airspeed is above 370 knots IAS.

c. Aileron and horizontal stabilizer trim switch—Test (all four positions).

WARNING

An improperly installed or defective trim switch is subject to sticking in any or all of the actuated positions, resulting in application of extreme trim. If this condition occurs during preflight check and the switch does not return automatically to the center OFF position, enter this fact in the Form 781 with red cross and do not fly the aircraft.

Note

Aileron and stabilizer takeoff trim indicator lights should illuminate as the trim motors pass through the takeoff setting. Stabilizer trim light should remain lighted if stabilizer trim is in TAKEOFF position.

6. Stability augmenters—Check. Turn on YAW-PITCH and ROLL augmenters and have ground crew verify operation.

7. Directional trim—Check. Operate the directional trim rheostat through full travel each direction and return to center. Have ground crew verify that rudder trim is neutral.

8. Trim—Set for takeoff (verified by ground personnel and indicator lights).

Note

Leading edge of horizontal stabilizer should be alined with black T index painted on the vertical stabilizer.

9. Automatic pitch control system—Check.

a. Wing flap lever—UP.

b. Rotate right vane clockwise until stick shaker operates at approximately 4½.

c. Continue clockwise rotation until stick kicker operates at 5. Check for ability to override stick kicker by aft movement of the control stick.

d. Wing flap lever—LAND. With the flaps in land setting, ground crew will check BLC for proper operation. At idle rpm, expect an EGT rise of approximately 40° C.

e. Wing flap lever—TAKEOFF (Check indicator).

Note

After the flaps have reached the takeoff setting, ground crew will verify flap position, absence of BLC, and that ducts are not crushed.

f. Have right vane rotated clockwise until stick shaker operates. Continue clockwise rotation of vane to stop to check that kicker does not operate.

g. Rotate left vane counter-clockwise until stick shaker operates.

10. Pitot heat check—ON then OFF. Have ground crew verify operation.

11. Rain remover—Verify operation.

ENGINE CHECK.

1. Anti-skid brakes—Hold.

2. Throttle—Military thrust (check acceleration and instruments).

a. RPM—100%.

b. EGT—575° C (±10° C).

c. Nozzle position 1/8 to 1/4 or 1 to 3.

d. Fuel flow—Check.

e. Oil pressure—Check placarded pressure.

3. Throttle—Slowly retard to 80 percent rpm, check for compressor stall.

4. Throttle—Military thrust.

5. Rapidly retard throttle to IDLE, check minimum fuel flow, compressor stall, and throttle linkage.

6. Chocks—Remove.

TAXI CHECK.

1. DSCE engage switch—Engage.
2. Anti-skid override switch—Check REMOTE.
3. Skid—ARM.
4. Circle turn—ARM and engage nosewheel steering.
5. Check the following while taxiing:

   Heading hold

   Skid control

   Nosewheel steering

   Anti-skid brakes
6. Circle turn—OFF.
7. DSCE—Disengage with trigger switch.
8. Stop with nosewheel straight and on marks.

REMOTE CHECKOUT.

Romeo (MRW-5 control station).

1. Romeo carrier—ON, Check No. 1 receiver and canopy carrier light for illumination.

2. DSCE engage switch—ON. Check DSCE off light —OFF.

3. Transfer to receiver No. 2. Check No. 2 receiver for light.

4. Brakes—ON. (Check that the brake pedals depress slightly and are firm to the touch).

5. Brakes—Off; check that the brake pedals are not firm to the touch.

6. Skid on—LEFT & RIGHT, check rudder pedal drives.

7. Skid—OFF.

8. Circle turn—Engage (check circle turn light on).

9. Circle turn—OFF (check circle turn light out).

10. Airspeed on throttle—Command (Echo); check airspeed light ON.

11. Direct throttle (Echo); check airspeed light OUT.

12. Throttle—Increase decrease (Echo).

13. Up and down—Commands (Echo); check up and down function light and that stick drives smoothly in proper direction.

14. Re-center stick (check pilot commands up or down to recenter stick and illuminate touch-and-go light).

YANKEE (AIRBORNE REMOTE PILOT).

1. Check pilot commands Yankee to turn his carrier ON and Romeo to turn his carrier OFF. Yankee and Romeo acknowledge and check, pilot confirms carrier light on in proper receiver. Check pilot request Yankee to command the following functions:

2. Airspeed on throttle—Command. (Check airspeed light on.)

3. Increase reference (throttle override switch—REMOTE, then OVERRIDE; check for throttle drive).

4. Direct throttle (Check airspeed light out).

5. Mach on throttle—Command. (Check Mach on throttle light on.)

6. Increase reference (throttle override switch—REMOTE, then OVERRIDE; check for throttle drive).

7. Direct throttle. (Check Mach on throttle light out.)

8. Mach on pitch—Command. (Check Mach on pitch light on.)

9. ACE on—Command. (Check Mach on pitch light off, and ACE light on.)

ZULU (AIRBORNE REMOTE PILOT).

1. Check pilot commands Zulu to turn his carrier ON and Yankee to turn his carrier OFF. Zulu and Yankee acknowledges and check pilot confirms carrier light ON in proper receiver. Check pilot requests Zulu to command the following functions.

2. Transfer to receiver No. 1. (Check receiver No. 1 light on and receiver No. 2 light off.)

3. Latch brakes—Command. (Check that brakes slightly depress and are firm to the touch.)

4. ATO—ARM. (Check ATO light on and ACE light off.)

5. Up pitch—Command. (Check ATO light off and stick for proper movement.)

6. Re-center stick. (Check pilot commands—Pitch signal to re-center stick. Pause long enough to allow all stick drives to cease. Check touch-and-go light—ON.)

7. Airspeed cruise reference—ON (check for reference increase).

8. Airspeed—OFF.

9. Throttle override—REMOTE. (Check pilot places override switch to REMOTE position.)

10. Throttle increase—Command. (Check throttle drives forward.)

11. Throttle decrease—Command. (Check throttle returns to IDLE.)

12. Skid—ARM, command LEFT and RIGHT. (Check movement of rudder pedals.)

13. Circle turn—ARM, command left and right. (Check nosewheel steering.)

14. ATO—ARM.

15. Calibrate telemetry. (Zulu will command the telemetry function while Yankee, the monitor board, and Zulu calibrate their respective telemetry instruments.)

FINAL COCKPIT CHECK.

(During final cockpit check, Yankee and the chase aircraft take off and assume orbit over runway.)

1. Throttle override—REMOTE.

2. Arrester hook override—REMOTE.

3. Anti-skid brake override—Check REMOTE.

4. Drag chute override—REMOTE.

5. Idle stop—Remove.

6. Afterburner stop—Remove.

7. Speed brakes switch—NEUTRAL.

8. Flaps—TAKE OFF.

9. Gear lever—DOWN.

10. Stabilizer trim light—Illuminated.

11. Carrier light—Guidance monitor panel shows receiver No. 1 in control. Canopy carrier light on.

12. Touch-and-go light—ON.

13. Warning panel lights—All OFF except canopy unsafe light. Leave master caution light—ON.

14. Metal stick switch—OFF.

15. Radar guidance switch—ON.

16. Receiver switches No. 1 and No. 2—ON.

17. Receiver transfer switch—OFF.

18. Telemetry switch—ON (UP for telemetry and DPN-50).

19. DSCE battery switch—Check ON.

20. Tank jettison—Pylon OFF. (If pylon tanks are carried, place switch in PYLON position. All other configurations place switch in OFF position.)

21. Fuel select switch—TIPS or PYLON. (Insure that position selected matches configuration of drone.

CAUTION

- If the TIPS position is selected with pylon tanks installed, tips will feed first, but pylons will not feed unless normally selected.
- If the PYLON position is selected with only pylon racks installed, fuel will syphon overboard.

22. VHF/NAV—As desired. (If ILS is to be used, set in ILS frequency; if no ILS, a homing VOR station can be used.)

23. J-4 synchronizing indicator—Center.

24. Nullo switches—NULLO. (Electronics specialist places Nullo switches in electronics compartment to NULLO position. These switches are checked prior to safety pilot departing aircraft.)

25. Automatic pitot heat switch—OVERRIDE.

26. Camera switch—STANDBY.

27. MATTS switch—ON if required.

28. Cockpit—Secure. (Seat pin—all straps tied down. Radio cord secured.)

29. Ammunition, electronics, and cockpit hatches—Check secured, and check warning lights—OFF and canopy hooks—Engaged.

30. All external pins—Removed except left gear pins and left pylon pin (if pylons installed). Safety pilot will check that these pins plus the left gear door safety bracket and the wheel chocks have been removed.

31. Check nosewheel centering marks—Aligned.

32. Visually check horizontal stabilizer "T" for takeoff trim.

EOD CHECK (PERFORMED BY EOD).

1. Landing gear and pylon pins removed.
2. Gear door safety bracket—Removed.
3. Chocks—Removed.
4. Hydraulic and destruct switches—ON.

LAUNCH.

Drone status prior to arming ATO is: brakes latched, skid on, nosewheel steering engaged, circle turn—ON. Director status is as follows: Yankee is in orbit 1000 feet over departure end of runway. Zulu is parked on the runway behind the drone, with carrier on. Chase status is: Chase in formation with Yankee director. When Yankee calls add the power, Zulu performs the following:

1. Throttle increase—HOLD.
2. Brakes—UNLATCH before afterburner lights.
3. Skid turns as necessary to keep drone on runway.

When drone breaks ground and landing gear is up (ATO ends), Zulu commands the following:

a. Airspeed on throttle. (Check light.)

b. Cruise reference. (Note reference drive to 300 knots.)

c. Afterburner gate—Hold until throttle retards to military thrust.

d. Pitch commands—As necessary.

Yankee assumes command after drone is out of afterburner and turns ACE—ON at the designated altitude. Yankee will transfer control to Oscar in the following configuration:

1. Proper outbound heading.
2. ACE—ON.
3. Airspeed on throttle—ON.
4. Cruise reference—ON.
5. Takeoff flaps.

PROFILE.

When drone passes over the carrier exchange point the Oscar controller will assume command of the drone on Yankee call. After Oscar turns his carrier ON the following functions are commanded to perform a typical mission profile:

1. Flaps—UP. This command establishes Oscar control and is confirmed by Yankee. Yankee also confirms that the gear-and-flap-up-and-locked light is illuminated and transmits this information to Oscar.
2. Direct throttle.
3. Mach on throttle.
4. Hold a decrease command until minimum Mach reference is reached (Mach 0.8).

When minimum Mach is reached by the drone, telemetry will indicate a decrease in rpm and EGT. At this time command the following:

5. Airspeed on throttle.
6. Airspeed reference—Increase. This command establishes the Mach reference in the follow-up mode and provides only a small change in Mach reference as Military thrust is established.
7. Direct throttle. Command this function when telemetry indicates rpm and EGT are established at military thrust.
8. Direct pitch.
9. Mach on pitch.
10. Mach reference—Recheck at climb Mach. (By using the above method to establish the Mach on pitch climb, the Mach, when commanding Mach on pitch, should be at the desired climb Mach or slightly higher. If an adjustment of Mach reference is needed, it should be a decrease in which case the drone will climb to match the Mach change.)

During this portion of the mission the Yankee and Zulu aircraft are proceeding to pre-briefed orbit points. The chase aircraft proceeds with the drone and the chase pilot relays any needed information to the Oscar controller (that is, airspeed, altitude, attitude, or function in operation).

At the level-off point at altitude the Oscar controller commands the following functions:

1. Mach on throttle.
2. ACE—ON.
3. Mach reference—Establish cruise Mach with Mach reference increase or decrease.

If pylon tanks are carried, the Oscar controller will command the following functions to jettison the pylon tanks:

1. HOLD TO ARM.
2. ARM.

CAUTION

HOLD TO ARM must be held prior to actuation of the ARM function or the RAT will be extended.

Note

If the pylons are to be jettisoned also, the complete sequence must be commanded a second time.

At a predetermined point, the following functions are commanded to accelerate the drone to a supersonic Mach number:

1. Mach cruise reference—OFF.
2. Mach reference—Increase to desired Mach number.
3. Afterburner—Hold gate open.

If Mach 1.0 is to be exceeded, in order to prevent large pitch changes during the Mach jump, command the following:

1. At 0.95—ACE OFF.
2. At 1.05—ACE ON.

When making a supersonic climb after desired Mach number is attained, as indicated by a reduction in rpm and EGT, command the following:

1. Direct throttle.
2. Direct pitch.
3. Mach on pitch.
4. Command full afterburner by holding throttle interlock while commanding throttle increase.
5. Mach reference—Reset for desired Mach number.

If a subsonic climb is to be performed proceed as follows:

1. Mach cruise reference—OFF.
2. Mach reference—Increase to 0.01 above desired climb Mach.

When telemetry indicates throttle at military thrust and Mach as desired, command the following:

1. Direct throttle.
2. Direct pitch.
3. Mach on pitch.

When approaching the dash altitude, command the following:

1. Mach on throttle.
2. ACE—ON.
3. Mach reference—Adjust for desired dash Mach.

Note

Turns at dash altitude will normally be made in the navigation turn mode. If the Mach number is supersonic, circle turn may be used to reduce the turn radius.

DESCENT.

At the completion of the dash, the deceleration and descent is accomplished by commanding the following:

1. Airspeed on throttle.
2. Airspeed cruise reference—ON.
3. Afterburner gate—OPEN. Hold until throttle retards to below Military thrust setting.
4. Direct pitch.
5. Down commands—Maintain a pitch attitude that maintains the throttle at in-flight idle and the airspeed at 330-320 knots IAS.

If the drone is to be cruised back at an altitude higher than intercept altitude, proceed as follows:

1. ACE—ON at cruise altitude.
2. Mach on throttle.
3. Mach reference—Set for best cruise Mach.

If drone is to be descended directly to intercept point ignore the procedures immediately above and proceed as follows:

1. ACE—ON at intercept altitude.
2. Airspeed on throttle.
3. Airspeed cruise reference—ON.

4. Flaps—TAKE OFF.

5. Cruise reference—OFF.

6. Airspeed reference—Decrease to 275 knots IAS.

Note

- During the descent to the intercept point the Oscar controller commands Smoke when *not* commanding any other functions.
- The Oscar controller will calibrate telemetry at his convenience.

At a predetermined point the drone will be intercepted by the DT-33 control aircraft. The intercept is normally a GCI-type intercept. When Yankee has made visual contact with the drone, he will join formation, take over control and command the following:

1. Direct pitch (when descent is to start).
2. Maintain 275-300 knots IAS with pitch commands.
3. Speed brakes out and in to check No. 2 hyd system operation.

During the descent Yankee will establish voice contact with the Romeo ground station and calibrate telemetry for Romeo. Upon completing the telemetry calibration, Yankee will check airspeed minimum reference to allow Echo to set his telemetry. Yankee will then transfer control of the drone to Romeo for a control check as follows:

1. Romeo carrier—ON.

Romeo will turn his carrier ON upon call from Yankee.

2. Yankee carrier—OFF.
3. Right navigation turn—Command (Yankee confirms the turn).
4. Left navigation turn—Command (Yankee confirms the turn).
5. Up—Command (Yankee confirms up).
6. Down—Command (Yankee confirms down).

Echo controller commands—Down and Yankee confirms down.

Note

If flaps are UP, DSCE pitch rate is on slow rate so down command must be long enough for Yankee to see.

7. Airspeed—OFF and ON (Yankee confirms airspeed OFF and ON).

Echo controller commands airspeed—OFF and ON, Yankee confirms airspeed—OFF and ON.

8. Yankee carrier—ON.

Yankee turns his carrier ON.

9. Romeo carrier—OFF.

Romeo turns his carrier OFF.

Yankee continues the descent with the drone and Zulu joins up in formation during this descent. Yankee will enter the drone traffic pattern on a downwind leg approximately 2 miles from the runway. When on downwind leg Yankee will command the following:

1. ACE—ON, at traffic pattern altitude.
2. Airspeed on throttle—Recheck on reference set of 230 KIAS.
3. Flaps TAKE OFF—Recheck.

Prior to turning on the base leg (approximately 6 miles from the runway), Yankee will check the fuel reading on telemetry and pass this information to Romeo.

When turning on the base leg, Yankee will command the following:

1. Circle turn.
2. Landing gear—DOWN.
3. Airspeed reference—Reduce to 215 knots IAS.
4. Navigation turn—Command when turn to base is completed.

When turning on final approach, Yankee will command:

1. Circle Turn.
2. Land Flaps.
3. Airspeed reference—Reduce to 190 knots IAS.
4. Navigation turn—Command when turn is completed.

When approximately 3-5 miles on final approach, Yankee will command the following:

1. ACE—OFF.
2. Down pitch commands.
3. Airspeed reference—Reduce to 170 knots IAS.

Note

Airspeed on final is based on 1000 lb of fuel onboard drone. Add 5 knots IAS for each additional 1000 lb of fuel on board.

When approximately 2-4 miles out on final approach, Romeo will take control of the drone and command the following:

1. Left and right navigation turn.

Turns will be confirmed by Yankee.

Note

Yankee will fly formation on the drone to an indicated altitude of 300 ft minimum. During this time Yankee will inform Romeo of the indicated airspeed and rate of descent of the drone.

Romeo will command navigation turns to line up the drone with the runway. Echo will issue pitch commands to establish the drone on a GCA/ILS type of final approach. During the flare the following functions will be commanded by the following controllers:

1. Direct throttle.

Echo commands the function when the drone has the runway assured.

2. Throttle—Decrease to inflight idle.

Echo commands this function at a time to land the drone approximately 1500 ft down the runway.

3. Skid—ON.

Romeo commands the function prior to drone touchdown.

4. Circle turn—ARM.

Romeo commands this function to engage nosewheel steering.

5. Up pitch commands.

Echo commands this function to touchdown drone on the main gear.

6. Down pitch commands.

Echo commands this function to put nosewheel on the ground after main gear has touched down.

7. Skid turns as necessary—To keep drone straight on the runway.

8. Brakes—Command.

Romeo commands this function as required. The first brakes command will deploy the drag chute and the arrestor hook; however, if the hook and/or chute do not deploy when brakes are commanded, the hook may be deployed with button No. 7.

When the drone is at a full stop, Romeo commands:

9. Latch Brakes.

DRONE RECOVERY.

The first personnel to the drone will be those who will disarm the destruct package. After the destruct key is operated to the SAFE position they will perform the following:

1. Place one set of chocks under the left main wheels.
2. Insert the left main gear pin.
3. Insert the left pylon pin—(If installed).
4. Cut hydraulic pressure to the left forward gear door, and open door.
5. Install left gear door safety bracket.
6. Remove destruct package.

When drone is safe, recovery pilot will:

1. Enter cockpit.
2. All override switches—OVERRIDE.
3. Metal stick switch—ON.
4. Nullo switches—SAFE.

Note

Electronics personnel will actuate these switches in the "E" compartment.

5. All guidance (ARW and APW) and telemetry switches—OFF.
6. Throttle stops—In place.
7. Call Romeo to turn his carrier OFF.
8. Disengage DSCE.
9. All augmentation switches—OFF (camera, MATTS, pitot heat etc).
10. Flaps—UP.
11. Drag chute—Disengage.

Note

When crew chief observes the flaps come full up he performs the following:

a. Restore the arrester hook to the part-stowed position.

b. Remove drag chute.

c. Remove left forward gear door safety bracket.

d. Hydro switch—ON to close left forward gear door.

e. Chocks—Remove on signal from recovery pilot.

12. Taxi back to line.

ENGINE SHUTDOWN.

1. Wing flap lever—UP. If no malfunction or warping has occurred, return wing flaps to the UP position with ground crew checking to ensure ducts are not crushed during flap movement.

2. Run engines for 3 minutes at IDLE rpm for proper engine cooling.

Note

Operation during taxiing can be considered as part of this time if performed at less than 82% rpm.

3. Throttle—OFF.

Note

Check that engine decelerates freely. Listen for any excessive noise during shutdown.

4. Airstart idle gate—Hold.

5. Hold throttle outboard while commanding a decrease until throttle is OFF.

Note

Check that engine decelerates freely. Listen for any excessive noise during shutdown.

6. Fuel shutoff switch—OFF.

7. Battery switch—OFF.

BEFORE LEAVING THE AIRCRAFT.

1. Ejection seat safety pin—Installed.
2. Pressure suit oxygen supply lever—OFF.
3. Diluter demand oxygen supply lever—ON.
4. Radio equipment—OFF.
5. Wheels—Chocked.
6. Landing gear ground safety pins—Installed.
7. External stores autodrop system—Safetied.
8. All override switches—OVERRIDE.
9. Check throttle stop plates in place.
10. ARW receiver switches—OFF.
11. Radar guidance switch—OFF.
12. Receiver limiter switch—OFF.
13. Metal stick switch—OFF.
14. Telemetry switch—OFF.
15. Form 781—Complete.

CAUTION

In addition to established requirements for reporting any system defects and unusual and excessive operations, the flight crew also will make entries in Form 781 to indicate when any limits listed in the Flight Manual have been exceeded.

SECTION III — EMERGENCY PROCEDURES

TABLE OF CONTENTS

	Page
PART 3A—MANNED FLIGHT EMERGENCIES	
Both Generators Out	3-1
Rudder Lock Fails To Unlock When Gear Is Down	3-1
PART 3B—DSCE GUIDANCE EMERGENCIES	
Manned Flight (Either Metal Stick or Remote Control)	3-2
DSCE Malfunctions	3-2
PART 3C—UNMANNED FLIGHT EMERGENCIES	
Unmanned Flight	3-3
Engine Failure During Flight	3-4
Yaw Damper Failure in Skid Mode	3-6
Weight on Nose Gear Switch Failure On Landing	3-6

Part 3A — Manned Flight Emergencies

When the QF-104A is manned during flight, emergency procedures outlined in T.O. 1F-104A-1, Section III will be followed with the exception of the following QF-104A-peculiar items:

BOTH GENERATORS OUT.

During emergencies resulting from loss of both engine driven ac generators, a 22 ampere-hour battery is installed which supplies power to the No. 1 dc bus provided the cockpit battery switch is ON. If the emergency occurs which requires complete de-actuation of electrical system, such as:

a. Engine fire during start.

b. Elimination of smoke or fumes.

c. Electrical fire.

Place battery switch to—OFF.

RUDDER LOCK FAILS TO UNLOCK WHEN GEAR IS DOWN.

Place rudder lock switch in UNLOCK position. This action will unlock rudder when gear is up. Refer to the Appendix for flight limits with unlocked rudder.

Note

Ruder lock operation is independent of DSCE engagement.

Part 3B — DSCE Guidance Emergencies

MANNED FLIGHT (EITHER METAL STICK OR REMOTE CONTROL).

DISENGAGEMENT.

WARNING

When any real emergency occurs immediately disengage the DSCE and resort to manual flight. The pilot should disengage the DSCE any time he suspects it may be unsafe to continue operation with it.

Disengagement is most easily accomplished as follows:

1. Control stick trigger switch—Squeeze to second detent.

In the event this action fails to disengage the system the following alternate methods are available:

1. DSCE engage switch—OFF.
2. DSCE standby switch—OFF.

Note

The above two switches are located adjacent to each other. Both may be operated simultaneously by one hand.

Failure of DSCE to Disengage.

1. Pull (or push) on control stick and develop +3G (or −0G). For manned flight the DSCE disengages automatically when either of these values of normal acceleration is achieved.

2. Pull hard (or push) on control stick to develop ±10 degrees per second stabilizer rate.

For manned flight above approximately 240 knots a stabilizer rate of 10 deg/sec or greater automatically disengages the DSCE.

3. If all the above procedures fail, do the following:
   a. Battery switch—OFF.
   b. Generator switches—OFF.

Note

- The main objective here is to disengage the dc solenoid-operated servoclutches.
- Reapply power cautiously.
- If DSCE does not disengage it is then necessary to continue the flight by overpowering the system.

After Disengagement.

1. Throttle and drag chute override switches—OVERRIDE.
2. Throttle quadrant stops—MANUAL position.

Yaw Damper Failure in Skid Mode.

1. Disengage DSCE and land in manual control.

WARNING

Do not attempt a landing with skid mode engaged with a failed yaw damper. Lateral directional oscillations in this condition can cause loss of control of the airplane during a landing.

DSCE MALFUNCTIONS.

It is recognized that a metal-stick flight is, in a sense, a training flight. Therefore, under favorable circumstances a partial failure may justify a partial disengagement (avoidance of operation or substitution of manual control) so that the value of the flight is not entirely lost. Particular reference is made to the following failures.

Hardover Failures.

1. Immediately overpower and disengage DSCE.

WARNING

At speeds below 240 knots, and especially at low altitudes, the pilot should keep his hand on the stick at all times. The rate disconnect feature of the autopilot is disabled below 240 knots. A stabilizer hardover failure in this condition will not disengage the DSCE until the G limit of 0 is reached for a nose-down hardover. For a nose-up hardover, the aircraft will stall before the 3G limit is reached. For either of these conditions the aircraft will attain unsafe attitudes if corrective action is not taken by the pilot within 1 second. In order to do this, the pilot must have his hand on the control stick.

Faulty Throttle Speed Control System.

1. Direct throttle—Command.

Faulty Throttle Servo.

1. Throttle override switch—OVERRIDE.

Note

Operate throttle manually with throttle stop plates in MANUAL position.

Faulty Mach-On-Pitch Control.

1. Direct pitch—Command.

Faulty Remote Landing Gear Control.

1. DSCE—Disengage.
2. Landing gear lever—As required.
3. DSCE engage switch—Engage.

Faulty Remote Flap Control.

1. DSCE—Disengage.
2. Wing flap lever—As required.
3. DSCE engage switch—Engage.

Faulty Anti-Skid Brakes (or anti-skid malfunction).

1. Anti-skid brake override switch—OVERRIDE.

Note

- Anti-skid brakes are inoperative.
- Drag chute deployment must be effected manually.

2. Normal brakes—As required.

Faulty Remote Drag Chute.

1. Drag chute release—Pull.

ATO Sequence Failure.

1. Pitch—Command to complete takeoff.

Note

The ATO sequence will be terminated at any time by commanding nose up or down.

2. Follow normal metal stick or remote procedure for control of landing gear.

Part 3C — Unmanned Flight Emergencies

UNMANNED FLIGHT.

ATO FAILURE.

Symptoms:

a. Aircraft does not follow scheduled ground or flight path during takeoff.

b. Nose rotation does not occur.

Action:

1. Hold a steady UP command until drone is airborne, then readjust pitch as necessary.

ABORT TAKEOFF.

1. Hold Throttle Decrease command until throttle is idle.

2. Brakes—Command (drag chute and tail hook will deploy unless override switch is in OVERRIDE).

3. Maintain directional control.

4. If hook fails to deploy, command pushbutton No. 7 and a decrease command.

FAILURE OF GEAR TO RETRACT AFTER ATO.

1. Set airspeed reference at 260 knots.
2. Gear up Command.
3. Turn the drone to a safe heading.

Note

Skid should have cycled off at 255 knots, if it did not, command skid off.

4. When drone is on the desired heading, slow to 230 KIAS, turn ACE off and attempt to open the weight on gear switch by porpoising the drone.

5. Gear up—COMMAND.

6. When in a safe area, turn all ARW and APW carriers off to see if carrier fail will retract the gear.

7. If gear still does not retract, Command gear down and burn out fuel and land.

AFTERBURNER FAILURE.

Symptoms:

a. Loss of speed.

b. RPM scale shift.

c. Reduction in EGT.

LOSS OF AFTERBURNER DURING TAKEOFF.

If afterburner fails during takeoff:

1. ABORT if speed and runway permit.

If committed to takeoff proceed as follows:

1. Throttle—Decrease command—to retard throttle to military thrust.

2. UP or DOWN—Command to break ATO (ATO blocks airspeed command).

3. Airspeed throttle—ON.

4. Cruise reference—ON.

5. Up command—to make a manual takeoff.

6. After drone is airborne, command gear—UP.

ENGINE FAILURE DURING FLIGHT.

Symptoms:

a. EGT drop.

b. RPM drop.

1. Air start—Command.

Note

This command provides the following modes automatically:

a. Direct pitch.

b. Direct throttle.

c. Ignition (45-second run). Check EGT and rpm for immediate relight.

2. Nose down and up—Command as required to maintain 275 knots IAS.

If relight is not obtained, continue with (3), following.

3. DECREASE—Command as necessary to retard throttle to inflight idle position.

4. Idle gate—Command; if relight is not obtained, simultaneously DECREASE command to bring throttle to cutoff.

5. Increase—Command while monitoring EGT and rpm for relight.

6. Repeat above until light-off occurs. If light-off does not occur within 4 minutes after flameout, proceed as follows:

Sustained Flameout.

When 4 minutes have elapsed since flameout, proceed as follows:

1. Range safety arm—Command.

Note

Do not extend RAT above 35,000 feet as chances of obtaining normal engine operation are remote and increased drag will reduce glide distance.

2. Nose up and down—Command to hold desired airspeed and rpm.

3. Speed increase and decrease—Command to jockey throttle as desired.

4. Air start—Command as necessary to provide ignition.

Dead-Stick Landing.

A remote dead-stick landing attempt is not advised. The drone should be steered toward open water or uninhabited areas during flameout.

ARW Carrier Failure.

Symptoms:

Telemetry (guidance automatically transfers to APW).

1. APW control of the drone is restricted to the four basic commands, DOWN, RIGHT, LEFT, and DECREASE.

The drone should be retained over open water until ARW command is re-established by either the ground or airborne director. When ARW control is regained, APW should be commanded—OFF.

The chances of re-establishing ARW increase as the airborne director closes in on the drone.

2. If ARW command cannot be established the drone should be retained over open water, since a landing attempt is not practical.

Total Carrier Failure (ARW and APW).

Symptoms:

a. Telemetry (ARW carrier will go OFF and APW transfer light will not come ON).

b. No response to either ARW or APW commands.

1. Airborne director is required to close into formation and attempt to re-establish command.

Telemetry Failure.

Symptoms:

a. All on-off function lights will flicker.

b. All proportional readout pointers are in same relative position.

Note

- If telemetry failure is suspected, calibration will confirm the failure.
- Certain telemetry failures, particularly those isolated to a single channel, may not be detectable.

1. The mission should not necessarily be aborted. The remote pilot should rely on his memory and other aids in knowing and determining drone status. Examples:

- Altitude is provided by radar tracking.
- Heading is provided by radar tracking.
- Aircraft speed can be determined also by radar tracking.

The minimum, cruise, and maximum commandable speeds are preset and known to the remote pilot.

2. Telemetry might be restored upon closure by the airborne director at the end of the mission.

3. The ground and airborne directors might find it convenient to share the telemetered data (by voice communication) if either is not receiving normally.

4. The remote director may find doubling each command advisable in the absence of confirming telemetry data.

5. There is no reason a normal landing cannot be achieved in the absence of telemetry data.

Flameout Plus Carrier Failure.

1. Observe radar tracking and wait for possible carrier recovery.

Flameout Plus Telemetry Failure.

Symptoms:

This situation must be detected by use of radar tracking.

1. It will be necessary to rely on radar tracking to estimate descent speed. In the absence of pitch up or pitch down commands the minimum descent limit will be governed automatically by the stall prevention system.

Oil Low Pressure Warning.

Symptoms:

Telemetry indications.

1. Upon indication of oil warning the remote pilot presumes that a finite drone operating time remains. If a landing can be effected within the remaining endurance period, then it should be attempted. If not, it is advisable to retain the drone over open water. If the drone continues to operate considerably beyond the predicted endurance then a false indication may be assumed and a normal landing attempted.

Airspeed Limit Warning.

Symptoms:

Telemetry indications.

1. Speed decrease—Command.
2. Pitch up—Command if descent rate is excessive.

External Stores Jettison.

Jettisoning external stores is more likely to be a normal procedure; however, it may be a necessary operation during a flameout or thrust loss just after takeoff. If pylon jettison has been selected, the first command will jettison the pylon tanks, the second command will jettison the pylons.

1. Hold to arm—Command and hold.
2. Jettison—Command.

Range Safety.

1. Hold to arm—Command and hold.
2. Arm—Command.
3. Explode—Command.

Smoke.

1. Smoke—Command.

Engine Cutoff.

1. Idle gate—Command and hold.
2. Speed decrease—Command.

Total Hydraulic Pressure Failure.

If the aircraft does not respond to maneuvering commands, hydraulic pressure failure may be suspected and may be checked as follows:

a. Check telemetry to ascertain ARW is still in command and aircraft is not in a carrier failure sequence.

b. Command APW transfer and observe if response can be obtained.

c. Command speed brakes out or landing gear down (if below speed limit).

Steps a and b above verify carrier operation; step c verifies operation of hydraulic system No. 2. If these checks confirm total hydraulic pressure failure, proceed as follows:

1. RAT extended—Command.

If airspeed is excessive, first command speed decrease.

YAW DAMPER FAILURE IN SKID MODE.

1. Skid—OFF.
2. Navigation turn—If on circle turn.
3. Land aircraft using navigation turns to control heading.

WARNING

Do not attempt a landing with skid mode engaged with a failed yaw damper. Lateral directional oscillations in this condition can cause loss of control of the airplane during a landing.

WEIGHT ON NOSE GEAR SWITCH FAILURE ON LANDING.

If the weight on nose gear switch fails to operate on landing, neither drag chute nor hook will be available automatically. In the event this occurs (no chute or hook is observed on landing roll), command hook—Down.

SECTION IV — AUXILIARY EQUIPMENT

TABLE OF CONTENTS

	Page
Communications and Associated Electronic Equipment	4-1
Drone Stabilization and Control Equipment (DSCE)	4-3
Miss Distance Indicator Equipment	4-15
X- and L-Band Augmentation System	4-17
Destruct System	4-19
Navigation Equipment	4-20
Lighting Equipment	4-20
Auxiliary Systems Operation	4-20

COMMUNICATIONS AND ASSOCIATED ELECTRONIC EQUIPMENT. (See Figure 4-5.)

RADIO COMMAND SYSTEM AN/ARW-64.

Two AN/ARW-64 receivers make up the receiving portion of the remote radio command system in the drone. The receivers are designated No. 1 and No. 2 and each consists of a receiver, audio decoder, relay assembly, and an antenna. Receiver No. 1 is connected to the top antenna and Receiver No. 2 is connected to the bottom antenna. Antenna locations are shown in figure 4-6. A transfer and carrier fail relay transfers control of the airplane to the other receiver when the rf signal to the control receiver drops below a preset value (threshold). If the rf input to both receivers is below this value, control is transferred to the radar guidance system. The receivers operate in the range of 406 to 549 megacycles. Power is supplied to the receivers by the No. 1 dc bus through the No. 1 and No. 2 circuit breakers.

Normal Operation.

The receivers are turned on by actuating the respective No. 1 or No. 2 guidance receiver switch on the lower center guidance panel. The receiver receiving a signal above threshold will be in control. If the received signal falls below the given threshold, the other receiver will assume control. The radio selector switch in this panel is provided for ground checking and manual transfer between No. 1 and No. 2 receivers. For automatic operation the switch is left in the OFF position.

RADAR GUIDANCE SYSTEM, AN/APW-20.

The AN/APW-20 radar guidance system is an auxiliary control system capable of energizing any one of six basic control commands for remote control of the drone. These six commands are UP, DOWN, RIGHT, LEFT, INCREASE, and DECREASE. It is interconnected with the AN/ARW-64 radio guidance system through the transfer and carrier fail relay box so that in the event the dual AN/ARW-64 radio command function is lost, automatic transfer to the AN/APW-20 system will occur. The equipment consists of a dual receiver, a decoder, a control selector, a transmitter, power supplies, and three antennas. Power is normally supplied by the No. 1 dc bus and the 2500 va inverter. Emergency power is from the emergency ac bus.

Normal Operation.

The system is actuated by turning on the radar guidance switch in the lower center guidance panel. An ARW carrier failure relay provides automatic transfer of control to the radar system. Manual transfer to the radar system is accomplished by commanding ACE and then APW transfer either by metal stick or remote control. Pushbutton 9 of the remote control panel commands the manual transfer if radio control is available.

TELEMETRY SET, AN/AKT-7.

The AN/AKT-7 telemetry transmitter set monitors flight information and converts this information into proportional varying electrical signals for transmission to the companion receiver sets located at the airborne or ground remote controller stations. Power is supplied by the No. 1 dc bus through the AN/AKT-7 circuit breaker. The equipment has 12 subcarrier channels available and operates in the 215 to 235 mc band with the TM 571 basic transmitter and AN 1235 basic rf amplifier. It operates in the 235 to 260 mc band with TM 571A (Mod) transmitter and AN 1235 (Mod) rf amplifier. Proportional flight information transmitted is altitude, EGT and fuel, airspeed and Mach No., airspeed reference and Mach reference, heading, and engine rpm. Additional ON-OFF commands transmitted include ARW system in command, APW transfer, airspeed limit, scoring arming and start (PARAMI on and cameras on); range safety, oil warning, and speed control.

Normal Operation.

The AN/AKT-7 transmitter is energized when the telemeter control switch on the guidance panel is placed in the ON position. For calibration of receivers a remote command channel is available on the AN/ARW-64 equipment which, when commanded by Pushbutton 2 on the remote control panel, removes varying transducer output voltages and substitutes precision step voltages of 0, +2.5, and +5.0 volts for calibration of the receiver indicators.

CAUTION

Ground checking of AN/AKT-7 should be limited to a maximum of 15 minutes without cooling air being provided to the T-rack manifold from the refrigerator.

C-BAND BEACON, AN/DPN-50.

Transponder set AN/DPN-50 is an airborne C-band pulse-type beacon used as a tracking aid to obtain precise positional data when used in conjunction with the AN/FPS-16 radar which is used as the beacon interrogator. The DPN-50 will respond to nonsynchronous interrogations from several radars which enables it to be utilized in a chain-radar drone instrumentation system. The beacon is capable of decoding and responding to coded interrogations of 1, 2, or 3 pulses. The 500-watt peak-power output of the beacon enables it to operate at ranges up to 200 miles.

The DPN-50 system consists of a power supply, receiver-transmitter, C-band antenna, and associated cabling. The power supply and receiver-transmitter are sealed units and are ruggedly built to operate in environments of high shock, vibration, and altitude.

The receiver-transmitter receives and decodes interrogations from the AN/FPS-16 and transmits a reply pulse whenever a valid interrogation is received. The receiver-transmitter contains a preselector-duplexer to enable operation with one antenna, an IF strip, decoder, driver, modulator, local oscillator, and magnetron.

The DPN-50 power supply and receiver-transmitter components are mounted on the forward ammo compartment bulkhead. 26.5 Volts dc is supplied from the emergency dc bus in the electronics compartment J-box. A 5-amp circuit breaker and an ON-OFF switch in the cockpit are provided to turn the equipment on and off as well as to provide a safeguard in case of equipment malfunction.

The dc power is applied to a time-delay relay, mounted in close proximity to the power supply, which provides a 60-second equipment warmup period before high voltage is applied to the receiver-transmitter.

A Canoga Corporation Model No. 9904 C-band antenna is installed on the bottom centerline of the fuselage. It is connected to the receiver-transmitter coaxial cable.

GLIDESLOPE RECEIVER, AN/ARN-31.

A glideslope receiver is installed for ILS landings. Selection of proper frequencies for an indication on the horizontal cross-pointer of the course indicator is automatic and needs no further action on the part of the pilot than selection of a frequency, authorized for the place of landing, on the AN/ARN-56 frequency selector knob. The horizontal cross-pointer will indicate to the pilot whether the aircraft is above, below, or on the glidepath during an ILS approach to landing. The vertical cross-pointer will indicate whether the aircraft is to the left, right, or on course during an ILS approach to landing. The AN/ARN-56 will be used for localizer information. The marker beacon indicator light, located on the upper right corner of the course indicator, is inoperative.

UHF COMMAND RADIO AND INTERPHONE SYSTEM, AN/ARC-66.

Note

Do not operate the ARC-66 tone button with ARW-64 system in command.

Information concerning the following equipment is presented in T.O. 1F-104A-1 and is applicable in its entirety to the QF-104:

- Interphone System.
- Operation of UHF Command Radio.

- Microphone and Headset Connections.
- Microphone Switch.
- VHF Navigation Equipment, AN/ARN-56.
- AN/ARN-56 Controls.
- AN/ARN-56 Indicators.

The following equipment shown in T.O. 1F-104A-1 is not installed in the QF-104A:

- Remote Channel Frequency Indicator.
- Glideslope and Marker Beacon Receiver, AN/ARN-57.
- TACAN, AN/ARN-21C.
- ARN-21C Control Panel.
- AN/APX-35 IFF System.

DRONE STABILIZATION AND CONTROL EQUIPMENT (DSCE).

The drone stabilization and control equipment (DSCE) consists of Sperry DSCE-104 equipment. This is similar to QF-80 DSCE with modification and new equipment necessary for QF-104A operation. It is basically an automatic pilot modified to be compatible with the QF-104A stability augmentation system. It operates in conjunction with and is compatible with the elevator, aileron, rudder, and engine throttle control system of the F-104A. The DSCE, when operated with radio or radar guidance equipment, enables the aircraft to be remotely controlled in normal flight configurations. The equipment consists of flight control and air data computers; aileron, rudder, elevator and throttle servomotors; a vertical gyro; a control assembly; IAS and Mach reference units; a pitch trim indicator; a phase converter, an airspeed amplifier; a trim adapter; and a transfer and carrier relay box. The equipment is installed with shock mounts and brackets in various parts of the airframe. (See Figure 4-2.) DC power for operation is furnished by the No. 1 dc bus and constant frequency ac power is from the 2500-va inverter. Emergency dc and constant frequency ac power can be furnished by the 22 ampere-hour battery. Emergency variable frequency ac power is available from the extended ram air turbine.

DSCE Components.

See Figure 4-2 for DSCE component locations.

NORMAL FLIGHT.

Normal flight operation is not affected by the addition of drone equipment. The normal configuration of the QF-104A is with the tip tanks installed.

METAL STICK FLIGHT.

"Metal stick" is a collective term identifying devices provided the pilot for purposes of simulating received radio guidance and control commands. It is used for in-flight or preflight checkout and control of the drone DSCE system. The metal stick consists of the following:

1. The remote control panel is mounted at the top of the drone instrument panel and is similar to the MRW-5A and range director control panel with the exception of the deletion of the two-position carrier ON-OFF switch. It is similar to a C-1530/ARW panel modified for QF-104A operation.

2. The control stick grip is a standard B-8A which has been internally modified for use with the DSCE equipment. The trim switch is used in a normal manner with DSCE disengaged; however, with DSCE engaged this switch becomes the turn and pitch controller for the DSCE system. The trim function is not normally required during DSCE operation. Other existing switches on the stick grip are used for CIRCLE TURN ARM and DISARM, throttle interlock, DSCE disengage, and nosewheel steering engage. The function of the nosewheel steering engage switch is unchanged except that if it is used with DSCE engaged the nosewheel steering rate will be at a more reduced rate than is compatible with DSCE operation.

3. The throttle has been modified by the addition of a speed INCREASE-DECREASE toggle switch on the inboard face of the grip. The old sight cage switch on the top of the grip is utilized for the application of the anti-skid brakes. Retractable stop plates are fitted and positioned to provide idle and afterburner detents and stops for manned flight.

4. Six command monitor indicator lights indicate commands by illuminating during the command. The six DSCE mode monitor lights indicate the control mode in effect.

The metal stick may be used to simulate all phases of drone operation including the auxiliary functions of flaps, gear, wheel brakes, speed brakes, and scoring. However, the metal stick does not incorporate destruct capabilities.

DRONE STABILIZATION AND CONTROL EQUIPMENT - GENERAL ARRANGEMENT -

1. VERTICAL GYRO
2. "G" SWITCH
3. THROTTLE SERVO
4. YAW DAMPER
5. YAW DAMPER ACTUATOR
6. HORIZONTAL STABILIZER POWER CONTROL ASSEMBLY
7. THROTTLE LIMIT CONTROL
8. LEFT AILERON POWER CONTROL ASSEMBLY
9. DSCE CONTROL ASSEMBLY
10. DSCE FLIGHT CONTROL COMPUTER
11. TRANSFER AND CARRIER RELAY BOX
12. PHASE CONVERTER
13. AIRSPEED AMPLIFIER
14. TRIM ADAPTER
15. MACH REFERENCE UNIT
16. PITCH TRIM INDICATOR
17. AIRSPEED REFERENCE UNIT
18. RUDDER SERVO
19. ELEVATOR SERVO
20. AILERON SERVO
21. AIR DATA COMPUTER

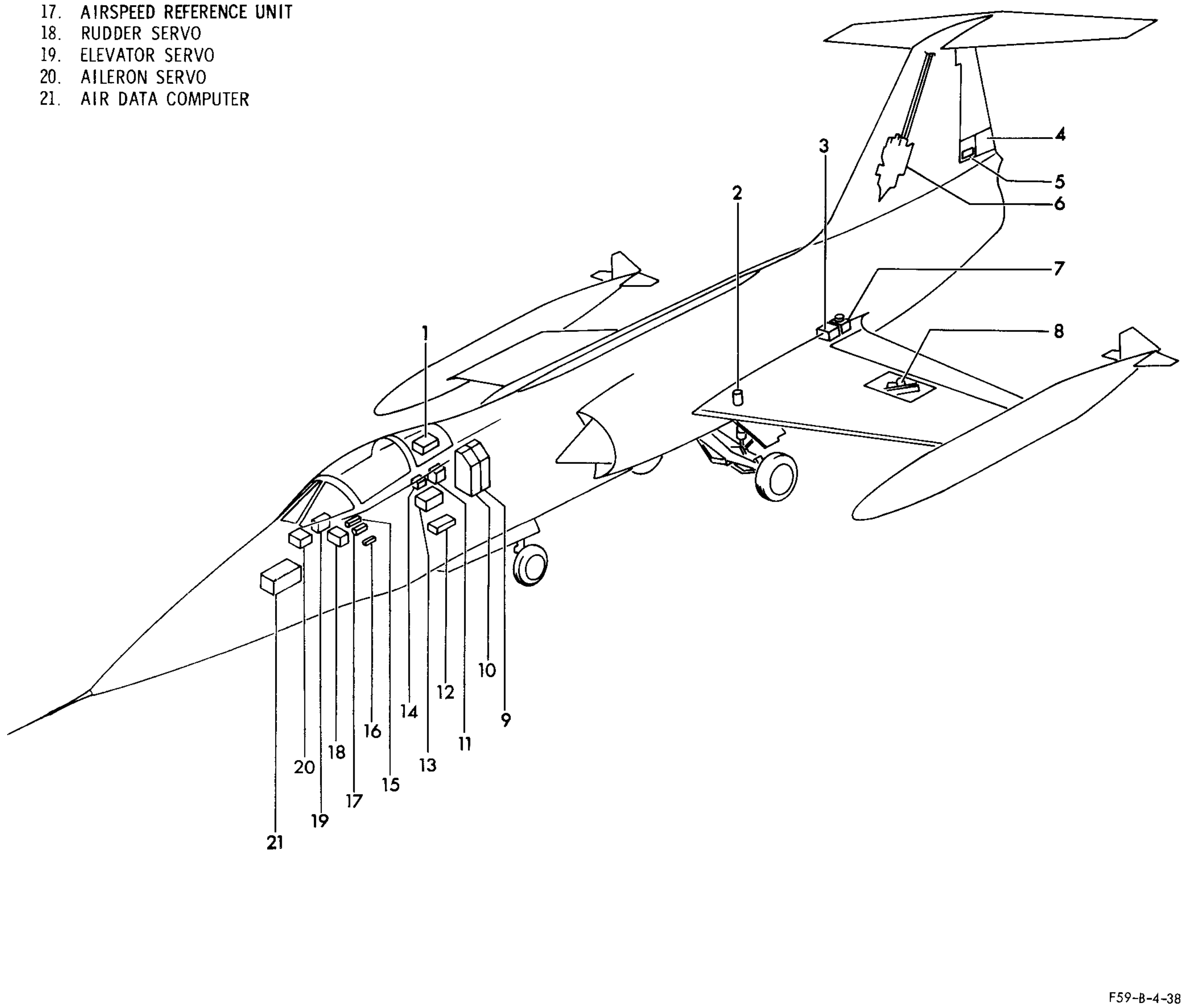


Figure 4-1

Flight techniques using the metal stick are identical with Nullo operation. The DSCE functions may be overpowered at any time by use of the normal airplane controls. Nullo switches are placed in the normal and guarded flight positions which make all normal fuses and overload protection available.

The override switches located on the drone left side console are used as necessary by the safety pilot in order to nullify undesired action. The override switch for a respective function must be turned to REMOTE before a remote or metal stick command will be received and executed by the drone.

Safety Pilot Flight.

During a complete checkout of the radio and radar guidance and control systems, a safety pilot in the drone monitors the flight. The drone is preflighted and prepared as for a Nullo flight, with the exception of the Nullo switches which are guarded in the normal flight position and the destruct charge which is not installed. During all phases, the operation is identical with Nullo flight techniques except that the safety pilot will position the override switches as necessary to lock out untimely commands and will manually position wing flap and landing gear levers prior to remote or automatic actuation.

The guidance monitor light panel is also used to monitor the operation of the radio and radar guidance systems and the range safety monitor panel is used to monitor the simulated operation of the destruct command system.

During ferry flights and other manned missions not incorporating the remote guidance system, the DSCE system may be used as an autopilot by energizing and engaging the DSCE system and turning the metal stick switch ON with the guidance radio and radar receiver switches OFF.

NULLO FLIGHT.

Nullo flight is an operational flight with no pilot aboard. The Nullo switches in the electronic compartment are positioned in the Nullo position which bypasses protective circuit breakers, fuses, relays, and switches to increase the mission accomplishment reliability. Control of the drone is by radio or radar signals from remote controllers in the terminal area, airborne directors, or radar site controllers.

Longitudinal Control.

Basic stabilization of the drone is accomplished by using the vertical gyro as reference. The aircraft pitch attitude is maintained at the engaged or commanded value by deflection of the horizontal stabilizer. Nose UP or DOWN commands are summed with the gyro reference to establish and maintain a new pitch attitude. With ACE engaged barometric pressure errors are summed with the gyro reference. With Mach-on-Pitch mode engaged, Mach errors are summed with the gyro reference. With ILS Glidepath engaged, glidepath beam errors are summed with the gyro reference. Penetration of the APC boundary, as evidenced by stick shaker or kicker operation, will cause the following reactions:

1. With gear down, flaps TAKEOFF, and airplane weight on nose gear; kicker and stick shaker will be disabled.

2. With gear down, flaps TAKEOFF, kicker will be disabled. With airplane weight off the nose gear, stick-shaker signal will:

   a. Reduce bank angle.

   b. Disable up commands.

3. With gear UP, flaps TAKEOFF, stick shaker will:

   a. Reduce bank angle.

   b. Disable up commands.

   c. Command down if in direct pitch and wings are level.

Stick kicker will:

   a. Revert system to direct pitch.

   b. Overpower stick to a position corresponding to 1 degree stabilizer forward of neutral.

   c. Command down.

If shaker signal persists after kicker release, it will continue a down command.

4. With gear up, flaps up, the operation will be the same as (2) above except that the down command rate will be at a lower rate.

DSCE CONTROLS AND INDICATORS

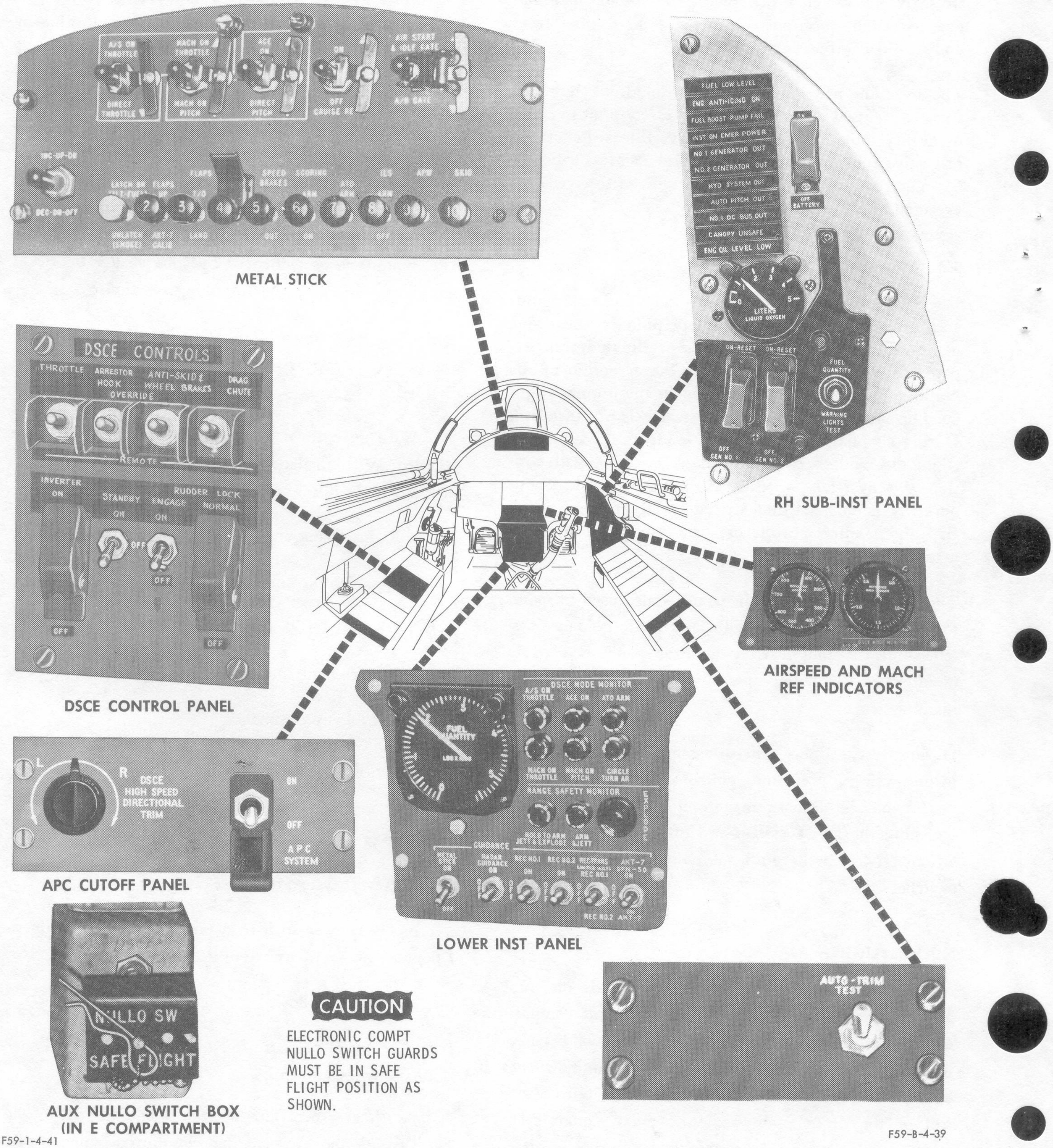


Figure 4-2

Note

- A 10-second timer is started as a shaker signal begins. Normal operation of the system continues as described above during this 10-second period. If shaker signal persists after this period, indicating a malfunction, the shaker input to the DSCE is disabled and reaction ceases. A subsequent kicker actuation will reset the timer and restore normal operation.
- For the Nullo condition the same operation will occur except that a kicker actuation in the absence of a shaker signal will release and lock out the kicker. A subsequent shaker signal will restore the system to normal operation.

Lateral Control.

Using a vertical gyro and directional gyro as basic references, the aircraft heading is maintained at the engaged value by deflection of the ailerons in the navigation-turn or circle-turn modes or by the deflection of rudder in the skid-turn mode. The heading reference is disconnected during turn commands. These commands are summed with the vertical gyro reference to introduce a bank angle in the navigation-turn and circle-turn modes. In the skid-turn mode the vertical gyro reference maintains the aircraft wings level by deflection of the ailerons while left and right turn commands deflect the rudder. With ILS localizer engaged in the navigation-turn or circle-turn modes, the heading reference is disconnected and localizer beam errors are summed with the vertical gyro to control the ailerons. In the skid-turn mode these beam errors are summed with the heading reference to control the rudder. See preceding explanation of APC operation under Longitudinal Control paragraph for APC lateral control operation. For manned DSCE flight, a means is provided for disconnecting the DSCE in response to a roll rate of 100°/sec, a bank angle of 80° (±5°), or various combinations of roll rates and displacements which are less than the above values, but which make pilot recovery within the first 90° of roll difficult. This automatic DSCE disconnect feature protects the pilot in case of aileron hardover, especially during a time when the airplane load factor is less than 1.

Thrust Control.

Using the airspeed and Mach reference units as the basic references, the aircraft speed is maintained at the engaged or commanded value by modulation of the throttle in the airspeed or Mach-on-throttle modes. In the Mach-on-pitch mode, the horizontal stabilizer is modulated. Increase or decrease commands vary the airspeed and Mach reference units when in speed modes. Variations of pitch attitude cause throttle motion in anticipation of a speed change in direct pitch. Upon automatic transfer to radar control speed increase or decrease commands are only effective in the direct throttle mode. Upon command transfer (if radio commands are also available) speed increase or decrease commands are effective also in the normal speed control modes.

DSCE CONTROLS. (See Figure 4-2.)

Inverter Control Switch. The inverter control switch is a guarded-ON switch located on the DSCE control panel on the left side-console. It turns on and off the 2500-va inverter which furnishes ac power for the DSCE equipment and the APW-20 radar. The switch controls a relay which connects the No. 1 dc bus power to the inverter. The inverter is normally ON for all flights. It is turned OFF in case of generator failure to prevent rapid depletion of the 22 ampere-hour battery during manned flight.

DSCE Standby Switch. The two-position DSCE standby switch located on the left console is turned ON after the inverter switch is turned ON and 3 minutes prior to the DSCE engage switch for warmup. When ON it applies 28 volts dc power from the No. 1 dc bus, through the DSCE engage circuit breaker in the J-box to the DSCE system power relay, which applies ac and dc power to the system. It is turned ON during all flights so that the DSCE gyro and air data computer will not be damaged by flight maneuvers.

DSCE Engage Switch. The DSCE engage switch is a two-position switch, located on the DSCE control panel on the left console. It is a single-throw, double-pole, momentary contact type switch with a solenoid-operated HOLD. To engage the DSCE, the switch is placed in the ENGAGE position. To disengage the DSCE, the switch may be operated to the OFF position. If the DSCE disengages by use of the trigger switch or automatically during metal-stick flight by exceeding acceleration or stabilizer rate limitations, the engage switch will return to the OFF position and must be re-engaged manually.

High Speed DSCE Directional Trim Control. A potentiometer placarded DSCE HIGH SPEED DIRECTIONAL TRIM is located on the left side-console. It is effective only when DSCE is engaged and speed is above 370 KIAS. It is set and marked on the first flight, and the setting should not deviate unless major components of the airplane are changed. If directional trim is not correct when DSCE is engaged and above 370 KIAS, the control should be reset and marked. If DSCE is disengaged above 370 KIAS, directional trim automatically returns to the normal trim control.

SUMMARY OF DSCE COMMANDS

COMMANDS			LOCATION OF REMOTE AND METAL STICK CONTROLS MRW-5	DT-33	QF-104
PUSHBUTTONS	1	LATCH Brakes (also fuel qty telemeter scale shift and high altitude telemeter scale verification)	MODIFIED C-1530	MODIFIED C-1530	MODIFIED C-1530
		UNLATCH Brakes (also smoke on)			
	2	Wing flaps (UP)			
		AKT-7 AND PARAMI CAL			
	3	Wing flaps (TAKE OFF/LAND)			
	4	Gear (UP-DOWN)			
	5	Speed Brakes (IN-OUT)			
	6	Scoring System (ARM-ON)			
	7	ARM ATO, HOOK DOWN			
	8	ILS (ARM-OFF)			
	9	APW (TRANSFER-OFF)			
	10	Skid Turn (ON-OFF)			
TOGGLE SWITCHES		Airspeed on Throttle			
		Direct Throttle			
		Mach on Throttle			
		Mach on Pitch			
		ACE ON			
		Direct Pitch			
		Cruise Reference (ON-OFF)			
		Air Start and Idle Gate			
		Afterburner Gate			
ARW (PRI-SEC)			MODIFIED C-1529	MODIFIED C-1529	NOT PROVIDED
Destruct (HOLD TO ARM+ARM+EXPLODE)					
Tank Jettison (HOLD TO ARM+ ARM)					
RAT Extend (ARM)					
Throttle Interlock (also FEI Event Marker)					CONTROL STICK GRIP
Pitch (UP-DOWN) Turn (RIGHT-LEFT) Circle Turn Arm (also Nosewheel Steer)			C-1531	RH GRIP	
Wheel Brakes					THROTTLE GRIP
Speed (INCREASE-DECREASE)				LH GRIP	

F59-P-4-40

Figure 4-3

2 Tanks and 4 Tanks Switch. The locking-type 2 tanks and 4 tanks switch is located in the nose cone on the right side of the pressurized electronic can. It is reached by unlocking and rolling the nose radome forward on its tracks. It has two positions, 2 TANKS and 4 TANKS. The switch sets the DSCE climb reference speed at 160 KIAS for 2 external fuel tanks and 170 KIAS for 4 external fuel tanks.

Tanks. The switch sets the DSCE climb reference speed at 160 KIAS for 2 external fuel tanks and 170 KIAS for 4 external fuel tanks.

Remote Control Panel. (See Figure 4-4.)

The modified C-1530 remote control panel is mounted on the top of the instrument panel. The panel permits selection of throttle and pitch control modes and operation of auxiliary systems. It is similar to the control panels in the director aircraft and ground director MRW-5. The controls on the panel consist of five double-throw momentary contact toggle switches with visual last position indicators and 10 pushbutton-type switches, numbered 1 to 10, and an INC-UP-ON DEC-DN-OFF momentary contact toggle switch. The pushbuttons latch down when depressed and only one switch will latch at a time. Each switch controls functions which are labeled above and below. Pressing a pushbutton arms those two functions and the INC-UP-ON DEC-DN-OFF toggle switch commands the function when actuated in the direction of the desired labeled command.

Toggle Switch Placarded A/S On Throttle and Direct Throttle. In the airspeed-on-throttle mode a speed increase-decrease command varies the airspeed reference. The throttle modulates to maintain the aircraft actual airspeed equal to the reference airspeed. The Mach reference unit is in the followup mode during airspeed-on-throttle.

In the direct throttle mode a speed increase-decrease command will vary the throttle position directly. The throttle does not modulate automatically. In this mode airspeed and Mach reference units are in the followup mode and repeat actual values.

Toggle Switch Placarded MACH-ON-THROTTLE and MACH-ON-PITCH. In Mach-on-throttle mode a speed increase-decrease command will vary the Mach reference unit. The throttle modulates to maintain aircraft actual Mach number equal to the reference Mach number. The airspeed reference unit is in the followup mode during Mach-on-throttle operation.

In the Mach-on-pitch mode a speed increase-decrease command will vary the Mach reference. Pitch attitude is controlled automatically to maintain aircraft actual Mach number equal to the reference Mach number. The airspeed reference unit is in the followup mode during Mach-on-pitch operation. If speed increase-decrease commands are accompanied by a throttle interlock command (first detent on control stick trigger switch) it will vary the throttle position directly; Mach reference will not move. Throttle does not modulate automatically in the Mach-on-pitch mode.

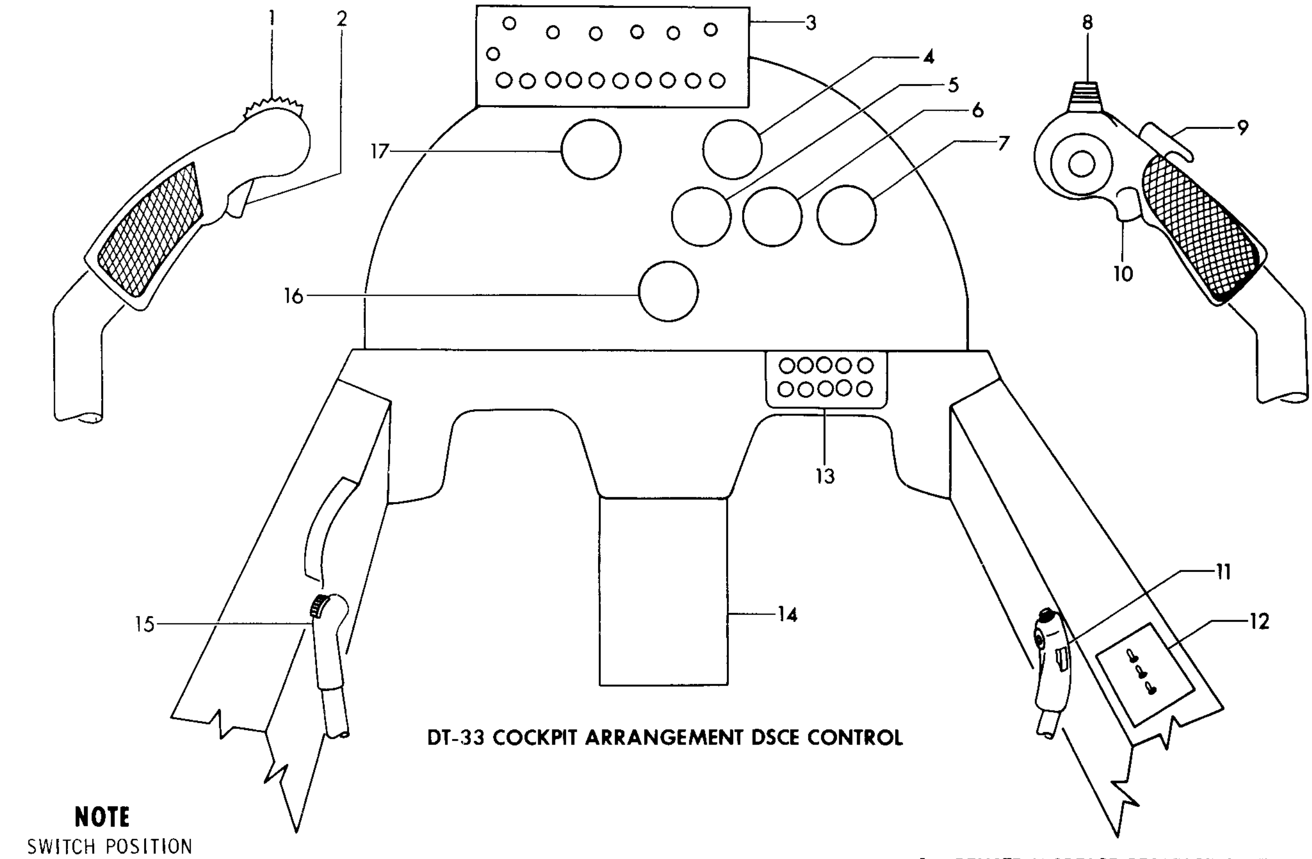
Toggle Switch Placarded ACE ON and DIRECT PITCH. In the ACE (altitude control equipment) mode, aircraft pitch attitude is controlled to maintain the aircraft at the barometric altitude existing at the time of ACE engagement.

Toggle Switch Placarded CRUISE REF., ON, and OFF. ON refers to direct pitch. In this mode up and down commands vary the pitch attitude. A cruise reference ON command automatically slaves the airspeed or Mach reference unit to a preset value of airspeed or Mach number. In the airspeed-on-throttle mode the airspeed reference is affected. In the Mach-on-throttle or Mach-on-pitch modes the Mach reference is affected. The throttle is automatically modulated to acquire and maintain the cruise reference value in airspeed or Mach-on-throttle modes; the pitch attitude is automatically varied to acquire and maintain the cruise reference value in the Mach-on-pitch modes. Speed increase-decrease commands are ineffective with cruise reference ON. Cruise reference commands are ineffective in the direct-throttle mode.

Toggle Switch Placarded AIR START & IDLE GATE and A/B GATE. The air start and idle gate switch is guarded and the guard must be lifted to actuate the switch. In this position a dual-purpose command provides initiation of ignition and ignition timing and permits throttle retardation to cutoff, a step which may be necessary in effecting an air start.

An afterburner gate command permits throttle transition either into or out of the afterburner region. Interlocking is provided to permit throttle to advance above minimum sector only after light-off has occurred.

DT-33 AND MRW-5 CONTROL PANEL ARRANGEMENTS

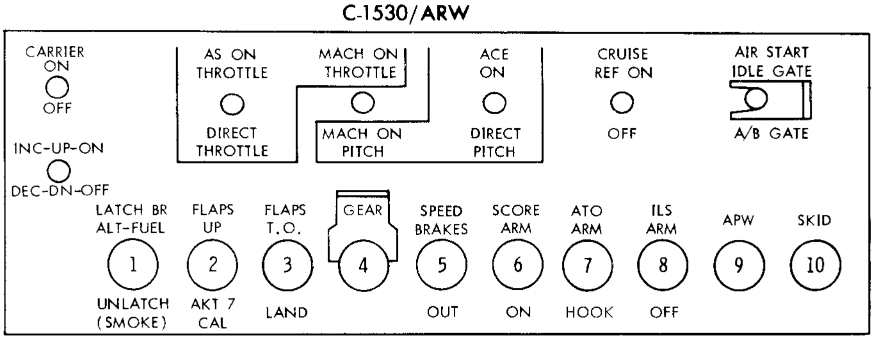


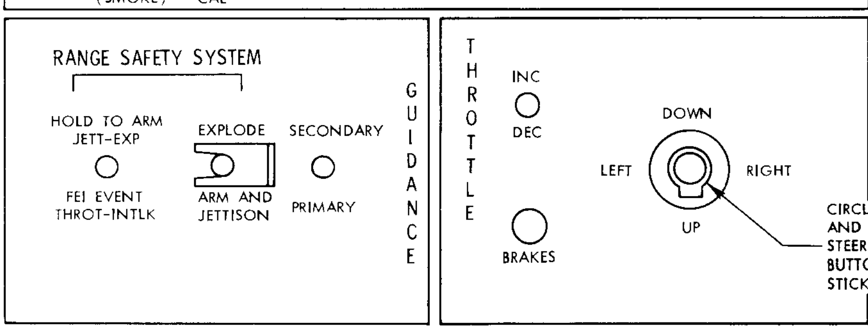
DT-33 COCKPIT ARRANGEMENT DSCE CONTROL

NOTE
SWITCH POSITION INDICATORS NOT SHOWN.

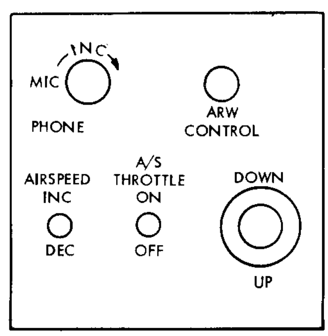
1. REMOTE INCREASE-DECREASE CONTROL
2. MICROPHONE
3. REMOTE CONTROL PANEL (MODIFIED C-1530)
4. TELEMETRY, EGT/FUEL
5. TELEMETRY, ACTUAL IAS/MACH
6. TELEMETRY, REFERENCE IAS/MACH
7. TELEMETRY, HEADING
8. REMOTE HEADING AND PITCH CONTROL
9. CIRCLE TURN ARM
10. REMOTE WHEEL BRAKES
11. RH GRIP
12. RANGE SAFETY PANEL (MODIFIED C-1529)
13. TELEMETRY, OFF-ON INDICATORS
14. TELEMETRY, CALIBRATION
15. LH GRIP
16. TELEMETRY, ALTITUDE
17. TELEMETRY, RPM/AB

C-1530/ARW





C-1529/ARW MRW5 REMOTE CONTROL PANEL C-1531/ARW



MRW5 ELEVATOR CONTROL PANEL

F59-P-4-42

Figure 4-4

WARNING

Do not make a manned in-flight check of the idle gate while holding a decrease throttle command. The accumulation of play in the throttle linkage and the throttle servo could result in a flameout even though the removable stop plate is in place.

Note

All pushbuttons are circuit arming and the INC-UP-ON, DEC-DN-OFF toggle switch must be operated in the correct direction to initiate the command.

Pushbutton No. 1. (Placarded LATCH BR (ALT-FUEL) and UNLATCH (SMOKE).) The latch brakes command, simultaneously with the remote brake command, will cause the brakes to remain ON upon release of the command. This command also transfers the telemetering indication from EGT to fuel quantity and the altitude scale from low to high range.

The unlatch brakes command will release the brakes from the latched position. A sustained SMOKE command operates the smoke generator cycle timer if weight of the aircraft is off the landing gear. Smoke emission is periodic with a sustained command.

Pushbutton No. 2. (Placarded FLAPS UP and AKT-7 CALIB.) The wing flaps up command activates the wing flaps to the UP position provided the wing flap lever has previously been placed in the UP position.

The AKT-7 and PARAMI command gives telemetering calibration output for adjustment of the ground or airborne telemetering receiver system. This command also activates the calibrator of the target transponder to simulate a missile transponder at zero distance.

Pushbutton No. 3. (Placarded FLAPS T/O and LAND.) The flaps T/O command activates the wing flaps to the TAKE OFF position provided the wing flap lever has previously been put in the TAKE OFF position.

The flaps land command activates the wing flaps to the LAND position provided the wing flap lever has been previously put in the LAND position.

Note

During Nullo flight the wing flap lever is positioned to the TAKEOFF position.

Pushbutton No. 4. (Placarded GEAR.) Pushbutton No. 4 has a guard which must be lifted before the pushbutton can be actuated.

The gear-up command raises the landing gear provided the landing gear lever has been positioned in the UP position and weight is off the gear.

Note

During Nullo flight the landing gear lever is positioned in the DOWN position.

The gear-down command puts the landing gear down provided the landing gear lever has been previously placed in the DOWN position.

Pushbutton No. 5. (Placarded SPEED BRAKES and OUT.) Speed brakes are remotely controllable when the pilot's speed brake control switch (mounted on the throttle grip) is in the center position. The safety pilot may override remotely generated commands by manually selecting the speed brake position desired, or he may control the speed brakes by metal-stick commands.

Pushbutton No. 6. (Placarded SCORING, ARM and START.) The arm command activates the PARAMI system. The ON command applies power and starts the cameras.

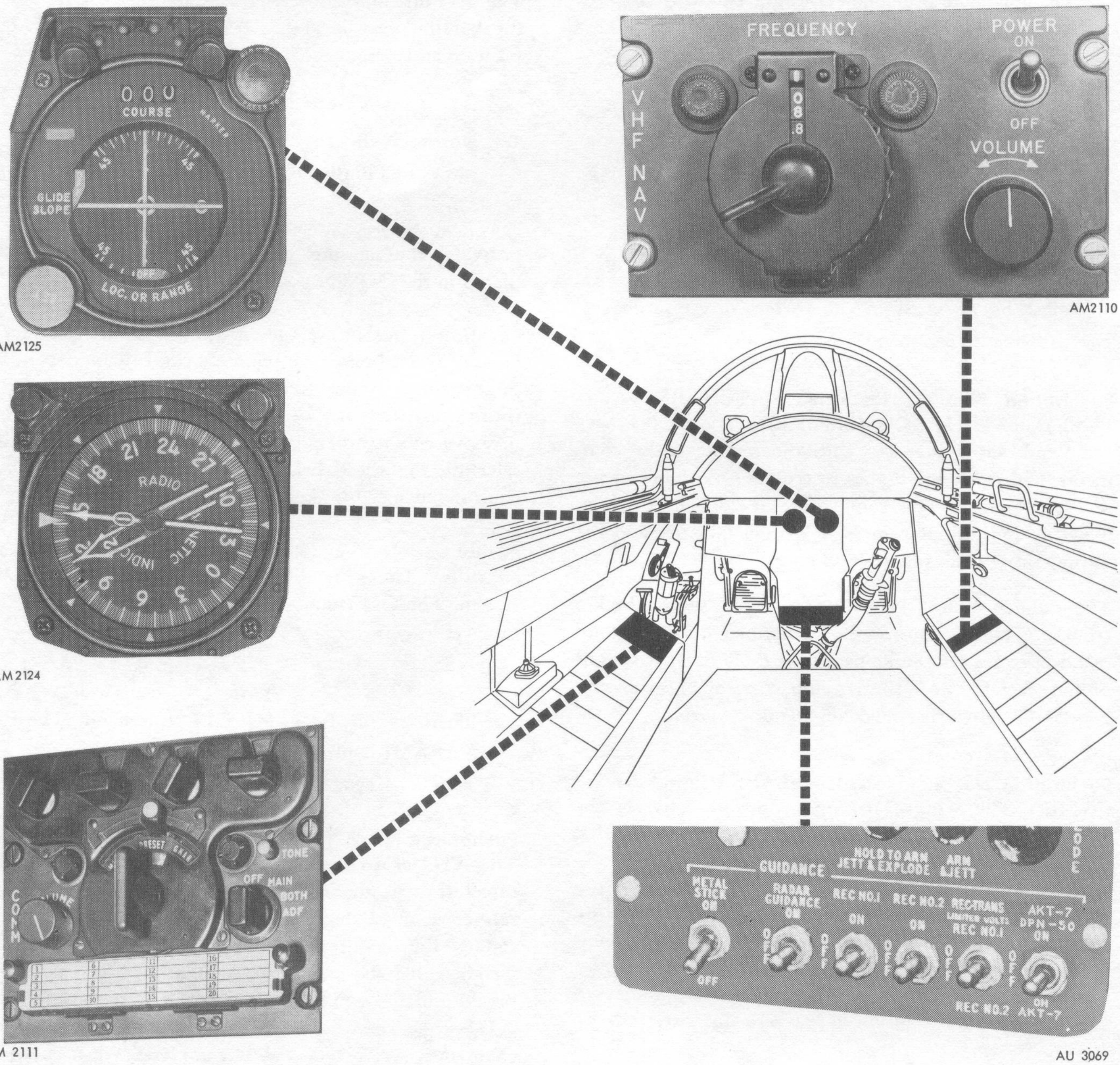
Note

There is no PARAMI OFF command. The PARAMI is turned off when the ILS-arm command is given.

Pushbutton No. 7. (Placarded ATO ARM and HOOK.) The ATO arm command establishes the throttle in the direct throttle mode. It will establish a climb attitude reference of 14 degrees at 160 or 170 KIAS, and will retract the landing gear at 227.5 KIAS when the weight is off the main gear. Skid turn on ILS arm, and breaks unlatch commands are required separately. The ATO sequence will be broken any time an up or down command is received, and is completed when the gear comes up and locks. When HOOK is commanded, the arrestor hook will be extended, regardless of the location of drone if hook override switch is in REMOTE. This command bypasses the weight on nose gear switch to allow deployment of the hook if the nose gear switch fails to close.

Pushbutton No. 8. (Placarded ILS ARM, and OFF.) After the ILS arm command the localizer will engage when the effective beam error is reduced to a value corresponding to approximately 2.5 degrees (left or right) from the beam center. A standoff localizer error

TABLE OF COMMUNICATIONS AND ASSOCIATED ELECTRONIC EQUIPMENT



TYPE	DESIGNATION	FUNCTION	RANGE	CONTROL LOCATION
UHF COMMAND	AN/ARC-66	TWO-WAY COMMUNICATION AND INTERPHONE	LINE OF SIGHT PILOT TO GROUND	LEFT CONSOLE RIGHT CONSOLE
VHF NAVIGATION	AN/ARN-56 AN/ARN-31	VOR NAVIGATION AND LOCALIZER VOICE RECEPTION GLIDE SLOPE	LINE OF SIGHT	RIGHT CONSOLE AND INSTRUMENT PANEL
GUIDANCE RADAR GUIDANCE TELEMETRY	AN/ARW-64 AN/APW-20A AN/AKT-7	NO. 1 & NO. 2 GUIDANCE RECEIVER RADAR GUIDANCE TELEMETRY	LINE OF SIGHT	CENTER PANEL

F59-B-4-43

Figure 4-5

will develop if wings are not level at time of ILS engage. A left or right turn command will disengage the localizer except during skid-turn operation. After the localizer engages, the glidepath will engage when the effective glidepath beam error is reduced to a value corresponding to approximately 0.05 degree below beam center. ACE automatically disengages at this point. Subsequent glidepath beam errors are summed with the vertical gyro reference to maintain the aircraft on the glidepath. UP or DOWN commands will disengage glidepath. To re-engage, ILS must be disarmed and re-engaged.

The OFF command turns off the ILS system and also must be commanded before the PARAMI scoring command will be effective.

Pushbutton No. 9. (Placarded APW.) The APW command must be preceded by an ACE command to be effective. After transfer, ACE may be disengaged to permit Mach-on-pitch operation. Left or right commands are effective in the navigation-turn mode only. Up-down commands are also available but are limited to $\pm 6°$ of pitch attitude. Increase and decrease commands are effective in the speed mode in effect at the time of transfer.

OFF. Commands the APW control off.

Pushbutton No. 10. (Placarded SKID.) After the skid command, which is effective only if the landing gear is extended, left and right turn commands disconnect the heading reference and deflect the rudder. Upon termination of the turn command the new heading reference is engaged and the rudder automatically maintains the new heading. Wings are maintained level in skid mode.

OFF. This command turns the skid mode off.

Control Stick Controls.

(See Figure 1-15.)

Turn and Pitch Control Switch. The turn and pitch control switch is a four-position thumb switch on top of the control stick. It is used for elevator and aileron trim when DSCE is not engaged and the selector switch on the left console is in the STICK TRIM position. With DSCE engaged and metal stick switch on, this switch is used for right and left and nose up and down commands.

Circle Turn Arm Switch. The circle turn Arm switch is a pushbutton type switch on the control stick grip which arms the circle turn function. When the switch is pushed, circle turn is armed. When left or right command is given the aircraft will turn and continue turning at the bank rate and angle reached at conclusion of command. The circle turn arm light will illuminate and the aircraft will remain in a circle turn until the opposite command is given or until the pushbutton is depressed again. Depressing the button a second time will return the aircraft to the navigation-turn mode. In the navigation-turn mode, the aircraft turns only while the command is held and returns to straight-and-level when turn command is released.

Trigger Switch. The trigger switch on the front of the control stick is a two-detent, spring-loaded switch. When depressed to the first detent it permits the throttle to be moved by increase-decrease commands as required during Mach-on-pitch operation. When depressed to the second detent it disengages the DSCE.

Manual Nosewheel Steering Button. The manual nosewheel steering button on the lower front side of the control stick has the same function as in the F-104A. When depressed, and the weight of the airplane is on the landing gear, steering is engaged.

Note

During DSCE operation, the normal nosewheel steering button may be used but will give low rate nosewheel travel of approximately 1.5° a second.

Manual External Stores Jettison Switch. The manual external stores jettison switch jettisons the tip or pylon tanks as selected by the external stores jettison selector switch on the left console. The second jettison command will jettison pylons if the selector is at PYLON position.

Throttle Handle Controls.

(See Figure 1-3.)

Speed Brake Switch. The speed brake switch, located on the top of the throttle, is a three-position switch. The neutral center position is also the remote control position for the control of the speed brakes with DSCE engaged.

Anti-Skid Brakes Switch (Old Sight Cage Switch). The anti-skid brakes pushbutton switch actuates the anti-skid brakes provided the override switch on the left console is in the REMOTE position. The anti-skid brakes may be used at any time. When the switch is pressed the brakes are full on. If a skid on either wheel develops, the brakes automatically release.

ANTENNA AND CAMERA LOCATION DIAGRAM

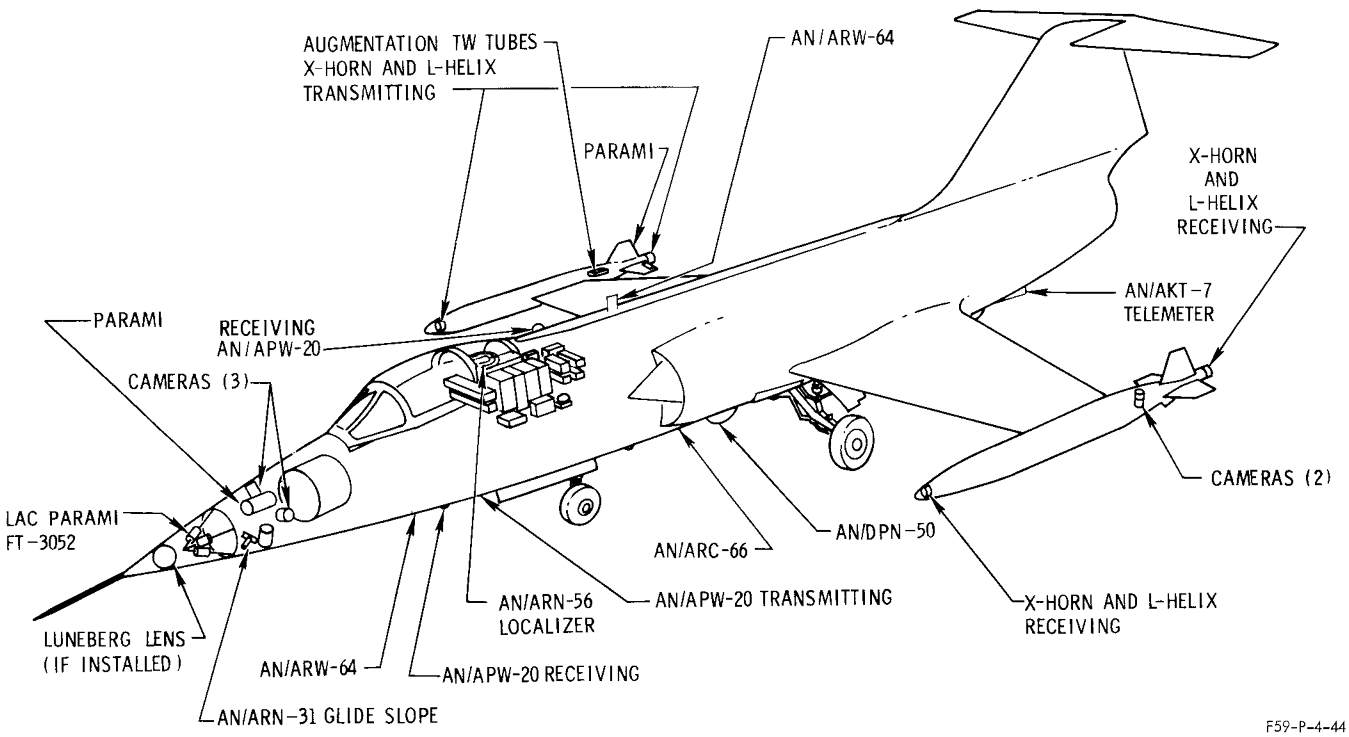


Figure 4-6

CAUTION

Do not use both normal and anti-skid brakes simultaneously. If normal brakes are used, release completely before anti-skid brakes are applied or the normal brake fluid will be returned to the No. 2 hydraulic system, and may thus deplete the normal brake supply.

Speed Inc.-Dec. Switch. The speed increase-decrease switch on the side of the throttle is used when on metal stick to increase or decrease throttle position in direct-throttle mode. In the airspeed or Mach-on-throttle modes, this switch varies the airspeed or Mach references and the throttle will modulate to maintain the reference. In Mach-on-pitch mode this switch will vary the Mach reference and the pitch attitude will change to maintain the reference speed. Increase-decrease commands in the Mach-on-pitch mode, accompanied by throttle interlock (trigger switch to first detent), will position the throttle directly with no change in Mach reference indication.

A summary of DSCE commands is shown in Figure 4-3.

Override Switches. (See Figure 4-2.)

Rudder Lock Switch. The guarded rudder lock switch located on the override console is a two-position switch. In the guarded NORMAL position the rudder is locked except when the landing gear is down. In the unguarded UNLOCKED position the rudder is unlocked at all times. When the rudder is locked, the rudder pedals are immovable. If the rudder is not centered, and gear is UP, hydraulic pressure will return the rudder to the center locked position when the switch is moved to the LOCKED position.

Throttle Override Switch. The two-position throttle override switch is located on the override panel. In the OVERRIDE position the throttle servo is de-activated and the throttle must be controlled manually. In the REMOTE position the throttle will follow REMOTE commands but may be overpowered manually by the pilot if necessary.

Note

For Nullo flight, the retractable throttle stops must be open for the throttle to have full remote cutoff and afterburner travel.

Anti-Skid Brakes Override Switch. The anti-skid brakes override switch is located on the override panel. In the OVERRIDE position the anti-skid brakes are not operative. In the REMOTE position the anti-skid brakes are operative either remotely or by the pilot.

Arrester Hook Override Switch (If Installed). The two-position arrester hook override switch is located on the override panel. The OVERRIDE position prevents the arrester hook from being extended with the drag chute after the application of brakes on command. In the REMOTE position the hook will extend when the drag chute deploys after the first application of brakes ON command if the nosewheel is on the ground. The arrestor hook may be extended any time by means of the arresting hook release button.

Drag Chute Override Switch. The two-position drag chute override switch on the override panel (when in the REMOTE position) will allow deployment of the drag chute on the first application of brakes on command if the nosewheel is on the ground. In the OVERRIDE position the drag chute will not deploy automatically.

DSCE INDICATORS.

Pitch Trim Indicator. The pitch trim indicator is located on the left side of the instrument panel. It indicates autopilot synchronization in the pitch axis, when DSCE is engaged, and stabilizer servo effort after engagement. A sustained out-of-trim indication in flight indicates improper operation of the automatic trim system. A pitch transient can be expected to occur if the DSCE is disengaged in this condition. Therefore, the system should be carefully disengaged while restraining the stick manually. The DSCE should not be engaged in flight unless the trim indicator is centered. Automatic trim is normally operative only while airborne; it is de-activated if weight of aircraft is on gear (however, the indicator continues to operate). The trim indicator should be centered before DSCE is engaged. The system should not be engaged while airborne if the trim indicator is not centered.

IAS Reference Indicator. The IAS reference instrument, located on the left side of the lower instrument panel, indicates commanded (reference) speed in the airspeed-on-throttle mode. In the direct-throttle mode and all Mach modes, the indicator is in the followup mode and displays actual IAS. This information is telemetered to the airborne and ground director where it is read out on a dual-scale instrument that also indicates reference Mach number.

Mach Reference Indicator. The Mach reference instrument, located on the right side of the lower instrument panel, indicates commanded (reference) Mach number in the Mach-on-throttle or Mach-on-pitch modes. The information is also telemetered to the airborne and ground director where it is read out on the IAS-Mach dual-scale instrument.

DSCE Mode Monitor Light Panel. The DSCE mode monitor light panel, located on the right side of the lower instrument panel, contains six green lights which indicate to the safety pilot the engaged mode of DSCE operation. When the light is on it indicates that the indicated mode of operation is in effect. The lights indicate the following conditions:

AIRSPEED ON THROTTLE	ACE ON
ATO ARM	MACH ON THROTTLE
MACH ON PITCH	CIRCLE TURN ARM

Command Monitor Light Panels. The command monitor light panels are located on the left side of the instrument panel. One panel contains four green lights, labeled UP, DOWN, LEFT, and RIGHT. Each light, when illuminated, indicates generation of that command either remotely or by metal-stick controls. Two green lights located on the lower left edge of the instrument panel are labeled INC. DEC. and when lighted indicate a speed increase or decrease command has been initiated.

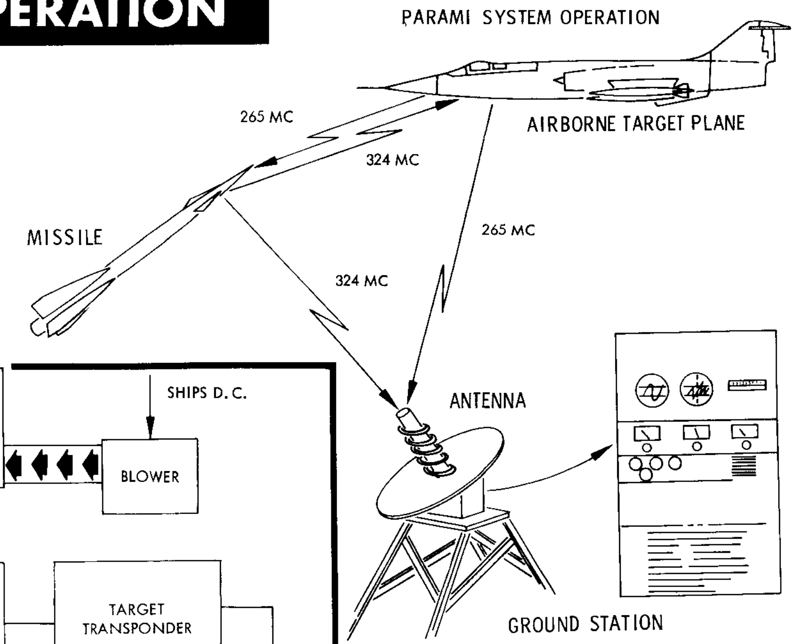
DSCE-OFF Indicator Light. An amber light is located on the upper right instrument panel and when illuminated indicates that the DSCE system is not engaged. The light is powered by the No. 1 dc bus and is effective any time the DSCE circuit breaker in the electronic compartment junction box is closed.

MISS DISTANCE INDICATOR EQUIPMENT.

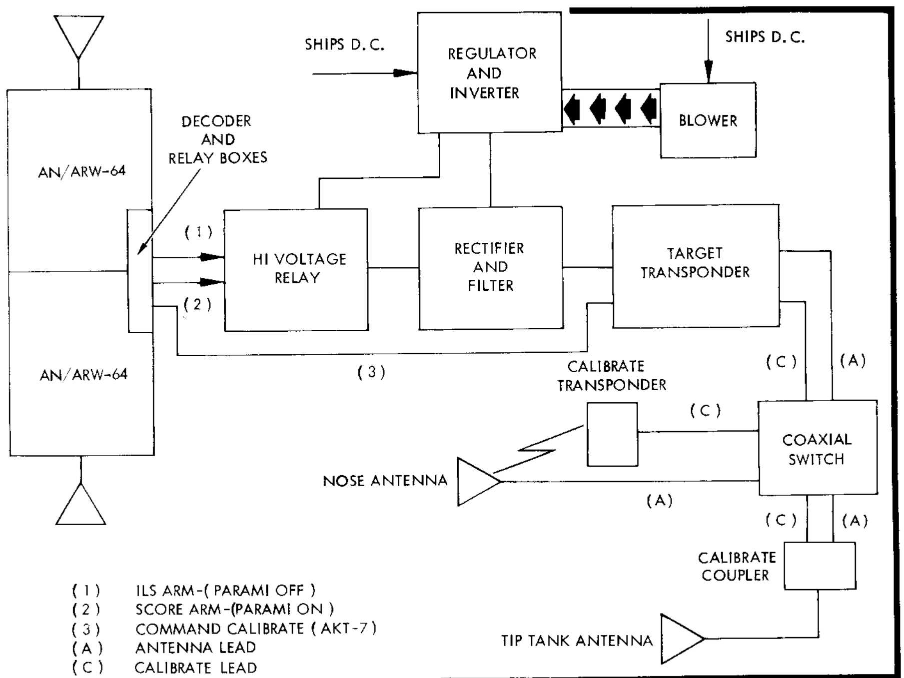
PARAMI SYSTEM (Parsons Active Ring Around Miss Indicator System) (See Figure 4-7.)

The complete PARAMI system consists basically of the QF-104 drone target subsystem, a missile subsystem (airborne), and a recording ground station (with their associated antennas and power sources). The airborne system forms a space-coupled, oscillating loop (ring-around) between the target transponder and the missile transponder. Two carrier frequencies in the UHF region are employed as the coupling link between the two airborne transponders.

PARAMI SYSTEM OPERATION



PARAMI SYSTEM BLOCK DIAGRAM



(1) ILS ARM-(PARAMI OFF)
(2) SCORE ARM-(PARAMI ON)
(3) COMMAND CALIBRATE (AKT-7)
(A) ANTENNA LEAD
(C) CALIBRATE LEAD

PARAMI SYSTEM SHIPS WIRING SCHEMATIC

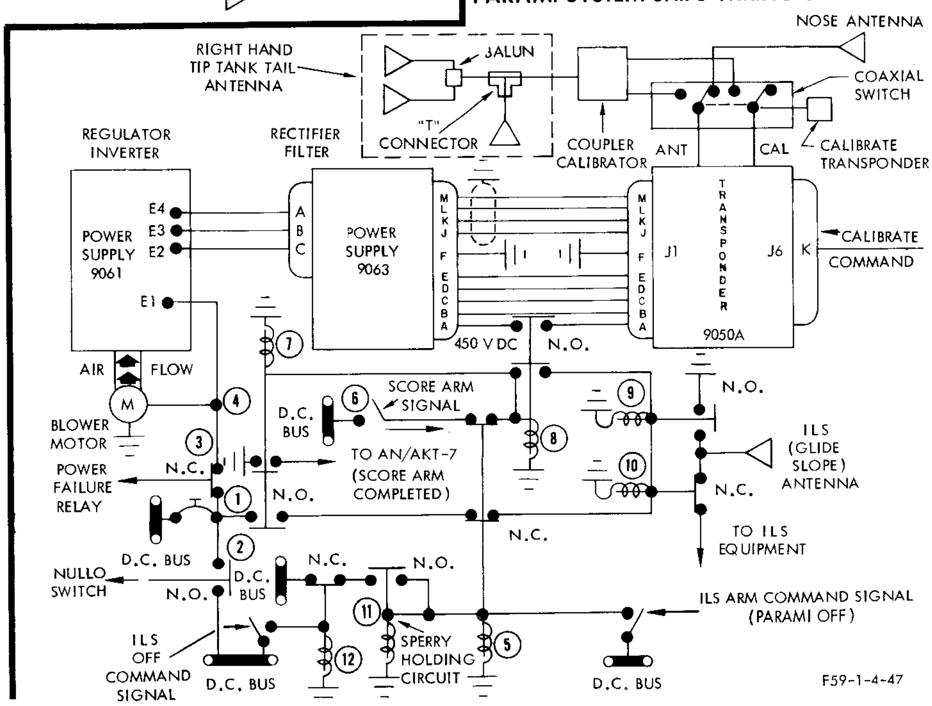


Figure 4-7

Prior to the launching of a missile, or before the missile enters the sphere of influence of the QF-104 drone target system, the output of the target transponder is of a random pulse nature. This output is due only to the fact that the target transponder is operaing in a maximum gain condition with no automatic gain control and is amplifying and transmitting any random noise present.

Once the missile approaches close enough to the QF-104 target for the missile transponder to receive one of these random output pulses, this pulse is amplified and transmitted by the missile transponder on a second UHF carrier frequency. The QF-104 target system receives this pulse, amplifies, delays, and again transmits it on the first UHF carrier frequency. At this time, the two units, drone target and missile, become locked together in a continuing electronic oscillating loop, and "ring around" will commence. The "ring-around" condition is intercepted by the ground station and the "miss-distance" is read from the permanent record at the ground station. The delay between receipt of signals established the "miss-distance."

The time of transmission of each pulse around the complete loop is dependent upon the distance separation between the QF-104 target drone and the missile, and between the internal system delay. As the distance between target drone and missile is reduced, the time of transmission of each pulse around the loop, or ring-around period, decreases. The shortest period at which the system can oscillate (zero distance) is controlled mainly by the fixed delay set into the target transponder. The value of this delay is 20 microseconds which limits the maximum oscillating frequency to 50,000 pulses per second.

Touch-and-Go Indicator Light. A black light with an amber center is located on the left side of the center windshield frame and illuminates when the aircraft is ready for a DSCE touch-and-go takeoff. When illuminated, it indicates that the weight of the airplane is on the landing gear, the stabilizer trim setting is at takeoff (also indicated by the illuminated stabilizer takeoff trim indicator light), and that the control stick is centered.

RADAR CONTROL.

Upon automatic transfer to APW control, ACE and airspeed-on-throttle is engaged automatically. Subsequent APW up or down commands automatically disconnect ACE and sum with the vertical gyro reference to establish a predetermined climb or descent reference attitude. Upon termination of the up or down command, ACE re-engages automatically and the aircraft levels off to maintain the acquired altitude.

Upon command transfer to radar control (where radio commands are also available), ACE must be engaged to effect the command transfer. After transfer, ACE may be disengaged to permit Mach-on-pitch operation. APW increase-decrease commands operate on the speed mode in effect in a normal manner. Left-right commands are in navigation-turn mode only.

In order to determine the space delay accurately, the equipment delay must be known to a high order of accuracy. Under extended airborne conditions, temperature variations may cause the target transponder delay to change; therefore, a method is provided to ascertain and correct, in the ground station, any change in the delay of target transponder. This is done by the use of a calibrate transponder, installed near the target transponder nose antenna, or a coupler-calibrator installed directly in the line to the tip-tank antenna. Calibration is initiated by the transmission of an "AN/AKT-7 Calibrate" command signal from the ground-based AN/ARW-65. Thus, it is possible to assure system accuracy just prior to intercept.

CAMERA SCORING SYSTEM. (See Figure 4-7.)

The camera scoring system as installed in the QF-104A provides permanent, visual records of missile evaluation missions. The system consists of five Traid Model 560 E Cameras mounted three in the nose radome and two in the rear of the left tip tank to provide almost spherical coverage. The camera system consists of a Traid Model 560 camera, a Traid Model 730A Periphoto Lens with a viewing angle of 165°, and a Traid No. 632 Timing System.

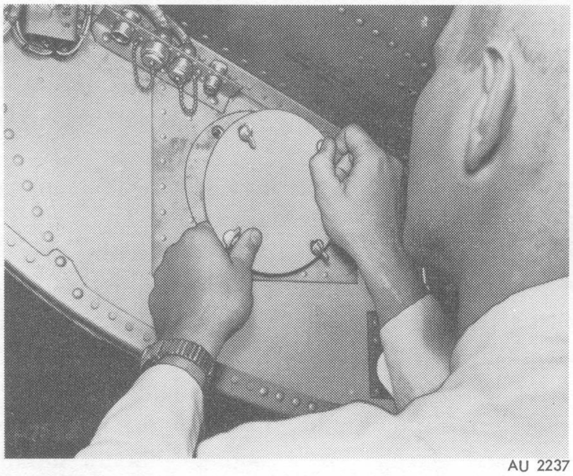
Scoring arm and ON commands turn on PARAMI and start cameras, respectively. An FEI event marker command is also provided.

X- AND L-BAND AUGMENTATION SYSTEM.

(See Figure 4-7.)

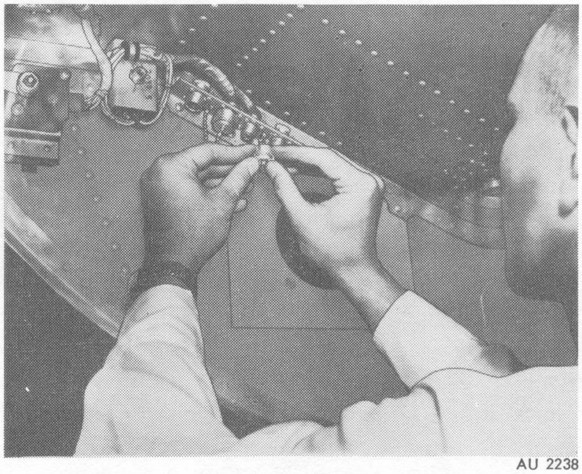
X- and L-band traveling wave tube (TWT) amplifiers are installed to provide X- and L-band radar augmentation capabilities. The system provides an effective radar cross-section of a minimum of 10 square yards and is capable of being adjusted to provide simulated signal return characteristics of small, medium or large aircraft as desired, provided appropriate attenuators are placed in the system. The system may be switched prior to flight to provide either forward or rearward coverage,

INSTALLATION OF DESTRUCTOR PACKAGE



AU 2237

❶ REMOVAL OF COVER PLATE

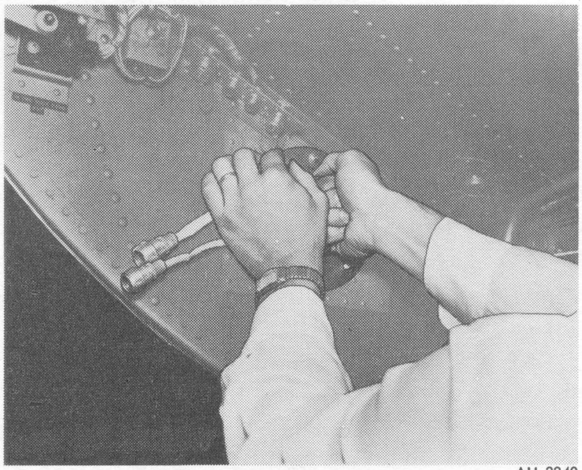


AU 2238

❷ TRANSFER OF DUST CAPS

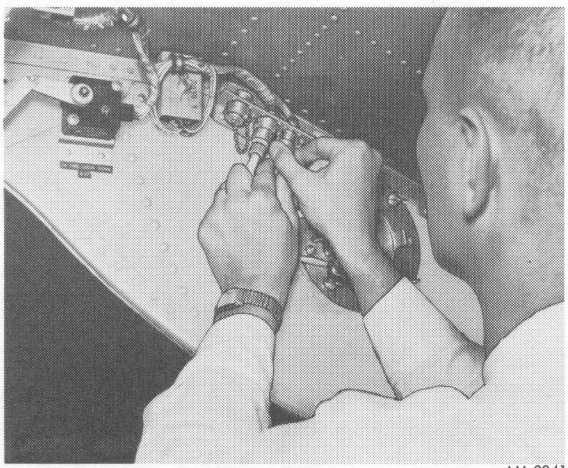
AU 2239

❸ INSERTION OF DESTRUCTOR PACKAGE



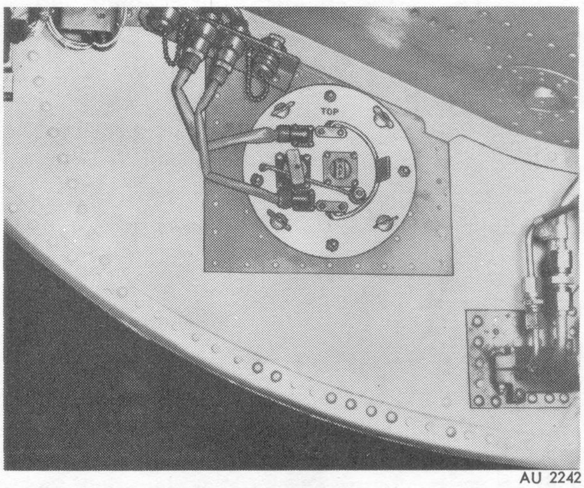
AU 2240

❹ SECURING OF PACKAGE



AU 2241

❺ CONNECTION OF PLUG



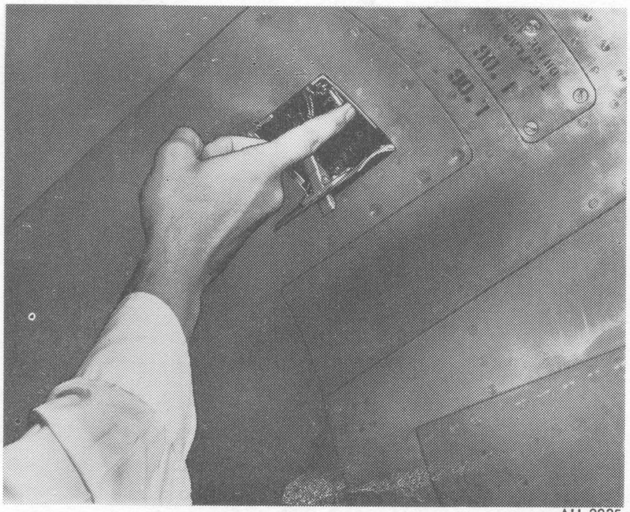
AU 2242

❻ INSTALLATION COMPLETE

F59-0-4-37 (2)

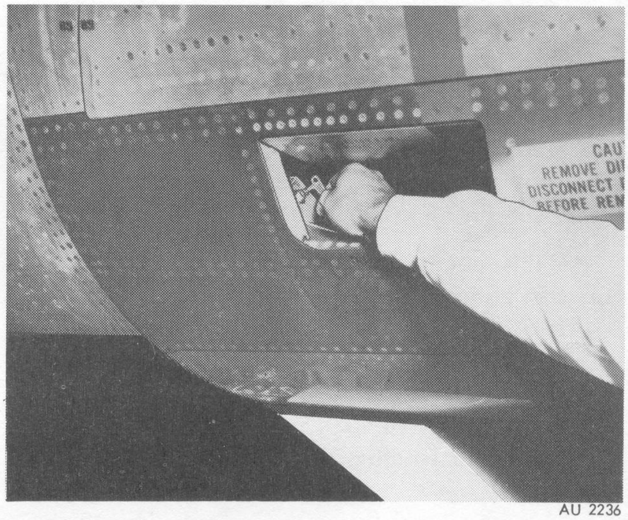
Figure 4-8 (Sheet 1 of 2)

POST-INSTALLATION PROCEDURE



AU 2235

CLOSING OF DESTRUCTOR INSTALLATION HYDRAULIC RELEASE SWITCH. (LANDING GEAR DOOR RELEASE SWITCH)



AU 2236

ACTUATION OF KEY SWITCH

Figure 4-8 (Sheet 2 of 2)

as required. Components of the system are located in the tip tanks. The two power supplies and traveling wave tubes are located within the aft section of the right tip tank. Transmitting antennas are in the nose and tail of the right tip tank. Receiving antennas are located in the nose and tail of the left tip tank. AC 115-volt power for the equipment is received from the emergency ac bus through the augmentation circuit breakers located in the ac load center. Coaxial switches in the rear of the tip tanks are set for forward or rearward coverage requirements prior to flight. The equipment is turned on prior to flight by the circuit breakers and remains on during the flight. No pilot controls are provided.

LUNEBERG LENS (If Installed).

A 12-inch Luneberg lens is installed in the nose cone to supplement or replace the X-band augmentation for forward radar augmentation.

DESTRUCT SYSTEM.

The destruct system (Figure 4-8) is actuated by remote command through the guidance control system and range safety interlock circuitry in the DSCE 104 equipment. The destruct package is inserted into the airplane prior to a Nullo flight.

The procedure for installation is as follows:

CAUTION

Prior to step 1, the fire-fighting access door should be checked to ensure the key switch is in the OFF position.

1. Open the small access door, in the left-hand wing fillet, labeled DESTRUCTOR INSTALLATION HYDRAULIC RELEASE SWITCH, and actuate to its OFF position.

2. Leave access door open.

3. Stoop and pull down main landing gear forward door.

4. Insert flagged landing gear door stop assembly and remove cover plate from bulkhead destructor package chamber (1, Figure 4-8).

5. Remove dust caps from the live receptacles in the middle of the bracket, and transfer them to the blank receptacles on each end of the receptacle bracket (2, Figure 4-8).

6. Lift destructor package by its handle, place destructor package in chamber with edge marked TOP uppermost, insert and fasten securely to bulkhead with airlock fasteners.

7. After the package is secured, ensure the handle is flush with the top of the package.

8. Connect the two plugs to their appropriate receptacles; be careful to mate the pins and sockets correctly before applying pressure (this will ensure that the pins are not bent during installation).

9. At this point, note the complete installation to ensure that nothing protrudes more than one inch above the surface of the bulkhead, and that the dust caps are in place.

10. Remove flagged landing gear door stop assembly.

11. Push main landing gear forward door back into position.

12. Return destruct system installation switch (landing gear door release switch) in the left-hand wing fillet to its ON position.

13. Close access door in wing fillet.

14. Open fire-fighting access door on the left-hand side of aircraft, insert key chained to side of key switch, and actuate the destruct system key switch to its ON position.

15. Leave key inserted in its LOCKED or ON position and close fire-fighting access door.

Remove self from area.

The reverse of this sequence is followed when recovering the destruct package.

NAVIGATION EQUIPMENT.

J-4 DIRECTIONAL INDICATOR SYSTEM.

All except the following is contained in T.O. 1F-104A-1.

Directional heading information is telemetered from this system to ground and airborne directors.

LIGHTING EQUIPMENT.

All except the following is contained in T.O. 1F-104A-1.

EXTERNAL INDICATOR LIGHTS.

Three external lights are provided to indicate to the director aircraft or ground controller the status of the drone. The lights are activated by the same circuits that activate the cockpit warning lights.

Carrier Light.

A white carrier light is mounted on the right side of the pilot's aft canopy. When illuminated it indicates that the aircraft is receiving a radio carrier.

Landing Gear and Wing Flaps Up and Locked Indicator Light.

The landing gear and wing flaps up and locked indicator light is located in the right wing fillet and when illuminated indicates that the wing flaps and landing gear are up and locked.

Low Fuel Warning Light.

The low fuel warning light is one of the rear navigation lights and when lighted indicates that fuel is below the level of 195 gallons.

AUXILIARY SYSTEMS OPERATION.

WHEEL BRAKES AND DRAG CHUTE.

Anti-skid brakes are applied on receipt of the brakes command. Simultaneous command of brakes and latch brakes will cause the brakes to hold upon release of the command. An unlatch command will release brakes.

With weight of the aircraft on the nosewheel and drag chute override switch in REMOTE, a brakes command will release the drag chute.

Brakes and manual drag chute deployment may be actuated at any time by the pilot regardless of the position of the override switches.

Separate override switches are provided to cut off remote or metal-stick command of these functions.

LANDING GEAR.

During manned flight the landing gear is operable remotely or by metal-stick command whenever the system is engaged and the landing gear lever is in the position required prior to the command. Upon DSCE disengagement, the gear will go to the position commanded by the gear handle. Interlocking is provided to prevent retraction unless weight is off gear and also ensure automatic retraction at the gear limit speed. During Nullo flight the gear lever is positioned in the DOWN position.

WING FLAPS.

During manned flight remote or metal-stick command of the flaps may be effected whenever the system is engaged, and the wing flap lever is in the position commanded prior to the command. Interlocking prevents flaps being raised to UP from LAND position directly. A flaps up command is effective only with flaps at TAKE OFF. During Nullo flight the wing flap lever remains at TAKE OFF. Automatic retraction is provided at flap limit speed and during the carrier failure ATO sequence. Upon DSCE disengagement, the flaps will go to the position commanded by the flap control handle.

SPEED BRAKES.

Speed brakes are remotely controllable when the pilot's speed brake control switch (mounted on the throttle grip) is in the center position. The safety pilot may override remotely generated commands by manually selecting the speed brake position desired, or he may control the speed brakes by metal stick.

SMOKE SYSTEM.

A sustaind "smoke" command operates the smoke generator timer if the landing gear is full up. Smoke emission is periodic.

RANGE SAFETY.

Commands associated with range safety are utilized for commanding RAT extension, external tank jettison, and for the destruct system.

To operate the destruct system it is necessary to command HOLD-TO-ARM: while maintaining this command, it is necessary to command ARM. While still maintaining the hold-to-arm command, it is next necessary to command EXPLODE.

To extend the ram air turbine, it is necessary only to command ARM.

External tank jettison is effected by commanding HOLD-TO-ARM and then ARM. If pylon jettison has been selected in the aircraft, a JETTISON command following pylon tank jettison will jettison the pylons.

Range Safety Monitor Panel.

The range safety monitor panel consists of three red indicator lights used for checking remote operation of the range safety system (destruct). When illuminated, the lights indicate that the commands, hold-to-arm, arm, and explode are being received.

DSCE AUTOMATIC SEQUENCES.

Automatic Takeoff.

When the automatic takeoff (ATO) command is transmitted, the following sequence is executed automatically:

1. Direct throttle mode is established which will cause the throttle to be advanced to full afterburner after an increase command is received. Brakes should be unlatched just prior to afterburner light off.

2. Climb reference (14°) will engage at 160 KIAS for 2 tanks, 170 knots IAS for 4 tanks, and localizer signal will disengage if armed.

3. The flaps would be in the TAKE OFF position during the takeoff.

4. Landing gear will begin to retract at 227.5 KIAS.

The ATO sequence is complete when the landing gear is retracted. At completion of the sequence, the climb reference will remain engaged, the throttle will remain at full afterburner in the direct-throttle mode, and flaps will remain at TAKE OFF. The ATO sequence can be disarmed by the following methods:

1. Completion of sequence.

2. UP or DOWN command.

If the landing gear or flaps are in transition at instant of ATO interruption such transition,will be completed. Throttle motion will cease at point of interruption.

Carrier Failure Sequences.

Carrier failure sequences are executed automatically upon ARW carrier failure after an appropriate delay as follows: With landing gear not up, 1.5 ±0.5 second noncumulative; with landing gear up, 5 seconds. The carrier failure sequences vary depending on the position and status of the aircraft when the carrier fails. These conditions and appropriate sequences are as follows:

Pre-Takeoff.

This condition is defined as follows:

1. Brakes on and latched.

2. Weight of aircraft on main gear.

Failure sequence as follows:

1. Brakes remain on and latched.

2. Direct-throttle mode engaged and throttle retarded to IDLE.

Note

Smoke generator is not operative when aircraft weight is on main landing gear.

Takeoff.

This condition is defined as follows:

1. Brakes off.
2. Weight on nose gear.
3. Flaps not in LAND position.

Failure sequence is as follows:

1. ATO arm after 1.5 seconds.
   a. Nosewheel steering engages.
   b. Airspeed on throttle (afterburner gate open).
   c. Cruise reference engages at 300 knots.
   d. ATO climb reference engages at preset speed.
   e. Smoke on when weight is off gear.
   f. Landing gear up at preset airspeed.
   g. Wing flaps up at preset airspeed.
2. ATO OFF (light off. Climb reference remains).
3. Aircraft turns to preset heading.
4. ACE on at reference altitude.

a. If radar carrier is available APW will transfer and radar control will be available.

b. If radar carrier is not available aircraft will maintain preset heading for preset time and then enter a left navigation holding turn.

Note

Heading mode is preset prior to takeoff. Turning maneuvers will not be executed in any aircraft configuration unless flaps are full up. If failure occurs upon completion of command ATO sequence, flaps shall go from TAKE OFF to UP at preset speed.

Observe the distinction between a normal ATO and a carrier failure ATO sequence. In the former, the throttle is advanced to full afterburner in the direct mode and stays there until commanded otherwise. In the latter, the airspeed-on-throttle mode is engaged to the cruise reference and the pitch-up reference is engaged. This concept takes into account a carrier failure during approach where full afterburner is required initially, and maximum flight time is required thereafter (presumably the fuel supply is low during approach).

The airspeed cruise reference speed and reference altitude conditions at which the aircraft ultimately stabilizes after an airborne carrier failure is selected to provide a compromise between suitable QF-104A endurance and DT-33A chase capabilities. However, to provide maximum flight time and range after carrier failure occurrence below reference altitude (especially at very low altitudes) it is desirable to introduce a gradual climb (pitchup reference) in the airspeed-on-throttle mode at the cruise reference. Thus, at slow speeds (approach and initial climbout) a large airspeed error is introduced resulting in the desired full afterburner operation. As the cruise reference is achieved, the throttle is retarded and stabilized in the sub-military thrust region. A carrier failure occurrence at speeds approximating or greater than cruise reference naturally does not initiate afterburner operation.

A rare condition which may occur alters the above sequence: With flaps down and aircraft airborne, the aircraft may touch down (weight on gear) after expiration of the time delay. Should this occur, the sequence specified for the landing condition will be executed upon actuation of main landing gear scissors switch.

Below Reference Altitude (4000 feet). With gear or flaps DOWN and weight off gear, failure sequence is as follows:

1. Smoke on.
2. ATO—ARM (ATO light on).
   a. Airspeed on throttle (afterburner gate open).
   b. Cruise reference engages at 300 knots.
   c. ATO climb reference engages.
   d. Landing gear up at preset airspeed.
   e. Wing flaps up at preset airspeed.
3. ATO—Off (light off). Climb reference remains.
4. Aircraft will turn to the preset heading after the flaps are full UP.
5. ACE will engage at the reference altitude and the heading timer will start.

a. If radar carrier is available, APW will transfer and radar control will be available.

b. If radar carrier is not available, aircraft will maintain preset heading for preset time and then enter a left navigation holding turn.

With landing gear and wing flaps up, failure sequence is as follows:

1. Smoke on.
2. ATO climb reference engages.

3. Airspeed on throttle (afterburner gate open).

4. Cruise reference engages at 300 knots.

5. Aircraft turns to preset heading.

a. If radar carrier is available, APW will transfer upon reaching 4000 feet and when ARW failure has endured for the long carrier failure time delay interval.

b. If radar carrier is not available, aircraft will maintain preset heading for preset time and then enter a left navigation holding turn.

At or Above Reference Altitude (below 40,000 feet). Any configuration.

1. Gear and flaps UP (if DOWN) upon reaching gear-down limit ATO airspeed and flaps takeoff limit airspeed, respectively.

2. Smoke on.

3. ACE engages.

4. If radar carrier is available, and APW transfers,

a. Airspeed on throttle (afterburner gate open).

b. Airspeed reference remains at existing airspeed.

c. Radar commands are available.

5. If radar carrier is not available,

a. Airspeed on throttle (afterburner gate open).

b. Cruise reference engages.

c. Aircraft enters left navigation holding turn.

At or above Reference Altitude (above 40,000 feet). Any configuration.

1. Gear and flaps up at or above preset airspeed.

2. Smoke on.

3. Airspeed on throttle at existing airspeed (afterburner gate open).

4. ACE ON.

5. If radar carrier is available, APW transfers and radar control is available.

6. If radar carrier is not available, aircraft enters left navigation holding turn.

Landing.

This condition is defined as follows:

1. Flaps in LAND position.

2. Weight of aircraft on main gear.

Failure sequence is as follows:

1. Brakes ON and latched.

2. Direct throttle mode engaged and throttle retarded to IDLE.

3. Drag chute deployed.

4. Nosewheel steering will engage when weight of aircraft is on nosewheel.

Carrier Recovery Sequence.

Recovery sequence will be executed as follows for the conditions indicated:

Pretakeoff Condition. The carrier failure sequence for this condition will not be interrupted or terminated.

Takeoff Condition. The carrier failure sequence for this condition will not be interrupted or terminated.

Recovery Below Reference Altitude.

1. If carrier failure ATO sequence is in progress, sequence will be completed in command-ATO-sequence mode:

a. Direct throttle replaces airspeed on throttle.

b. Afterburner gate open and throttle increase.

c. Cruise reference OFF.

d. ATO climb reference engages or remains engaged.

e. Flaps go from LAND to TAKE OFF (if at LAND).

2. If carrier failure ATO sequence is complete at time of recovery:

a. Airspeed-on-throttle mode remains engaged.

b. Cruise reference ON.

c. Afterburner gate closes.

d. ATO climb reference remains engaged.

3. Speed brakes will complete retraction if in transit.

4. Smoke generator OFF.

5. Aircraft will roll to wings level and maintain heading acquired at wings level unless circle turn is armed.

Recovery At or Above Reference Altitude.

1. Airspeed on throttle remains engaged.

2. Afterburner gate closes.

3. Cruise reference remains engaged if previously engaged during failure sequence.

4. Smoke generator OFF.

5. Aircraft will roll to wings level and maintain heading acquired at wings level unless circle turn is armed.

Recovery Above 40,000 Feet. Same procedure as Recovery At or Above Reference Altitude. (See preceding paragraph.)

Recovery in Landing Condition. The carrier failure sequence for this condition will not be interrupted or terminated.

Recovery After Radar Carrier Transfer. If below reference altitude and the APW-20 has not transferred automatically, the radio command may be utilized for recovery.

If above reference altitude and transfer to APW-20 has been accomplished automatically, the APW-20 can be commanded OFF by radio.

SECTION V — OPERATING LIMITATIONS

PROHIBITED MANEUVERS.

The following information is in addition to that contained in T.O. 1F-104A-1.

PITCH ATTITUDE.

Pitch attitudes in excess of ±70 degrees are prohibited. The DSCE vertical gyro can be damaged at pitch attitudes in excess of ±70 degrees. DSCE control of the airplane would be lost if DSCE were in operation or engaged following a maneuver of this magnitude. In Nullo flight structural damage to the airplane could occur if the gyro were damaged and malfunctioning.

ACCELERATION LIMITATIONS (See Figure 4-1).

The following information is in addition to that contained in T.O. 1F-104A-1.

CAUTION

At speeds above Mach 1.9, DSCE nose-up pitch commands exceeding 1 second will result in airplane load factors in excess of limits with tip tanks installed. Do not maintain a nose-up command for more than 1 second or repeat a command until an interval of time equal to the previous command time has elapsed.

MAXIMUM ALLOWABLE AIRSPEED AND ACCELERATION LIMITS

SYMMETRICAL MANEUVERS

CONFIGURATION		AIRSPEED LIMITS *	ACCELERATION LIMITS: MORE THAN 4000 POUNDS INTERNAL FUEL OR FUEL IN EXTERNAL FUEL TANKS	ACCELERATION LIMITS: 4000 POUNDS OR LESS FUEL REMAINING AND EMPTY EXTERNAL FUEL TANKS
NO EXTERNAL STORES		• ABOVE 5000 FEET, 750 KNOTS EAS, MACH 2.0, OR ENGINE AIR INLET TEMPERATE LIMIT, WHICHEVER OCCURS FIRST. • BELOW 5000 FEET 650 KNOTS IAS, MACH 2.0, OR ENGINE AIR INLET TEMPERATURE LIMIT, WHICHEVER OCCURS FIRST.	4.0	6.0
TIP TANKS		• ABOVE 25,000 FEET-750 KNOTS IAS, MACH 2.0, OR ENGINE AIR INLET TEMPERATURE LIMIT, WHICHEVER OCCURS FIRST. • BELOW 25,000 FEET-575 KNOTS IAS.	DO NOT EXCEED 2.0 G ABOVE MACH 1.9 3.5	5.0
PYLON TANKS		575 KNOTS IAS OR MACH 1.5, WHICHEVER OCCURS FIRST.	3.5	5.0
PYLON TANKS AND TIP TANKS		• 575 KNOTS IAS OR MACH 1.5, WHICHEVER OCCURS FIRST. • DO NOT EXCEED 500 KNOTS IAS WITH EMPTY TIP TANKS AND MORE THAN RESIDUAL FUEL IN PYLON TANKS.	3.5	5.0
TAKEOFF FLAPS	DURING EXTENSION	** 370 KNOTS IAS OR INDICATED MACH 0.80. THERE IS NO MACH LIMITATION IF 290 KNOTS IAS IS NOT EXCEEDED.	SEE APPLICABLE EXTERNAL CONFIGURATION ABOVE	
	EXTENDED OR RETRACTING	** 450 KNOTS IAS OR INDICATED MACH 0.80. THERE IS NO MACH LIMITATION IF 350 KNOTS IAS IS NOT EXCEEDED.		
THE MINIMUM SYMMETRICAL G LIMIT IS: (a) -2.5 G WITH FLAPS UP (b) -1.0 G WITH TAKE OFF FLAPS (c) -0.0 G WITH LANDING FLAPS				

* NULLO DSCE OPERATION IS PROHIBITED:
- WITHOUT EXTERNAL STORES
- BELOW 400 KNOTS IAS AT ALTITUDES ABOVE 45,000 FEET
- ABOVE 55,000 FEET

** AIRCRAFT PRIOR TO 55-2968 ARE RESTRICTED TO THE USE OF TAKEOFF FLAPS EXCEPT FOR TAKEOFF AND LANDING OPERATIONS.

ROLLING PULLOUTS

CONFIGURATION	AIRSPEED	MORE THAN 4000 POUNDS	4000 POUNDS OR LESS
NO EXTERNAL STORES	MACH 1.9 TO 2.0	3.0	3.5
	BELOW MACH 1.9	2/3 OF SYMMETRICAL LIMITS SHOWN ABOVE	
TIP TANKS AND/OR PYLON TANKS	ANY PERMISSIBLE SPEED SHOWN FOR SYMMETRICAL MANEUVERS		
TAKEOFF FLAPS	SEE AILERON ROLL LIMITATIONS		
FOR ROLLING PUSHOVERS SEE AILERON ROLL LIMITATIONS			

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Figure 5-1

SECTION VI — FLIGHT CHARACTERISTICS

TABLE OF CONTENTS

	Page
Introduction	6-1
Flight Controls	6-1
Performance Capabilities	6-1
Level Flight Characteristics	6-3
Flight With Asymmetrical Load	6-4
Heavyweight Landing	6-4

INTRODUCTION.

All except the following information is contained in T.O. 1F-104A-1.

AUTOMATIC (DSCE) FLIGHT.

In general, the airplane flight characteristics are the same as in manual flight with only slight differences. The most notable difference during metal-stick flight will be the lack of feel. Since all changes in flight attitude or flight condition are commanded by metal stick, there will be no feel to judge airplane response. The desired attitude change will have to be commanded by a timed signal through the metal stick. This will require a thorough knowledge of airplane response rate in order to obtain the most efficient use of the airplane in automatic (DSCE) flight.

FLIGHT CONTROLS.

All except the following information is contained in T.O. 1F-104A-1.

RUDDER.

Operation and effectiveness of the rudder is conventional at low speeds with the landing gear extended. The rudder is effective above approximately 70 KIAS. Retraction of the gear locks the rudder in the neutral position. The rudder is locked with gear up to prevent aerodynamic interaction with the yaw stability augmenter nullifying the yaw stability augmenter effectiveness in damping directional oscillations. The aircraft is coordinated in normal maneuvers at these higher speeds without the use of rudder; therefore, locking the rudder does not reduce aircraft maneuvering performance.

STABILITY AUGMENTERS.

1. The roll damper should be on at all times to provide optimum damping.

2. Should the yaw damper fail while skid mode is engaged, a large amplitude divergent lateral—directional oscillation will be experienced. If this occurs in manned flight, the DSCE should be disengaged and the landing should be made using manual control. For Nullo flights refer to the recommended Emergency Procedure (Section III, Part 3c).

WARNING

Do not attempt a landing with skid mode engaged with a failed yaw damper. Lateral-directional oscillations in this condition can cause loss of control of the airplane during a landing, resulting in loss of the airplane. If a safety pilot is aboard, disengage the DSCE and land under manual control. For Nullo flight use the recommended emergency procedure.

PERFORMANCE CAPABILITIES.

All except the following information is contained in T.O. 1F-104A-1.

ZOOM CLIMBS.

The zoom climb techniques discussed under manual control (DSCE off) may be used in manned DSCE flight. Flight tests of the DSCE—airplane combinations have not been made above the power-limited ceiling; however,

NULLO FLIGHT ENVELOPE

TIP TANKS INSTALLED

STANDARD DAY ATMOSPHERE

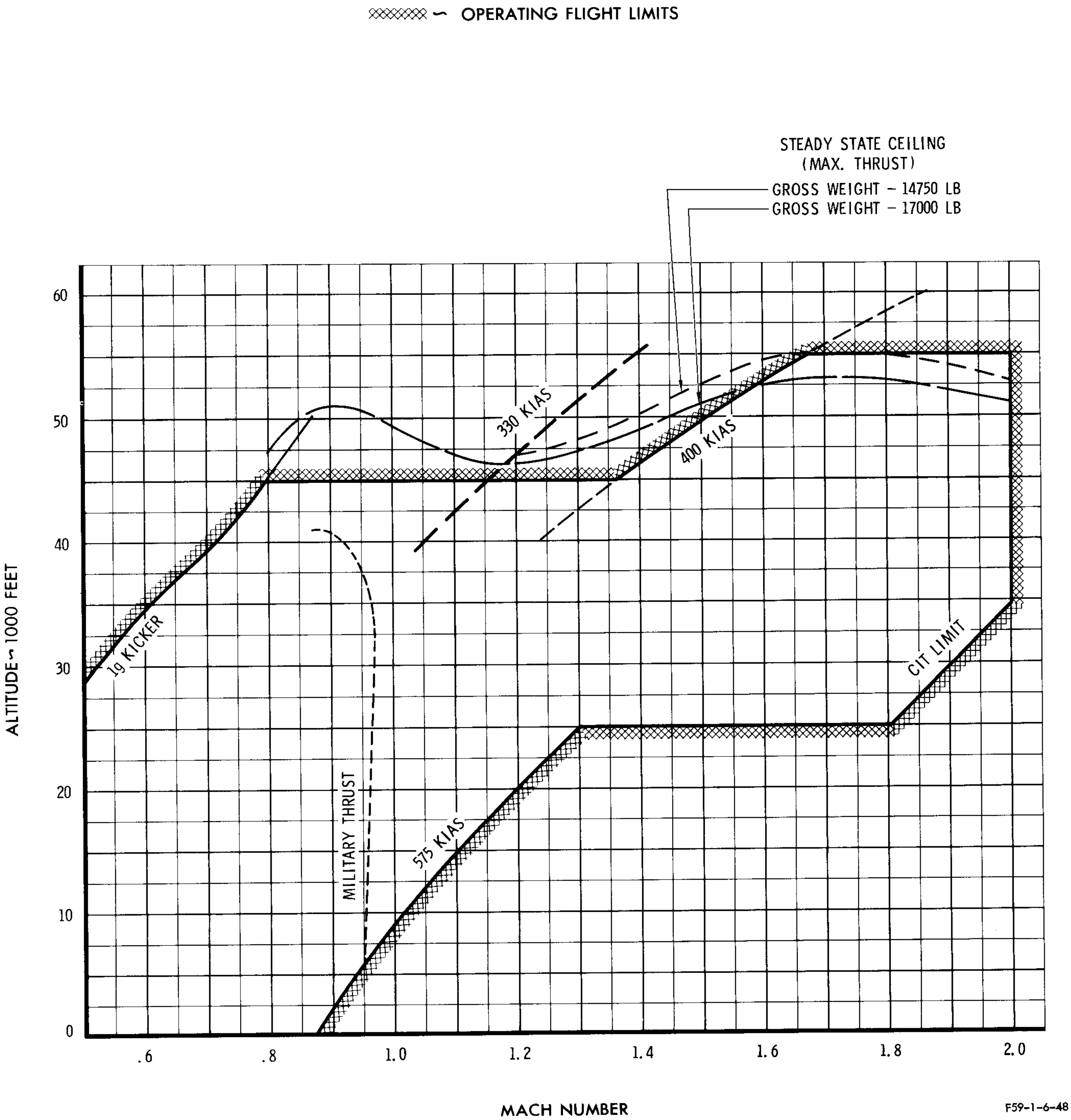


Figure 6-1

FORWARD CENTER-OF-GRAVITY FINAL APPROACH SPEED, TAKE OFF FLAPS

Configuration	*Fuel on Board for Forward CG*	*Recommended* Final Approach Speed*
No external stores	5500 lb or more	215 knots IAS at 5500 lb remaining
Tip tanks	6000 lb or more	220 knots IAS at 6000 lb remaining
Pylon tanks and tip tanks	6000 lb or more	225 knots IAS at 6000 lb remaining

*For heavier fuel loadings, add 5 knots for each additional 1000 lb weight.

Figure 6-2

limited theoretical studies have shown that the dynamic longitudinal stability of the DSCE—airplane combination is marginal and may be unstable. Therefore, zooms into this area may result in undesirable oscillation characteristics about the pitch axis. Lateral dynamic stability should be adequate with the yaw stability augmenter operative but with augmenter OFF, the airplane may be unstable. Under manned DSCE flight, there will be no flight hazard, since the safety pilot may disengage the DSCE and resume manual control should oscillations occur. Also, automatic DSCE disengagement is provided to prevent large pitch excursions or high stabilizer rate inputs through the G limiter and stabilizer-rate-disconnect features. In the case of Nullo flight, the protection afforded by automatic disconnect or a safety pilot is not available. Therefore, Nullo flight zooms above the power-limited ceiling are prohibited to prevent the possibility of entering this area of instability. Figure 5-1 presents the flight limits for Nullo flight while Figure 6-1 shows the relationship of the flight limits to the power limited ceiling.

NULLO FLIGHT NEAR STEADY CEILING.

Cognizance of the thrust and drag capabilities must be taken when operating at or near the steady-state ceiling of the airplane. Due to the carrier-fail sequence above 40,000 feet which commands airspeed-on-throttle and ACE to maintain the existing airspeed and altitude at the time of carrier fail, the possibility of entering the flight region above the steady-state ceiling exists. For example, referring to Figure 6-1, if a carrier-fail were to occur near 400 knots IAS during a retarded throttle, level deceleration in the altitude range from 50,000 to 55,000 feet, it may not be possible to regain sufficient thrust to stop the deceleration before speed has reduced to the flight regime above the maximum thrust steady-state ceiling. In this flight regime the carrier-fail would command aft stick to maintain the altitude until the airplane reached the stall resulting in loss of control of the airplane.

CAUTION

Avoid Nullo flight level decelerations to speeds below 450 knots IAS in the altitude range from 50,000 to 55,000 feet. If a carrier-fail should occur during a deceleration in this range, speed may decrease below 400 knots IAS to a flight regime where thrust is not sufficient to maintain the carrier fail sequence requirements and loss of control of the airplane will occur.

LEVEL FLIGHT CHARACTERISTICS.

All except the following information is contained in T.O. 1F-104A-1.

TRANSONIC FLIGHT.

There is no provision in the DSCE to correct for the airspeed system static location error through the transonic "jump." Therefore, during acceleration or deceleration through Mach 1.0, with ACE engaged, a deviation in altitude will occur. During an acceleration the airplane will climb prior to the "jump" and after the "jump" the airplane will descend. At 35,000 feet, the deviation from the desirable stable altitude will be approximately 1000 feet. If Mach-on-pitch is engaged through the airspeed jump, undesirable stabilizer inputs will occur during the jump. During an acceleration on Mach-on-pitch wherein an increase in Mach is commanded, nose-down stabilizer will be applied through the DSCE but at the airspeed "jump" nose-up stabilizer will be applied, causing the airplane to nose up. These conditions can be alleviated by conducting accelerations or decelerations through Mach 1.0 on direct pitch control.

FLIGHT WITH ASYMMETRICAL LOAD.

All information contained in T.O. 1F-104A-1 is applicable, except the following:

AIM-9B MISSILES.

Not applicable to QF-104A.

HEAVYWEIGHT LANDING.

Heavyweight landings are critical due to the forward center-of-gravity position. At forward center-of-gravity positions there is danger of insufficient stabilizer travel to land with LAND flaps. Inasmuch as TAKE OFF flaps require less stabilizer travel for trim, it is recommended that TAKE OFF flaps be used for landings in the extreme forward CG range. The typical landing pattern described in Section II is satisfactory except that final approach and touchdown speeds should be increased to compensate for use of TAKE OFF flaps and the heavier weight. Airplane loadings where extreme forward center-of-gravity positions are encountered, and recommended final approach speeds, are tabulated in Figure 6-2.

SECTION VII — SYSTEMS OPERATION

USE OF LANDING WHEEL BRAKES.

All except the following information is contained in T.O. 1F-104A-1:

The anti-skid brakes are independent of the DSCE system and may be used instead of the normal brakes at any time differential braking is not required, provided that the anti-skid or wheel brake override switch is in the REMOTE position.

CAUTION

The anti-skid brakes should not be used while the normal brakes are depressed as this condition positions the brake shuttle valve in the anti-skid position, and when brake pressure is released, the brake fluid is returned to the No. 2 hydraulic return system and may deplete the normal brake system supply.

SECTION VIII — CREW DUTIES

Although this section is generally not applicable to a single-place aircraft, drone operation involves a crew consisting of pilots who, with the exception of the safety pilot when used, do not fly in the drone. Close coordination between the different remote pilots and the safety pilot is mandatory.

SECTION IX — ALL WEATHER OPERATION

For manual flight of the drone, follow the instrument flight procedures outlined in T.O. 1F-104A-1. The design of the QF-104A drone did not provide for night, instrument, or adverse weather operation during remote or NULLO flight. Formal flight testing in this area has not been conducted; however, operational experience indicates that limited weather operation is feasible.

This precludes operation in known adverse weather conditions such as heavy icing, heavy turbulence, or heavy rain.

Flights under non-adverse conditions may be conducted when necessary for mission accomplishment.

PERFORMANCE DATA

Appendix I

TABLE OF CONTENTS

1. INTRODUCTION A1-1
2. TAKEOFF A2-1
3. CLIMB A3-1
4. RANGE PROFILES A4-1
5. ENDURANCE PROFILES A5-1
6. MILES PER POUND DATA .... (Refer to T.O. 1F-104A-1)
7. F-104B AIRCRAFT MILES PER POUND DATA .... (Deleted)
8. DESCENT .... (Refer to T.O. 1F-104A-1)
9. LANDING .... (Refer to T.O. 1F-104A-1)
10. COMBAT PERFORMANCE A10-1
11. MISSION PLANNING A11-1

Part 1 — Introduction

SCOPE AND ARRANGEMENT.

This performance appendix supplements information contained in T.O. 1F-104A-1 change dated 31 July 1965. It is applicable to QF-104A aircraft operating with tip tanks; tip tanks and pylon tanks, and the J79-GE-3B engine installed.

Refer to T.O. 1F-104A-1 for the following:

- Performance Data Basis
- Fuel and Fuel Density
- Symbols and Definitions
- MA-1 Airspeed Head Position Error Corrections
- Compensated Pitot-Static Head Position Error Corrections
- Airspeed-Mach Number Conversion and Sample Problems
- Airspeed Compressibility Correction and Sample Problem
- Standard Altitude Table
- Standard Units Conversion Chart
- Use of CIT to Obtain True Airspeed

Part 2 — Takeoff

TAKEOFF PLANNING AND CHARTS.

Maximum and Military thrust takeoff performance in T.O. 1F-104A-1 is applicable to QF-104A aircraft using the normal takeoff technique in Section II.

Gross weight adjustment to account for fuel used during ground operation at idle and Military thrust, prior to afterburner ignition, can be made based on an average idle thrust fuel flow of 1300 lb/hr at 69% rpm and an estimated 7050 lb/hr at Military thrust.

Loaded gross weights prior to engine start for the tip tank configuration is 22,900 pounds; tip tank and pylon tank configuration, 26,000 pounds. The takeoff gross weights given below assume a 15 minute period for ground checkout at 69% rpm and 1 minute for Military thrust:

	With Pilot	*Without Pilot*
Tip tanks	22,430 lb	22,190 lb
Tip tanks and pylon tanks	25,530 lb	25,290 lb

TOTAL DISTANCE TO CLEAR A 50 FOOT OBSTACLE.

Refer to T.O. 1F-104A-1 for total distance charts to clear a 50 foot obstacle with Maximum or Military thrust. To approximate the total distance to clear a 100 foot obstacle, multiply the air distance to the 50 foot obstacle by 1.5 and add this to the ground run distance. When maximum performance takeoff speeds and normal climbout speeds are used, the distance to reach a height of 50 feet is approximately 1.04 times the normal distance.

Refer to T.O. 1F-104A-1 for the following:

- Takeoff Performance Nomogram
- Takeoff Speed Schedules
- Wind Component Chart
- Ground Run Distance
- Refusal Speed and Distance
- Acceleration Check Speed and Distance
- Go-No Go Speed and Distance
- Acceleration Tolerance
- Runway Wind Component
- Total Distance to Clear a 50-Foot Obstacle
- Runway Marking System
- Lineup Allowance
- Takeoff Planning Problems

Part 3 — Climb

TRANSITION TIME AND FUEL ALLOWANCES.

Figure A3-1 of T.O. 1F-104A-1 provides information regarding fuel used and time to accelerate from brake release to climb speed for a range of gross weights. Drone configuration estimated takeoff gross weights are presented in part 2 and can be used to obtain transition time and fuel allowances. If ground checkout and taxi time is known to be different than that used in part 2, use the fuel flows provided and determine the gross weight at brake release. Time and fuel used in acceleration to 300 knots IAS can be read at Mach 0.46, for combined usage of Maximum and Military thrust where the throttle setting is changed at that speed.

Refer to T.O. 1F-104A-1 for the following;

- Climb Control
- Subsonic Climb Performance
- Effect of Free Air Temperature on Climb Performance
- Determination of Equivalent Weight
- Climb Performance Sample Problem

Part 4 — Range

TABLE OF CONTENTS

(Page numbers in bold face denote illustrations)

Mission Profile Charts **A4-2**
Optimum Return Profile Charts **A4-8**

RANGE DATA PRESENTED.

Mission and Optimum Return Profiles present the range characteristics of the aircraft in a convenient pictorial form, and provide a simplified method of flight planning for the majority of missions where long-range schedules can be used.

The charts are based on the following representative gross weights and fuel loads (pilot weight included).

Configuration	*Gross Weight—lb**	*Usable Fuel—lb*
Tip tanks	22,900	8,730
Tip tanks and pylon tanks	26,000	11,265

*Minor variations in aircraft basic weight do not affect the usability of the charts. Adjust chart range by 1% per 300 lb variation in basic aircraft gross weight.

CRUISE DATA AT 300 KNOTS IAS.

The mission profile charts include tabulated data for a cruise speed of 300 knots IAS, at altitudes of 4000 and 20,000 feet. Computed values of time, rpm and fuel flow for each altitude are tabulated for gross weight increments of 1000 pounds and extend over the probable operating weight range of the drone configurations.

Non afterburning cruise performance at 300 knots IAS during the low altitude escort phase of the flight can be approximated from figures A6-2 and A6-3 of T.O. 1F-104A-1. At 300 knots IAS and 2000 to 2500 feet altitude, true Mach number is 0.48. In the tip tank configuration (figure A6-2) at 20,000 lb and 2500 ft, nautical miles per 1000 lb of fuel is 76.0; with tip and pylon tanks (figure A6-3) at 25,000 lb, nautical miles per 1000 lb of fuel is 59.0.

Refer to T.O. 1F-104A-1 for the following:

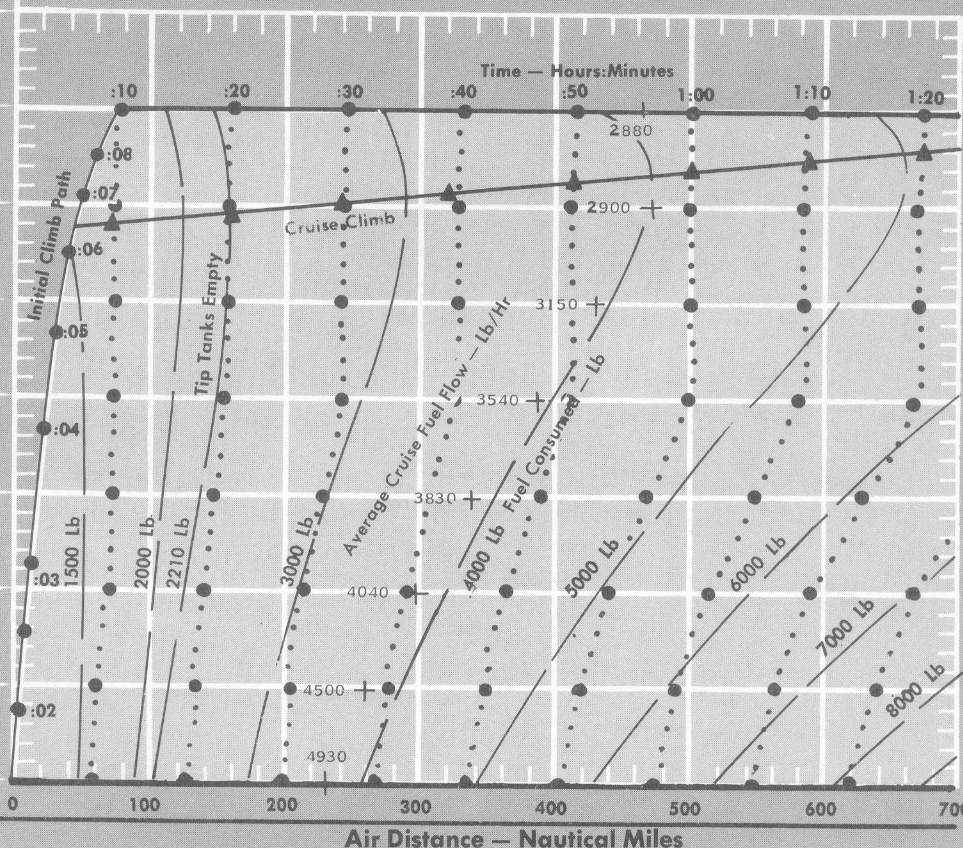
- Mission Profile Charts
  - Arrangement and Use
  - Tabulated Data
- Return Performance
- Allowances for Wind
- Optimum Return Profile Charts
  - Use of Optimum Return Profile Charts
  - Optimum Return Level-Flight Range
- Mission Profile Sample Problem
- Optimum Return Sample Problem

MISSION PROFILE

Model: QF-104A
Date: 30 June 1966
DATA BASIS: ESTIMATED

Engine: J79-GE-3B
Fuel Density: 6.5 LB/Gal
Fuel Grade: JP-4

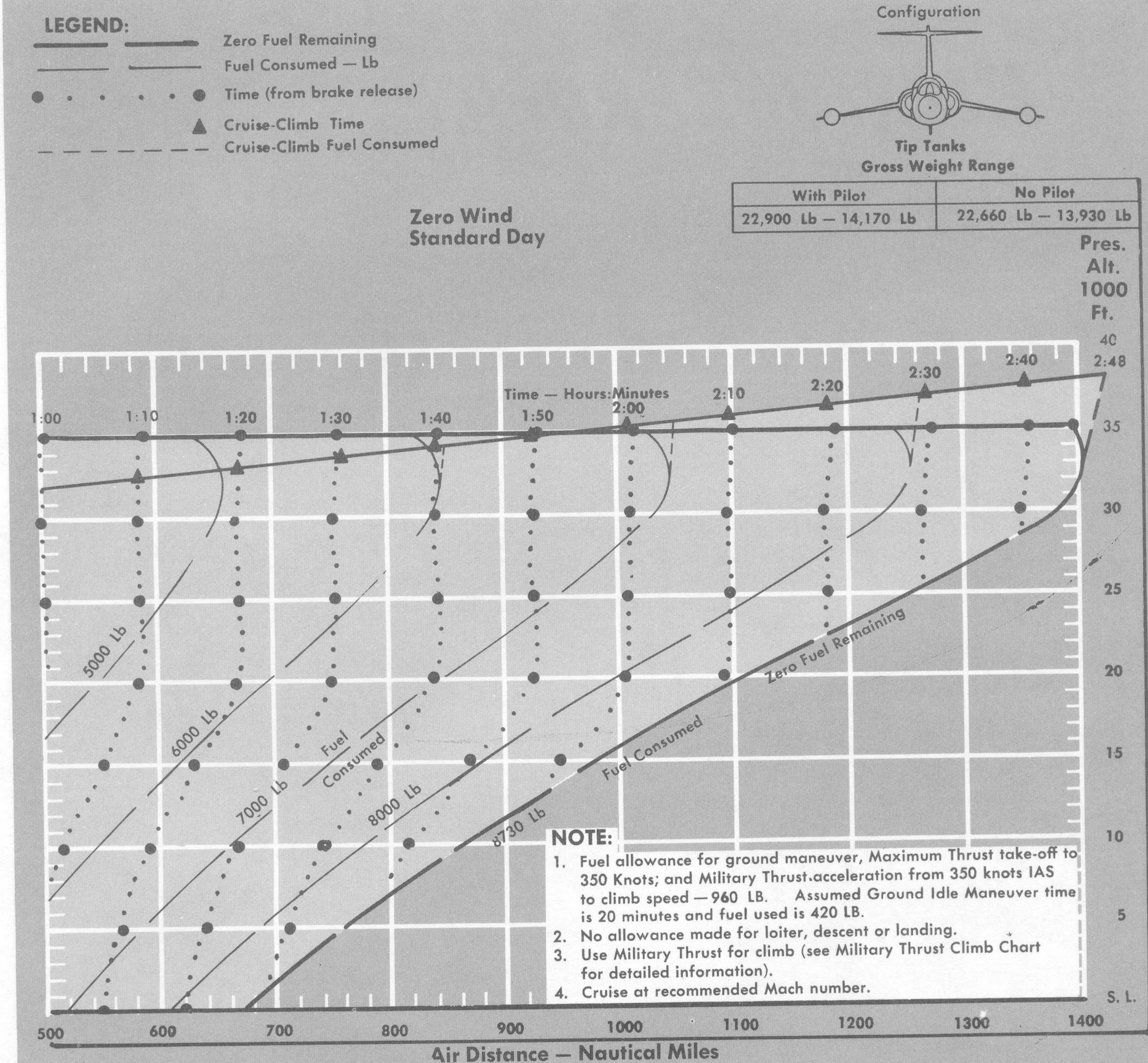
Climb Data			
Military Thrust			
True Mach No.	Ind. Mach No.	IAS Knots	Pres. Alt. 1000 Ft.
.88	.85	262	40
.88	.85	294	35
.88	.85	331	30
.88	.85	366	25
.88	.85	403	20
.88	.85	443	15
.88	.85	484	10
.88	.85	525	5
.88	.85	569	S.L.



TIP TANKS
300 KNOTS — IAS CRUISE DATA
4,000 AND 20,000 FT. PRESSURE ALTITUDE

ALTITUDE — FT. — IND./PRES. — 3750/4000 MACH NO. — IND./TRUE — .480/.49 KNOTS — IAS/TAS — 300/325	GROSS WEIGHT — 1000 LB.						
	15–16	16–17	17–18	18–19	19–20	20–21	21–22
TIME — MINUTES AVERAGE RPM % AVERAGE FUEL FLOW — LB/HR.	18.3 86.0 3280	17.4 86.5 3450	16.5 87.0 3630	15.7 87.5 3820	14.9 88.0 4020	14.2 88.5 42 30	13.8 89.0 4350
ALTITUDE — FT. — IND./PRES. — 19,600/20,000 MACH NO. — IND./TRUE — .65/.67 KNOTS — IAS/TAS — 300/410							
TIME — MINUTES AVERAGE RPM % AVERAGE FUEL FLOW — LB/HR.	21.7 86.5 2760	20.9 87.5 2870	20.1 88.0 2980	19.4 88.5 3100	18.7 89.0 3200		

Figure A4-1 (Sheet 1 of 2)



NOTE:

1. Fuel allowance for ground maneuver, Maximum Thrust take-off to 350 Knots; and Military Thrust acceleration from 350 knots IAS to climb speed — 960 LB. Assumed Ground Idle Maneuver time is 20 minutes and fuel used is 420 LB.
2. No allowance made for loiter, descent or landing.
3. Use Military Thrust for climb (see Military Thrust Climb Chart for detailed information).
4. Cruise at recommended Mach number.

CRUISE DATA

ALTITUDE		MACH NO.		IAS KNOTS	TAS KNOTS	*% RPM	*LB./HR.
PRESSURE	INDICATED	TRUE	INDICATED				
Optimum Cruise (Cruise-Climb)		.88	.85	335/280	520/500	93.5/91.0	3340/2135
35,000	34,350	.90	.87	300	515	100 MIL	3450
30,000	29,400	.87	.84	325	510	94.0	3280
25,000	24,400	.85	.82	355	510	91.5	3390
20,000	19,400	.83	.81	380	510	91.0	3730
15,000	14,450	.76	.74	385	480	90.5	4040
10,000	9,550	.70	.68	385	450	90.0	4250
5,000	4,550	.67	.65	400	435	90.0	4710
S. L.	—400	.64	.62	410	420	90.0	5120

* INITIAL APPROXIMATE VALUES

Figure A4-1 (Sheet 2 of 2)

MISSION PROFILE

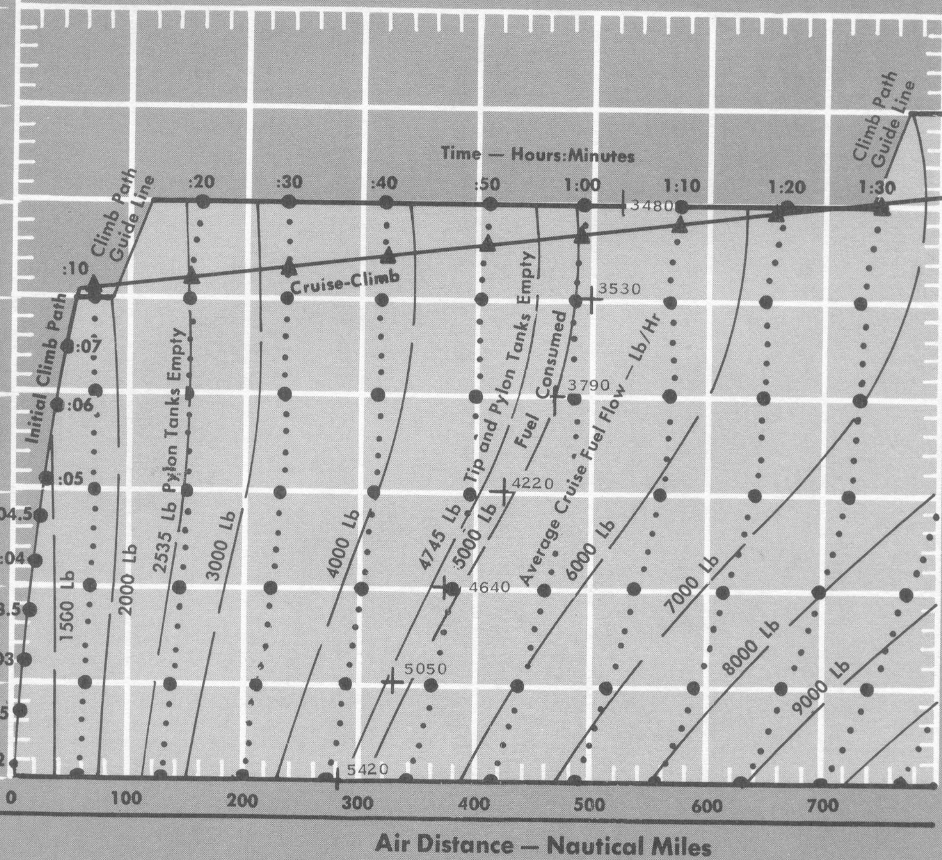
Model: QF-104A
Date: 30 June 1966
DATA BASIS: ESTIMATED

Engine: J79-GE-3B
Fuel Density: 6.5 LB/Gal
Fuel Grade: JP-4

Climb Data

Military Thrust

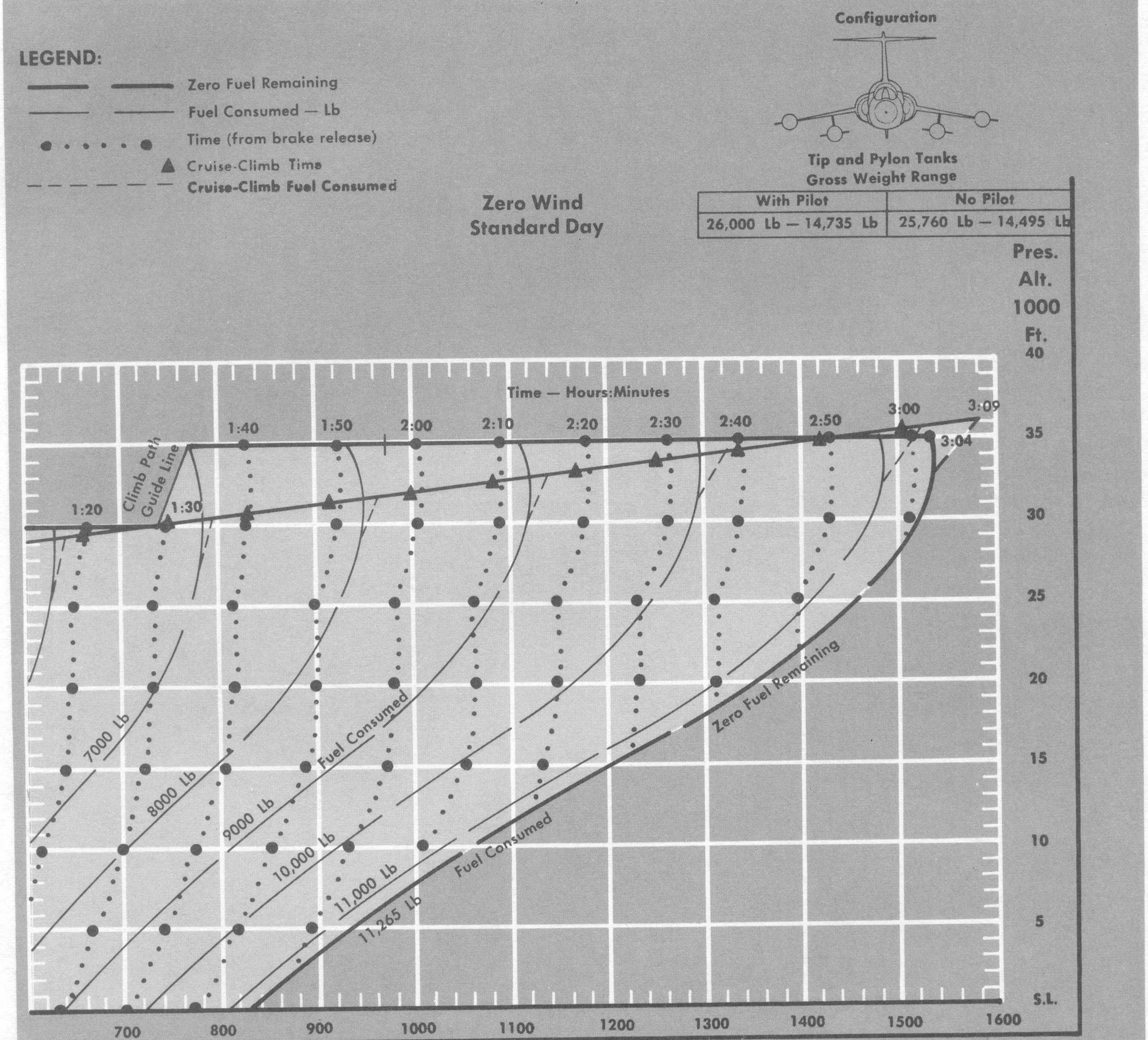
True Mach No.	Ind. Mach No.	IAS Knots	Pres. Alt. 1000 Ft.
.825	.80	245	40
.825	.80	275	35
.825	.80	308	30
.825	.80	341	25
.825	.80	378	20
.825	.80	415	15
.825	.80	453	10
.825	.80	494	5
.825	.80	534	S.L.



TIP TANKS + PYLON TANKS
300 KNOTS — IAS CRUISE DATA
4,000 AND 20,000 FT. PRESSURE ALTITUDE

ALTITUDE — FT. IND./PRES. — 3750/4000 MACH NO. — IND./TRUE — .480 / .49 KNOTS — IAS/TAS — 300/325	GROSS WEIGHT — 1000 LB.									
	15–16	16–17	17–18	18–19	19–20	20–21	21–22	22–23	23–24	24–25
TIME — MINUTES	16.8	16.0	15.4	14.7	14.0	13.5	12.0	12.4	11.9	11.5
AVERAGE RPM %	87.0	87.5	88.0	88.5	89.0	89.5	90.0	90.5	91.0	91.5
AVERAGE FUEL FLOW — LB/HR.	3570	3740	3910	4090	4270	4450	4640	4830	5020	5210
ALTITUDE — FT. IND./PRES. — 19,600/20,000 MACH NO. — IND./TRUE — .65/.67 KNOTS — IAS/TAS — 300/410										
TIME — MINUTES	20.5	19.5	18.8	18.2	17.4	16.7	15.8	15.0	14.2	13.5
AVERAGE RPM %	87.0	87.5	88.0	88.5	89.0	89.5	90.0	90.5	91.0	92.0
AVERAGE FUEL FLOW — LB/HR.	2930	3070	3190	3300	3440	3600	3790	4000	4230	4450

Figure A4-2 (Sheet 1 of 2)



NOTE:
1. Fuel allowance for ground maneuver, Maximum Thrust take-off to 350 Knots, and Military Thrust acceleration from 350 knots IAS to climb speed — 1095 LB. Assumed Ground Idle Maneuver time is 20 minutes and fuel used is 420 LB.
2. No allowance made for loiter, descent or landing.
3. Use Military Thrust for climb (see Military Thrust Climb Chart for detailed information).
4. Cruise at recommended Mach number.

ALTITUDE		MACH NO.		IAS KNOTS	TAS KNOTS	* %RPM	* LB./HR.
PRESSURE	INDICATED	TRUE	INDICATED				
Optimum Cruise (Cruise-Climb)		.86	.83	355—280	515—490	96	4150
35,000	34,400	.88	.85	295	505	99.0	3270
30,000	29,400	.87	.84	325	510	100.0	4050
25,000	24,400	.84	.81	345	500	96.0	4050
20,000	19,400	.81	.79	375	500	93.0	4190
15,000	14,450	.78	.76	395	490	92.0	4500
10,000	9,500	.73	.71	405	470	92.0	4900
5,000	4,550	.69	.67	415	450	92.0	5320
S.L.	— 450	.65	.63	420	430	92.0	5710

* INITIAL APPROXIMATE VALUES

Figure A4-2 (Sheet 2 of 2)

MISSION PROFILE

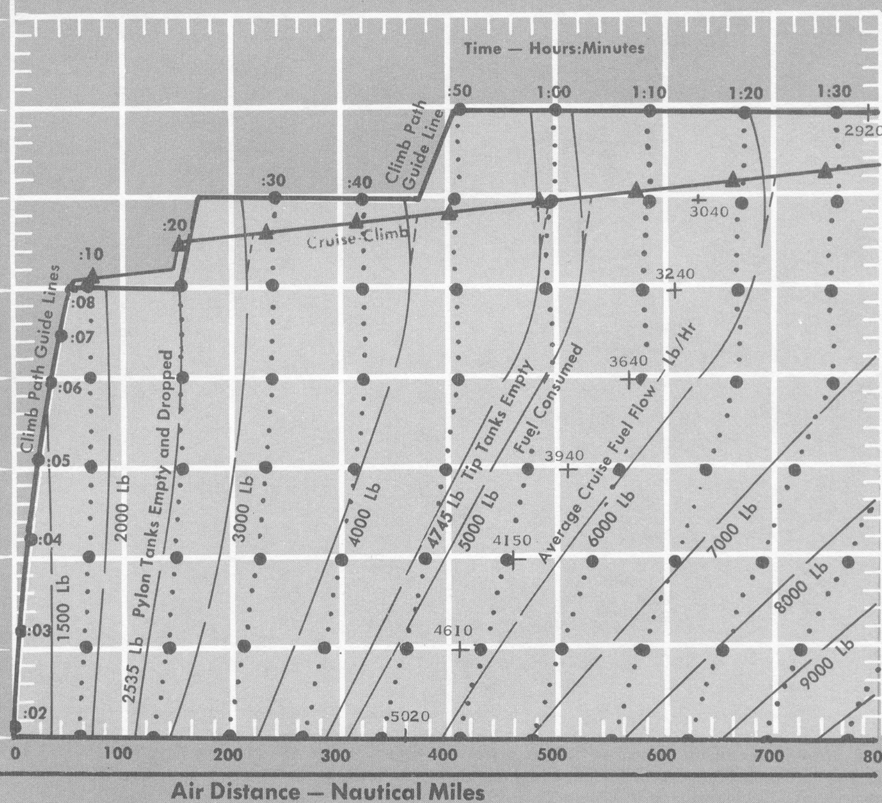
Model: QF-104A
Date: 30 June 1966
DATA BASIS: ESTIMATED

Engine: J79-GE-3B
Fuel Density: 6.5 LB/Gal
Fuel Grade: JP-4

Climb Data

Military Thrust

True Mach No.	Ind. Mach No.	IAS Knots	Pres. Alt. 1000 Ft.
.825	.80	245	40
.825	.80	275	35
.825	.80	308	30
.825	.80	341	25
.825	.80	378	20
.825	.80	415	15
.825	.80	453	10
.825	.80	494	5
.825	.80	534	S.L.

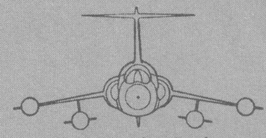


NOTE:

1. Fuel allowance for ground maneuver, Maximum Thrust take-off to 350 Knots, and Military Thrust acceleration from 350 knots IAS to climb speed —1095 LB. Assumed Ground Idle Maneuver time is 20 minutes and fuel used is 420 LB.
2. No allowance made for loiter, descent or landing.
3. Use Military Thrust for climb (see Military Thrust Climb Chart for detailed information).
4. Cruise at recommended Mach number.
   Change Cruise Speed and Altitude When Pylon Tanks are Dropped
6. Climb speed schedule for Tip Tanks is Mach 0.88. (Ind. Mach — 0.85).

Figure A4-3 (Sheet 1 of 2)

Configuration



Tip and Pylon Tanks

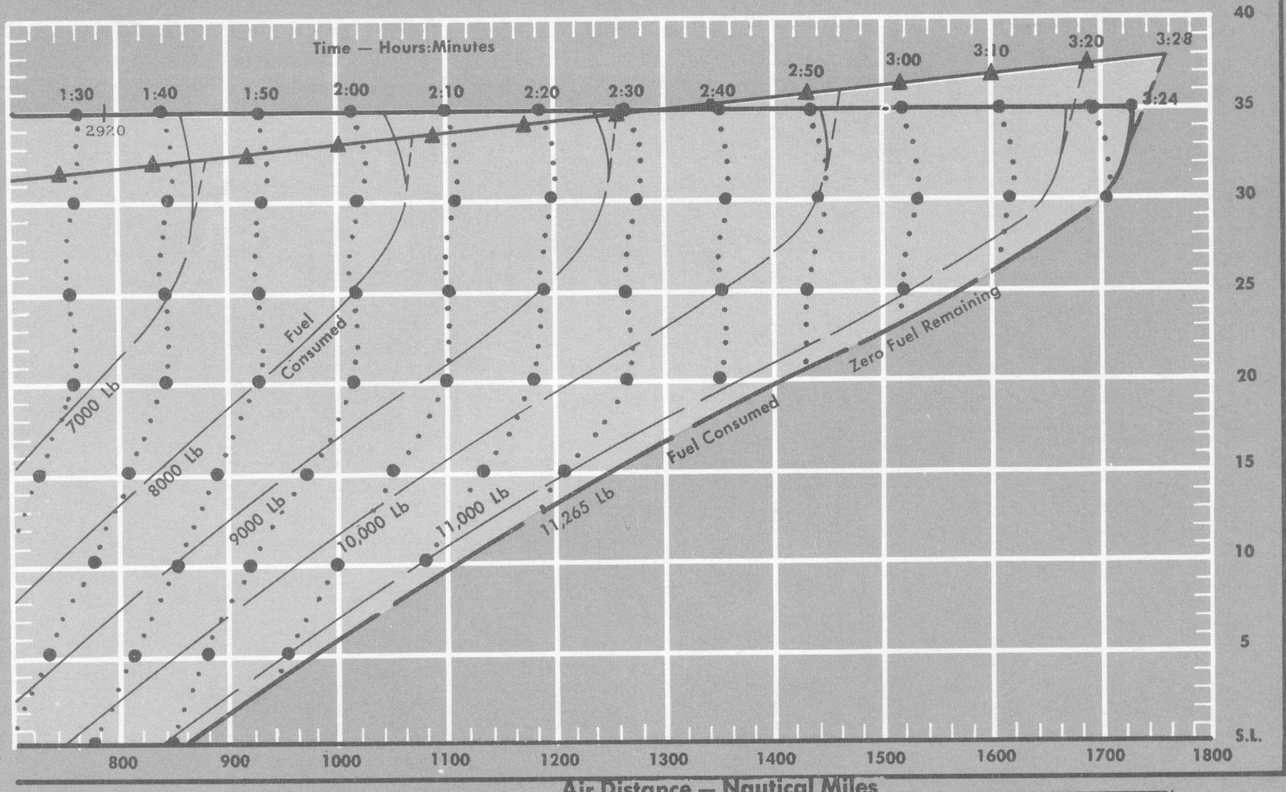
LEGEND:

- Zero Fuel Remaining
- Fuel Consumed — Lb
- Time (from brake release)
- Cruise-Climb Time
- Cruise-Climb Fuel Consumed

**Zero Wind
Standard Day**

Gross Weight Range

	With Pilot	No Pilot
Pylons Retained	26,000 Lb — 14,385 Lb	25,760 Lb — 14,145 Lb
Pylons and Tanks Dropped	26,000 Lb — 14,170 Lb	25,760 Lb — 13,930 Lb



CRUISE DATA FOR TIP AND PYLON TANKS

ALTITUDE		MACH NO.		IAS	TAS		
PRESSURE	INDICATED	TRUE	INDICATED	KNOTS	KNOTS	*% RPM	*LB./HR.
Optimum Cruise (Cruise-Climb)		.85	.83	355/345	510	95.5/95.0	4050/3900
25,000	24,400	.84	.82	350	510	96.0	4080
20,000	19,400	.82	.80	375	505	93.5	4210
15,000	14,400	.80	.78	405	505	92.5	4600
10,000	9,450	.77	.75	420	490	92.0	5050
5,000	4,500	.72	.70	430	470	92.0	5500
S. L.	—450	.68	.66	440	450	92.0	5950

CRUISE DATA FOR TIP TANKS

ALTITUDE		MACH NO.		IAS	TAS		
PRESSURE	INDICATED	TRUE	INDICATED	KNOTS	KNOTS	*% RPM	*LB./HR.
Optimum Cruise (Cruise-Climb)		.88	.85	350/280	520/500	94.0/91.0	3580/2135
35,000	34,350	.90	.87	300	515	100% MIL	3450
30,000	29,400	.87	.84	330	515	96.0	3530
25,000	24,400	.86	.83	355	515	92.0	3550
20,000	19,400	.84	.81	385	515	91.5	3840
15,000	14,450	.78	.76	390	485	91.0	4180
10,000	9,500	.71	.69	390	455	90.0	4400
5,000	4,550	.68	.66	405	440	90.5	4860
S. L.	—400	.64	.62	415	420	90.5	5260

*INITIAL APPROXIMATE VALUES

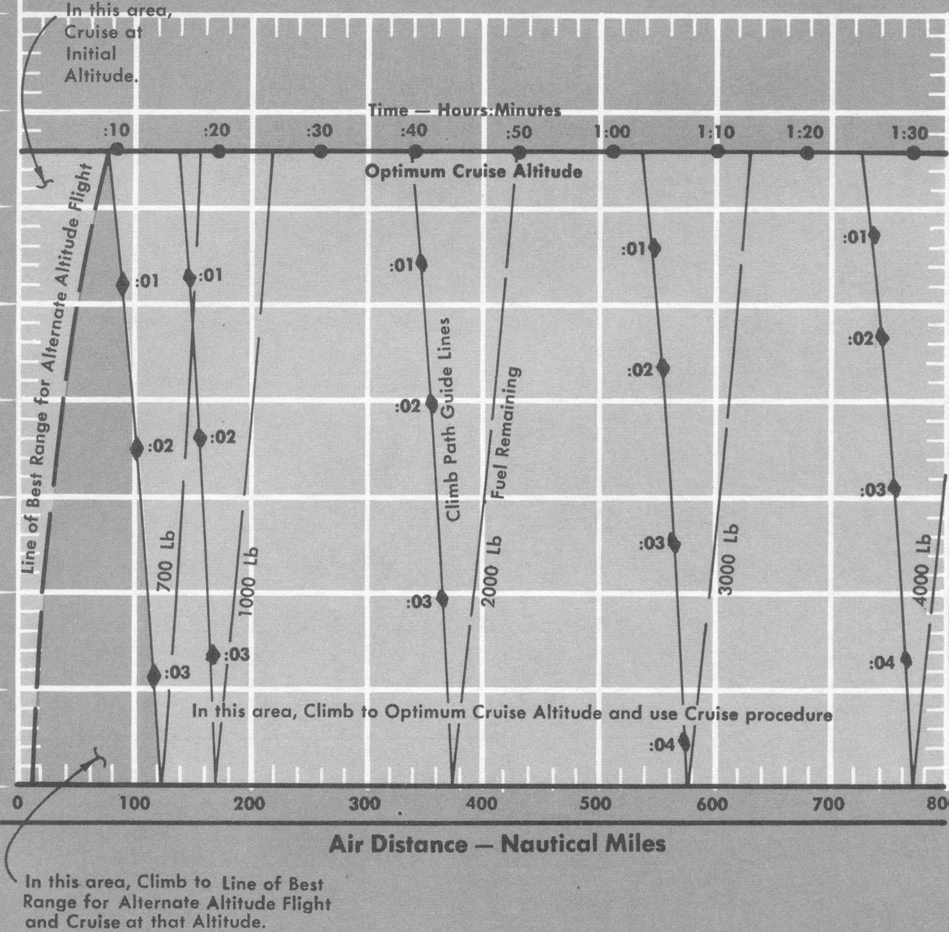
Figure A4-3 (Sheet 2 of 2)

OPTIMUM RETURN PROFILE

Climb Data			
Military Thrust			
True Mach No.	Ind. Mach No.	IAS Knots	Pres. Alt. 1000 Ft.
.88	.85	262	40
.88	.85	294	35
.88	.85	331	30
.88	.85	366	25
.88	.85	403	20
.88	.85	443	15
.88	.85	484	10
.88	.85	525	5
.88	.85	569	S.L.

Model: QF-104A
Date: 30 June 1966
DATA BASIS: ESTIMATED

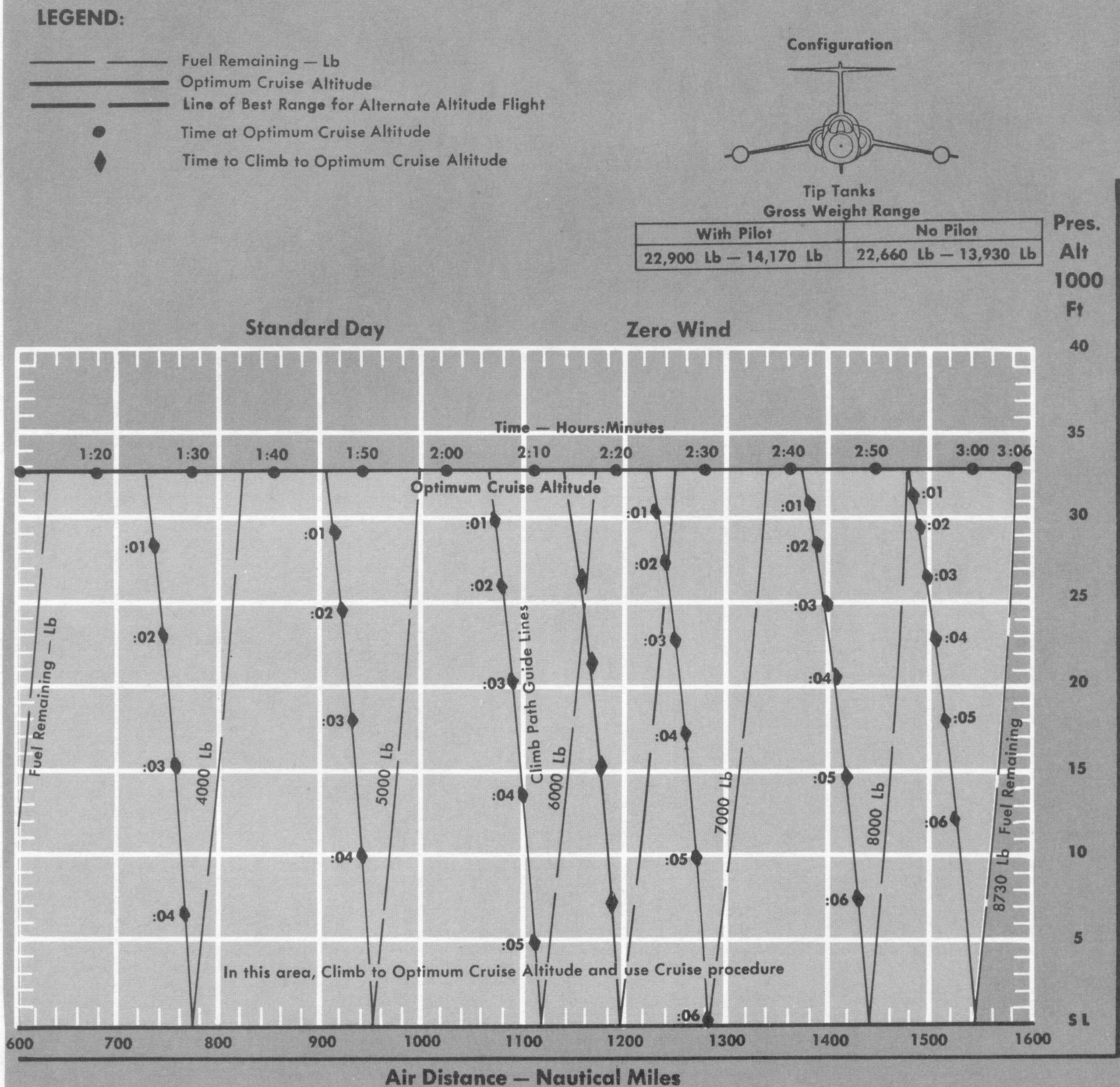
Engine: J79-GE-3B
Fuel Density: 6.5 LB/Gal
Fuel Grade: JP-4



NOTE:

1. Fuel at any point includes Military Thrust climb, if required, to Cruise-Climb altitude.
2. No allowance or reserve made for loiter, descent or landing.
3. Best cruise condition is determined by intersection of climb path guide lines and lines of best range.
4. Cruise at recommended Mach number.

Figure A4-4 (Sheet 1 of 2)



CRUISE DATA AT OPTIMUM CRUISE ALTITUDE

ALTITUDE		MACH NO.		IAS KNOTS	TAS KNOTS	%RPM	LB /HR
PRESSURE	INDICATED	TRUE	INDICATED				
32,900	31,300	.88	.85	310	510	100—88.0	3780—2300

CRUISE DATA FOR ALTERNATE ALTITUDE FLIGHT (LOW FUEL VALUES)

ALTITUDE		MACH NO.		IAS KNOTS	TAS KNOTS	* %RPM	* LB /HR
PRESSURE	INDICATED	TRUE	INDICATED				
30,000	29,400	.84	.82	320	500	87.5	2400
25,000	24,450	.81	.79	335	490	87.5	2710
20,000	19,500	.74	.72	335	455	87.0	2845
15,000	14,600	.68	.66	340	425	86.5	3050
10,000	9,600	.65	.63	350	410	87.0	3415
5,000	4,650	.61	.59	360	395	87.5	3790
S L	—300	.56	.54	360	370	88.0	4045

* INITIAL APPROXIMATE VALUE

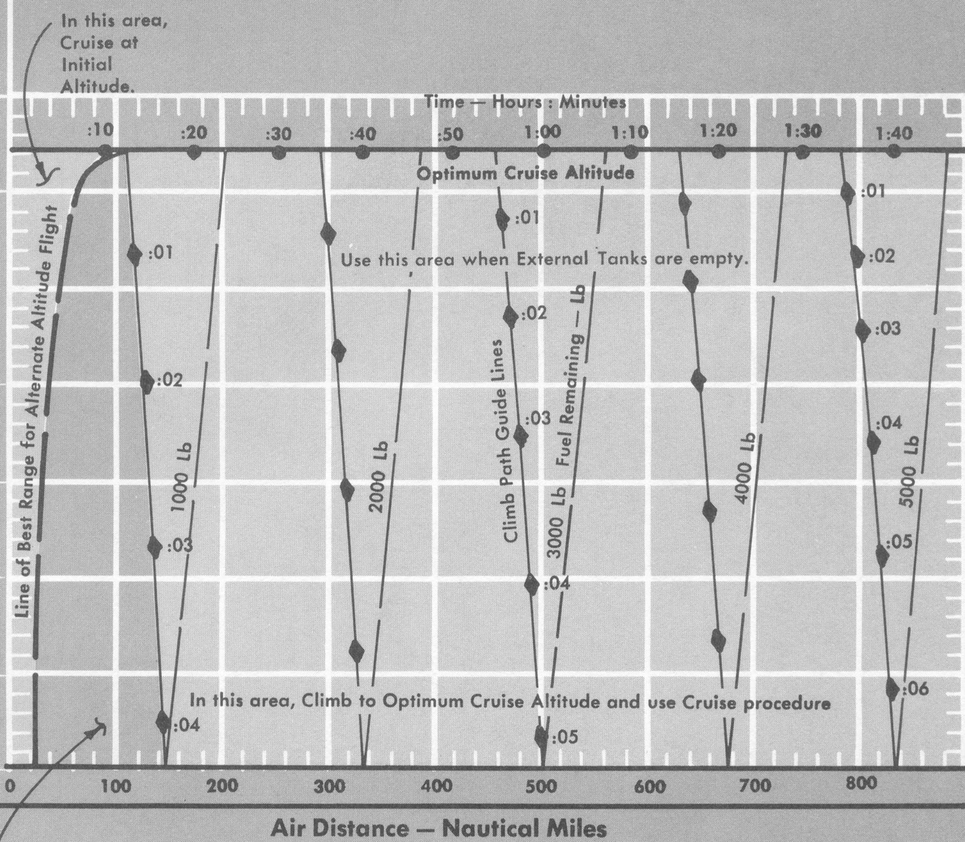
Figure A4-4 (Sheet 2 of 2)

OPTIMUM RETURN PROFILE

Model: QF-104A
Date: 30 June 1966
DATA BASIS: ESTIMATED

Engine: J79-GE-3B
Fuel Density: 6.5 LB/Gal
Fuel Grade: JP-4

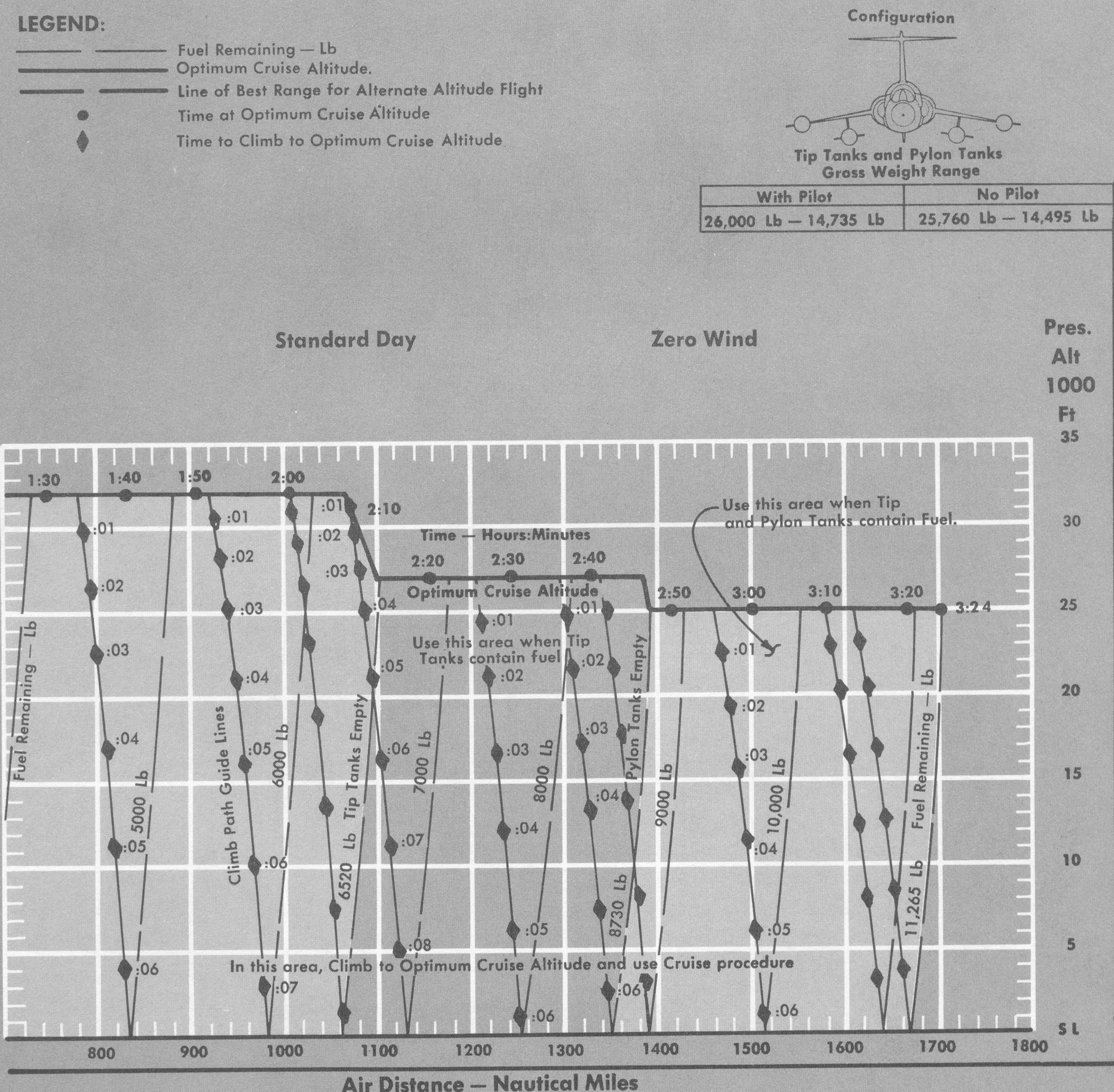
Climb Data			
Military Thrust			
True Mach No.	Ind. Mach No.	IAS Knots	Pres. Alt. 1000 Ft.
.825	.80	275	35
.825	.80	308	30
.825	.80	341	25
.825	.80	378	20
.825	.80	415	15
.825	.80	453	10
.825	.80	494	5
.825	.80	534	S.L.



NOTE:

1. Fuel at any point includes Military Thrust climb, if required, to Cruise-Climb altitude.
2. No allowance or reserve made for loiter, descent or landing.
3. Best cruise condition is determined by intersection of climb path guide lines and lines of best range.
4. Cruise at recommended Mach number.
5 Change Cruise Speed When Cruise Altitude is Changed

Figure A4-5 (Sheet 1 of 2)



With Pilot	No Pilot
26,000 Lb — 14,735 Lb	25,760 Lb — 14,495 Lb

CRUISE DATA AT OPTIMUM CRUISE ALTITUDE

ALTITUDE		MACH NO.		IAS KNOTS	TAS KNOTS	%RPM	LB/HR
PRESSURE	INDICATED	TRUE	INDICATED				
PYLON TANKS AND TIP TANKS FUEL REMAINING							
25,000	24,400	.85	.83	355	510	97.5—94.5	4380—3920
PYLON TANKS EMPTY, BUT NOT DROPPED							
27,000	26,400	.85	.83	340	505	96.0—93.5	3780—3530
PYLON TANKS AND TIP TANKS EMPTY, BUT NOT DROPPED							
32,000	31,400	.85	.83	310	495	99.0—89.0	3400—2490

CRUISE DATA FOR ALTERNATE ALTITUDE FLIGHT (LOW FUEL VALUES)

ALTITUDE		MACH NO.		IAS KNOTS	TAS KNOTS	*%RPM	*LB/HR
PRESSURE	INDICATED	TRUE	INDICATED				
30,000	29,450	.82	.79	305	480	88.5	2520
25,000	24,450	.80	.77	330	480	88.0	2760
20,000	19,500	.75	.73	340	460	88.0	3040
15,000	14,550	.70	.68	345	435	88.0	3330
10,000	9,600	.65	.63	350	410	87.5	3590
5,000	4,650	.59	.57	350	380	87.5	3770
S L	− 250	.53	.51	340	350	87.5	3870

*INITIAL APPROXIMATE VALUE

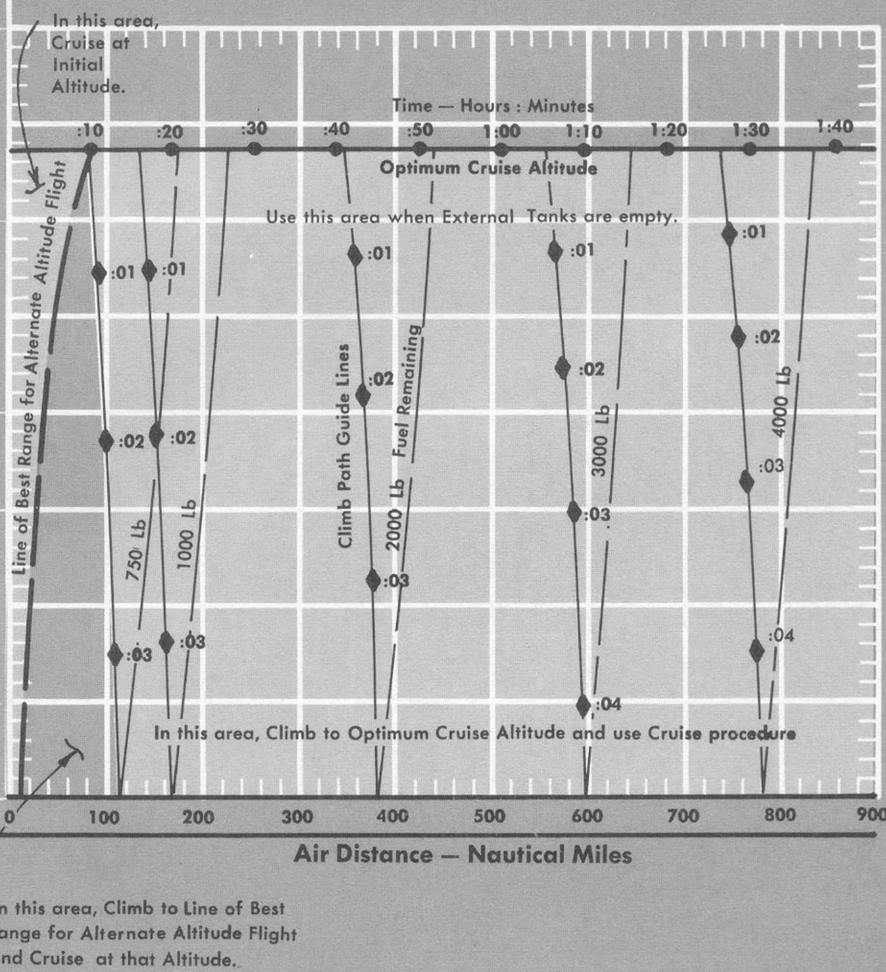
Figure A4-5 (Sheet 2 of 2)

OPTIMUM RETURN PROFILE

Climb Data — Tip Tanks			
Military Thrust			
True Mach No.	Ind. Mach No.	IAS Knots	Pres. Alt. 1000 Ft.
.88	.85	262	40
.88	.85	294	35
.88	.85	331	30
.88	.85	366	25
.88	.85	403	20
.88	.85	443	15
.88	.85	484	10
.88	.85	525	5
.88	.85	569	S.L.

Model: QF-104A
Date: 30 June 1966
DATA BASIS: ESTIMATED

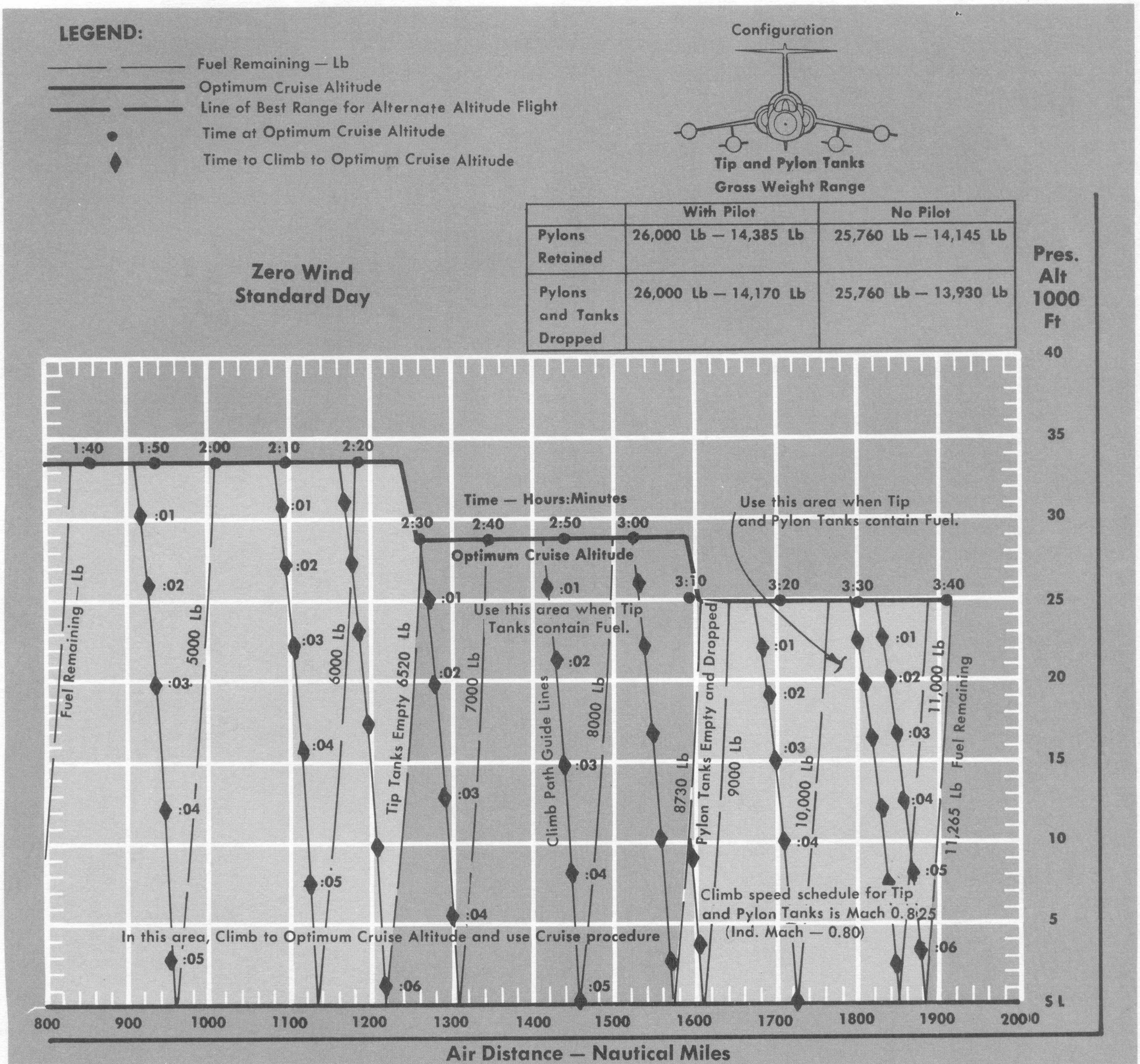
Engine: J79-GE-3B
Fuel Density: 6.5 LB/Gal
Fuel Grade: JP-4



NOTE:

1. Fuel at any point includes Military Thrust climb, if required, to Cruise-Climb altitude.
2. No allowance or reserve made for loiter, descent or landing.
3. Best cruise condition is determined by intersection of climb path guide lines and lines of best range.
4. Cruise at recommended Mach number.
5 Change Cruise Speed When Cruise Altitude is Changed

Figure A4-6 (Sheet 1 of 2)



CRUISE DATA AT OPTIMUM CRUISE ALTITUDE

ALTITUDE		MACH NO.		IAS	TAS		
PRESSURE	INDICATED	TRUE	INDICATED	KNOTS	KNOTS	%RPM	LB/HR
PYLON TANKS AND TIP TANKS FUEL REMAINING							
25,000	24,400	.85	.82	355	510	97.5–94.0	4380–3830
PYLON TANKS EMPTY AND DROPPED							
28,800	28,150	.87	.84	340	515	95.0–92.5	3570–3220
TIP TANKS EMPTY BUT NOT DROPPED							
33,600	33,000	.87	.84	300	505	97.0–88.0	3250–2270

CRUISE DATA FOR ALTERNATE ALTITUDE FLIGHT (LOW FUEL VALUES)

ALTITUDE		MACH NO.		IAS	TAS	*	*
PRESSURE	INDICATED	TRUE	INDICATED	KNOTS	KNOTS	%RPM	LB/HR
30,000	29,400	.84	.82	320	500	87.5	2400
25,000	24,500	.81	.79	335	490	87.5	2710
20,000	19,500	.74	.72	335	450	87.0	2850
15,000	14,600	.68	.66	340	425	86.5	3050
10,000	9,600	.65	.63	350	410	87.0	3420
5,000	4,650	.61	.59	360	395	87.5	3790
S L	– 300	.56	.54	360	370	88.0	4050

*INITIAL APPROXIMATE VALUE

Figure A4-6 (Sheet 2 of 2)

Part 5 — Endurance

TABLE OF CONTENTS

(Page numbers in bold face denote illustrations)

Maximum Endurance Profile Charts **A5-2**
Optimum Maximum Endurance Profile Charts.... **A5-4**

ENDURANCE DATA PRESENTED.

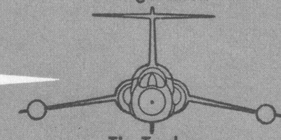
Endurance data are presented in this part by means of maximum endurance and optimum maximum endurance profile charts. The optimum maximum endurance profiles show the flight plan necessary to achieve maximum loiter time, whereas the maximum endurance charts show the performance available at other altitudes in addition to performance at the optimum altitude. Both types of profiles are based on operation at the speed schedules tabulated on the charts. Performance at other speed schedules can be obtained from data shown on the miles per pound charts in part 6 of T.O. 1F-104A-1.

Refer to T.O. 1F-104A-1 for the following;

- Allowance for Drag Items
- Maximum Endurance Profile Charts
- Optimum Maximum Endurance Profile Charts
- Best Altitude for Endurance
- Use of Optimum Maximum Endurance Profile Charts
- Maximum Endurance Profile Sample Problem
- Optimum Maximum Endurance Profile Sample Problem

MAXIMUM ENDURANCE PROFILE

Configuration



Tip Tanks

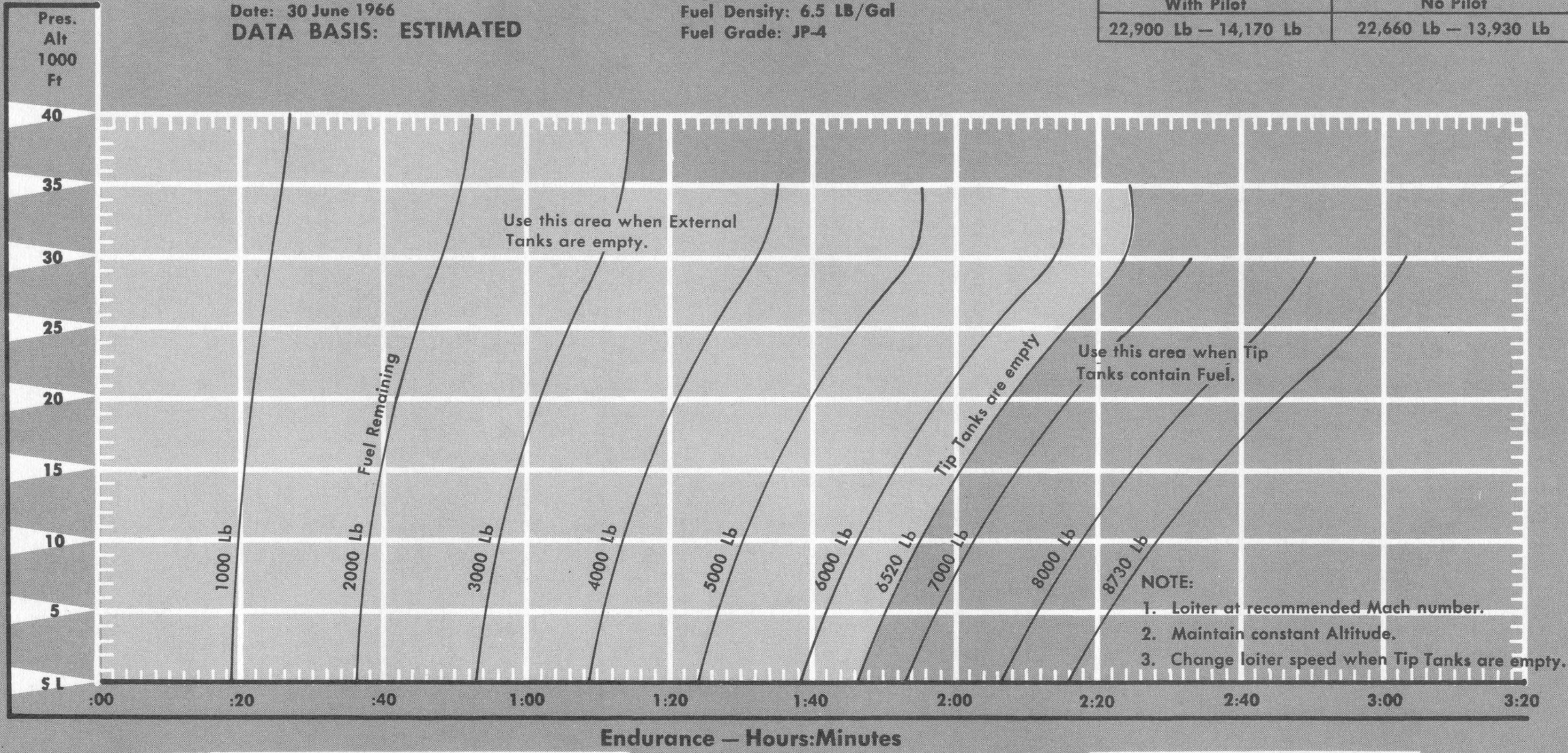
Gross Weight Range

With Pilot	No Pilot
22,900 Lb — 14,170 Lb	22,660 Lb — 13,930 Lb

Model: QF-104A
Date: 30 June 1966
DATA BASIS: ESTIMATED

Engine: J79-GE-3B
Fuel Density: 6.5 LB/Gal
Fuel Grade: JP-4

Standard Day
Zero Wind



		TIP TANKS EMPTY, BUT NOT DROPPED.						TIP TANK FUEL REMAINING.						
ALTITUDE-FT.		MACH NO.						MACH NO.						
PRESSURE	INDICATED	TRUE	INDICATED	IAS KNOTS	TAS KNOTS	* % RPM	* LB/HR	TRUE	INDICATED	IAS KNOTS	TAS KNOTS	* % RPM	* LB/HR
40,000	39,400	.89	.86	265	510	97.0	2440						
35,000	34,400	.90	.87	305	520	93.5	2720						
30,000	29,400	.86	.84	325	510	89.5	2700	.89	.86	335	520	94.5	3410
25,000	24,450	.80	.78	330	480	88.5	2890	.83	.81	345	500	91.0	3460
20,000	19,500	.73	.71	330	445	88.0	3070	.76	.74	350	470	90.5	3570
15,000	14,600	.66	.64	325	410	87.5	3240	.69	.67	345	430	90.0	3760
10,000	9,650	.58	.57	315	370	87.0	3410	.62	.60	335	395	89.0	3990
5,000	4,700	.53	.52	315	345	87.5	3680	.56	.54	330	360	88.5	4190
SL	− 250	.49	.48	315	325	87.5	3950	.51	.49	330	335	89.0	4590

* AVERAGE VALUES FOR EACH SEGMENT

Figure A5-1

MAXIMUM ENDURANCE PROFILE

Configuration

Tip and Pylon Tanks

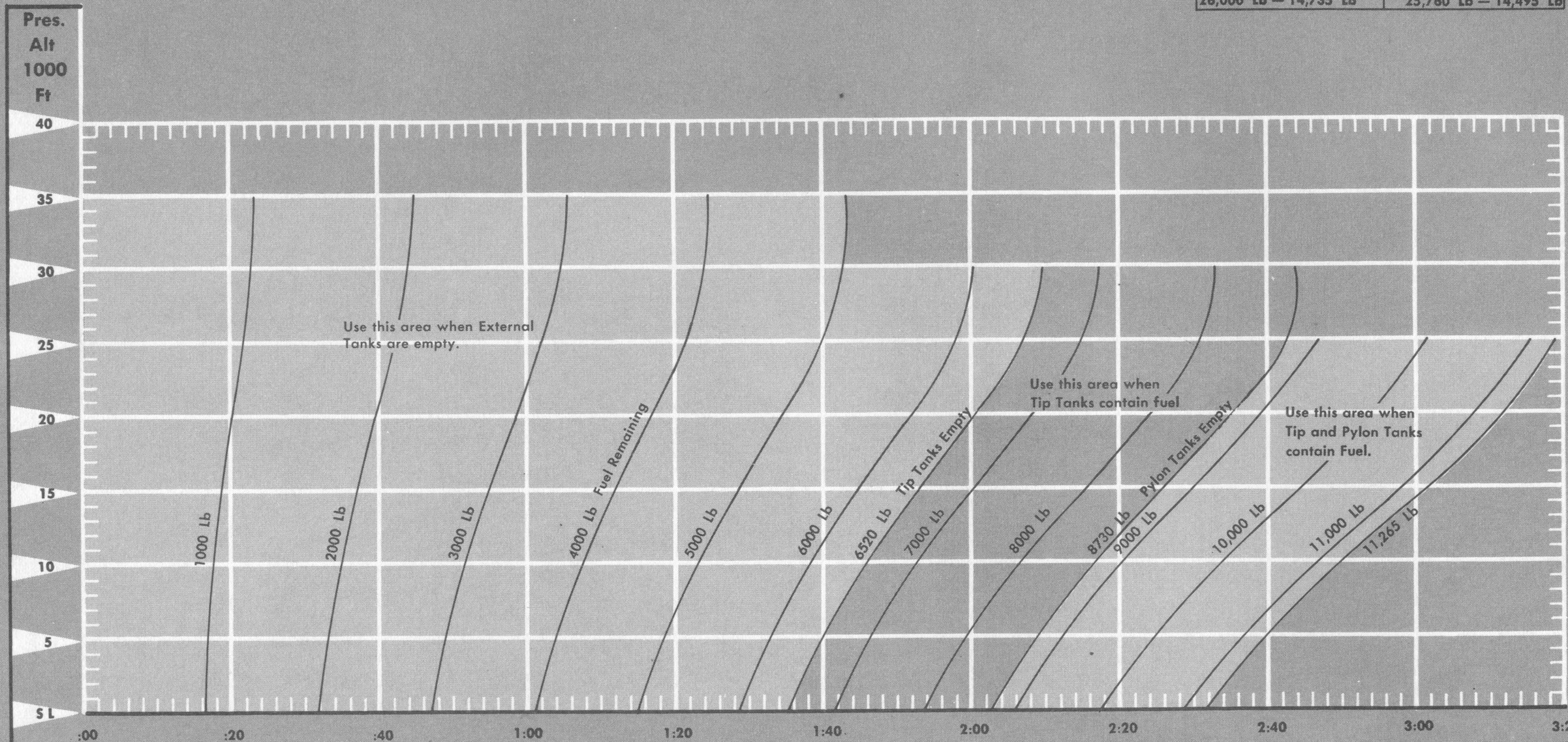
Gross Weight Range

With Pilot	No Pilot
26,000 Lb — 14,735 Lb	25,760 Lb — 14,495 Lb

Model: QF-104A
Date: 30 June 1966
DATA BASIS: ESTIMATED

Engine: J79-GE-3B
Fuel Density: 6.5 LB/Gal
Fuel Grade: JP-4

Standard Day
Zero Wind



NOTE:
1. Loiter at recommended Mach number.
2. Maintain constant Altitude.
3. Change loiter speed when Tip or Pylon Tanks are empty.

TIP AND PYLON TANKS FUEL REMAINING

ALTITUDE-FT PRESS	ALTITUDE-FT IND	MACH NO. TRUE	MACH NO. IND	IAS KNOTS	TAS KNOTS	* %RPM	* LB/HR
25,000	24,400	.85	.82	355	510	96.5	4180
20,000	19,450	.80	.77	365	490	93.0	4170
15,000	14,500	.73	.71	365	455	92.0	4320
10,000	9,600	.66	.65	365	425	91.0	4580
5,000	4,650	.61	.59	360	395	91.0	4910
S L	− 300	.56	.55	365	375	90.5	5290

TIP TANK FUEL REMAINING
(PYLON TANKS EMPTY, BUT NOT DROPPED.)

ALTITUDE-FT PRESS	ALTITUDE-FT IND	MACH NO. TRUE	MACH NO. IND	IAS KNOTS	TAS KNOTS	* %RPM	* LB/HR
35,000	34,400						
30,000	29,400	.88	.85	330	515	98.4	3860
25,000	24,450	.82	.80	340	495	93.5	3720
20,000	19,500	.77	.75	350	470	91.5	3790
15,000	14,550	.70	.68	345	435	90.5	4000
10,000	9,650	.63	.61	345	400	90.0	4270
5,000	4,700	.57	.56	340	370	89.5	4560
S.L.	− 250	.53	.51	340	345	89.5	4820

TIP AND PYLON TANKS EMPTY,
BUT NOT DROPPED.

MACH NO. TRUE	MACH NO. IND	IAS KNOTS	TAS KNOTS	* %RPM	* LB/HR
.89	.87	300	515	95.5	2960
.85	.83	320	500	92.0	3020
.80	.77	330	480	90.0	3080
.74	.72	335	455	90.0	3260
.66	.64	330	415	88.5	3470
.60	.58	325	380	88.0	3700
.54	.53	325	355	88.0	3920
.50	.49	325	330	88.0	4120

* AVERAGE FOR EACH SEGMENT

Figure A5-2

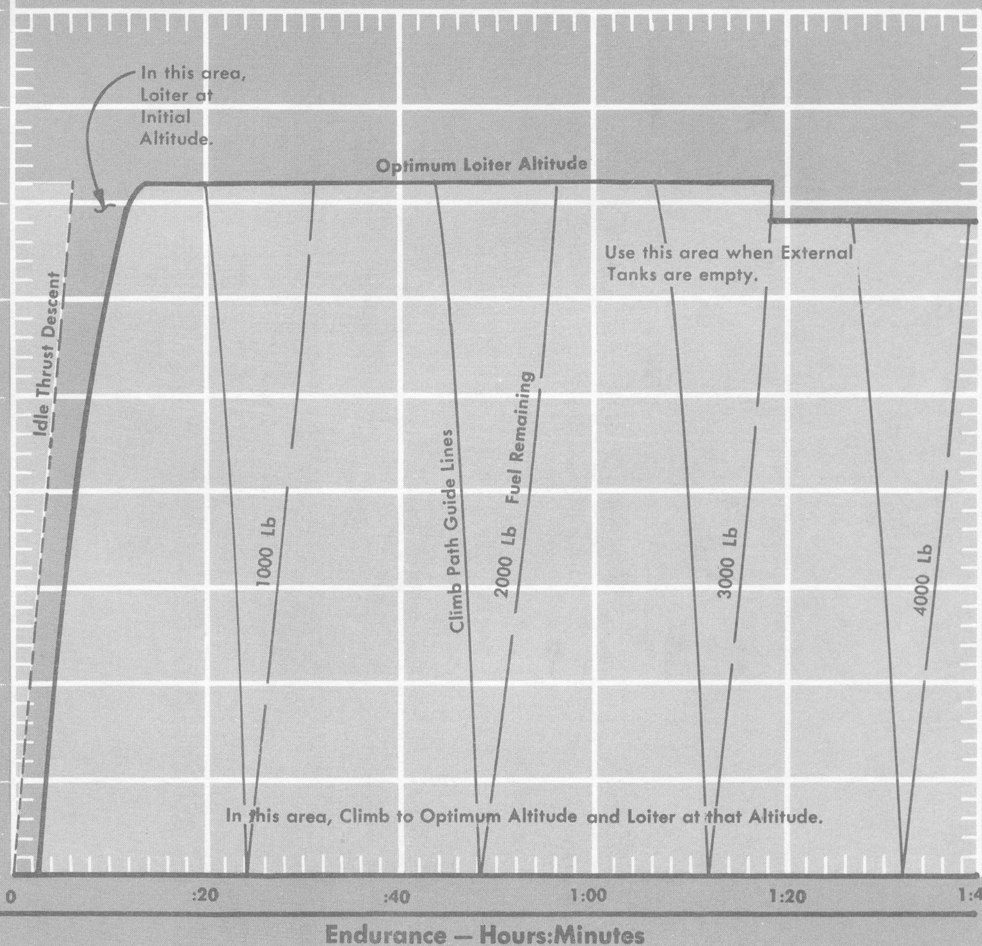
OPTIMUM MAXIMUM ENDURANCE PROFILE

Model: QF-104A
Date: 30 June 1966
DATA BASIS: ESTIMATED

Engine: J79-GE-3B
Fuel Density: 6.5 LB/Gal
Fuel Grade: JP-4

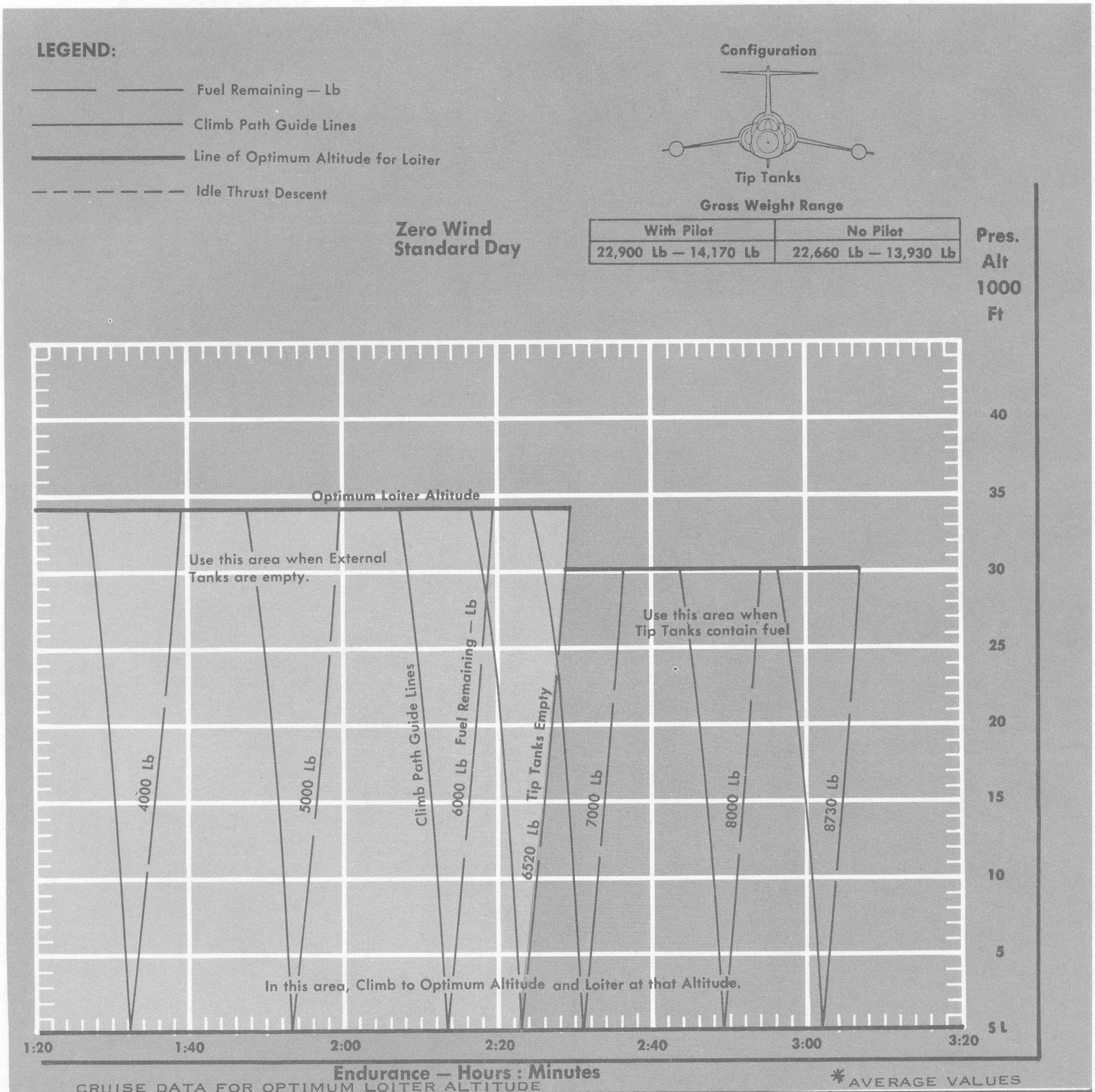
Climb Data — Military Thrust

True Mach No.	Ind. Mach No.	IAS Knots	Pres. Alt. 1000 Ft.
.88	.85	233	
.88	.85	262	40
.88	.85	294	35
.88	.85	331	30
.88	.85	366	25
.88	.85	403	20
.88	.85	443	15
.88	.85	484	10
.88	.85	525	5
.88	.85	569	S.L.



NOTE:
1. Fuel required at any point includes Military Thrust climb, if required, to altitude, loiter and Idle Thrust descent to Sea Level (see Military Thrust Climb Chart for detailed information).
2. Loiter at recommended Mach number.
3. Recommended descent at Idle Thrust and 300 knots IAS (see Descent Chart for detailed information).
4. No allowance or reserve made for landing.
5. Change loiter speed when Tip Tanks are empty.

Figure A5-3 (Sheet 1 of 2)



CRUISE DATA FOR OPTIMUM LOITER ALTITUDE

* AVERAGE VALUES

ALTITUDE – FT		MACH NO.		IAS KNOTS	TAS KNOTS	%RPM	LB/HR
PRESSURE	INDICATED	TRUE	INDICATED				
TIP TANKS FUEL REMAINING							
30,000	29,350	.89	.86	335	525	96.0 – 93.5	3560 – 3220
TIP TANKS EMPTY BUT NOT DROPPED							
34,000	33,350	.90	.87	325	520	97.5 – 92.0	3280 – 2670
3000 POUNDS OR LESS FUEL REMAINING							
36,000	35,400	.88	.85	290	505	93.5 – 89.0	2580 – 2150

CRUISE DATA FOR LOW FUEL REMAINING VALUES

ALTITUDE – FT		MACH NO.		IAS KNOTS	TAS KNOTS	* %RPM	* LB/HR
PRESSURE	INDICATED	TRUE	INDICATED				
35,000	34,450	.82	.80	275	480	88.0	2090
30,000	29,550	.76	.73	280	445	87.0	2220
25,000	24,600	.68	.66	275	410	86.0	2390
20,000	19,700	.60	.58	270	370	85.5	2520
15,000	14,750	.53	.52	265	335	85.0	2670
10,000	9,800	.47	.46	260	300	85.5	2840
5,000	4,800	.46	.45	270	300	86.0	3140
S L	–150	.41	.40	265	270	86.5	3300

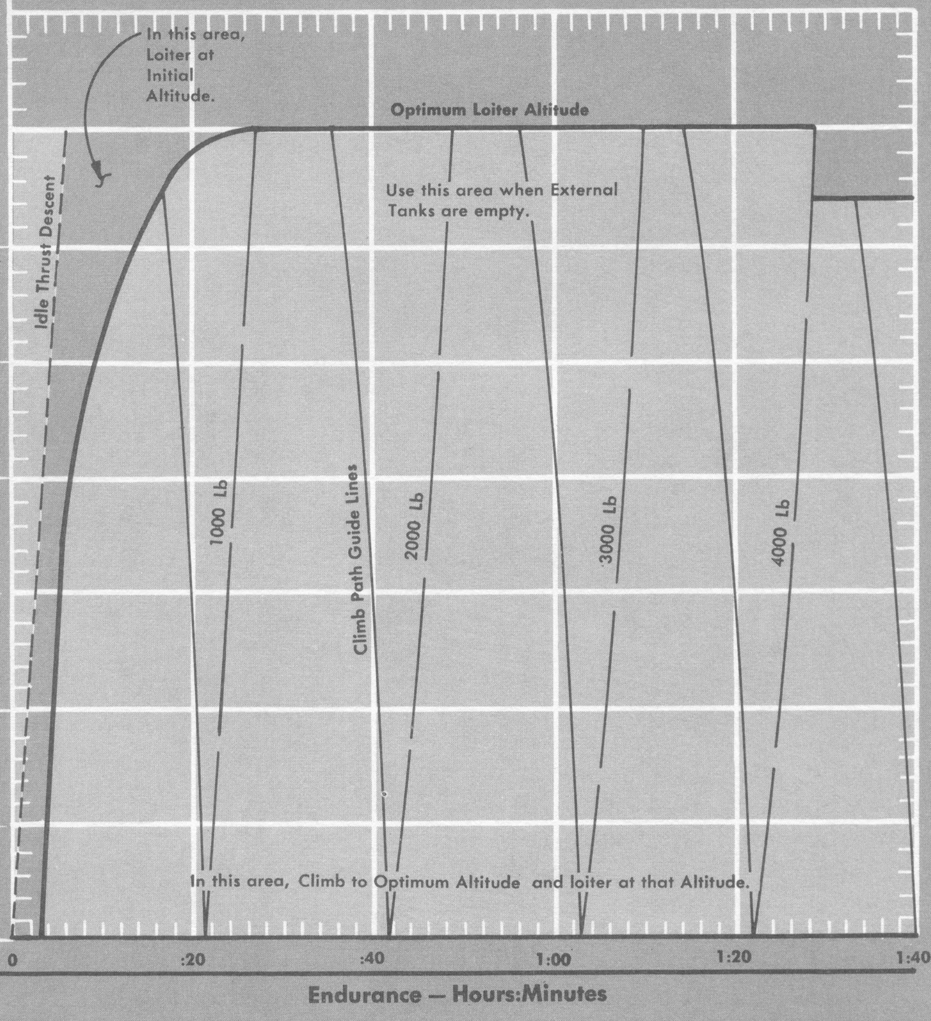
Figure A5-3 (Sheet 2 of 2)

OPTIMUM MAXIMUM ENDURANCE PROFILE

Model: QF-104A
Date: 30 June 1966
DATA BASIS: ESTIMATED

Engine: J79-GE-3B
Fuel Density: 6.5 LB/Gal
Fuel Grade: JP-4

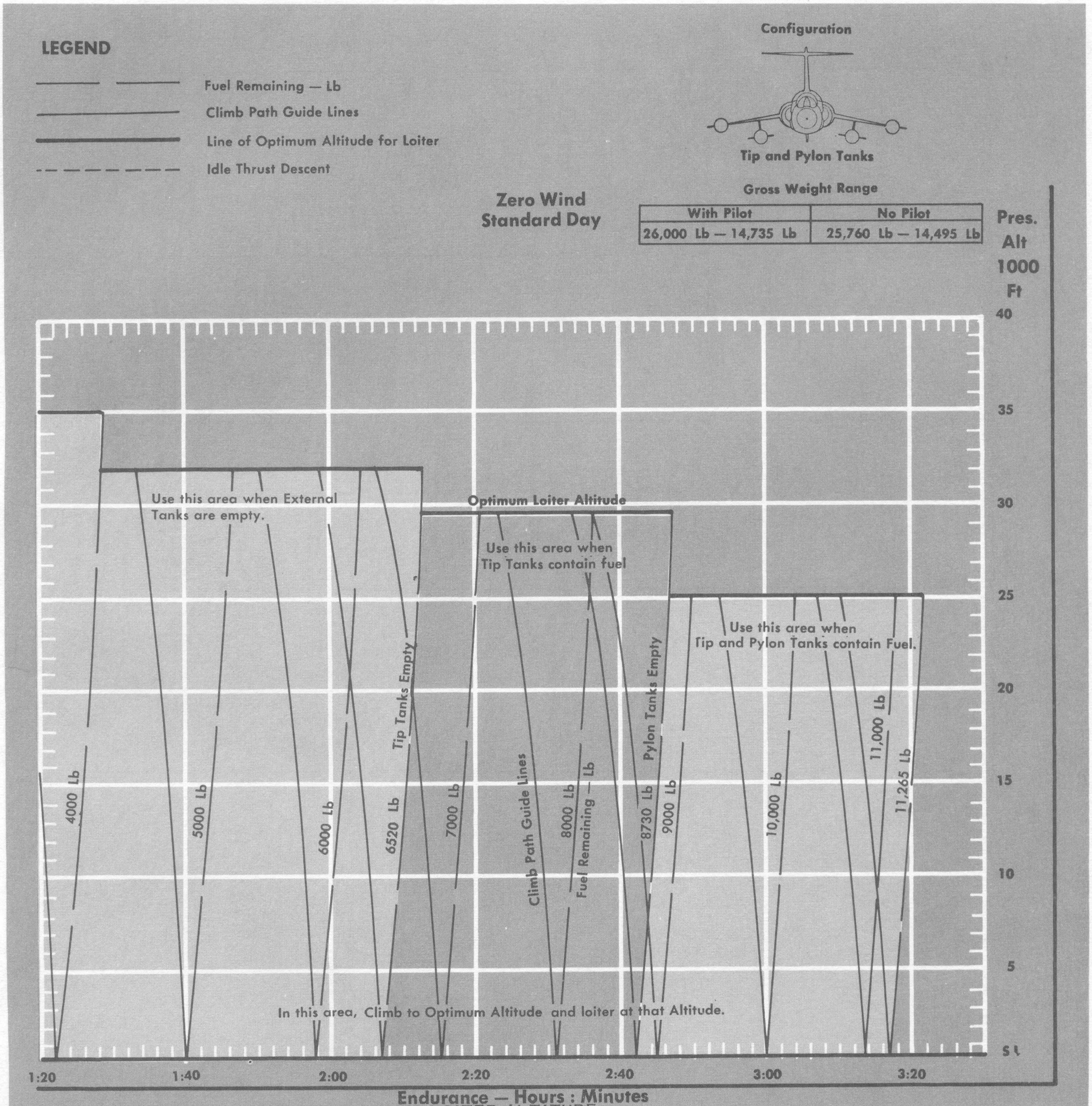
Climb Data			
Military Thrust			
True Mach No.	Ind. Mach No.	IAS Knots	Pres. Alt. 1000 Ft.
.825	.80	245	40
.825	.80	275	35
.825	.80	308	30
.825	.80	341	25
.825	.80	378	20
.82	.80	415	15
.825	.80	453	10
.825	.80	494	5
.825	.80	534	S.L.



NOTE:

1. Fuel required at any point includes Military Thrust climb, if required, to altitude, loiter and Idle Thrust descent to Sea Level (see Military Thrust Climb Chart for detailed information).
2. Loiter at recommended Mach number.
3. Recommended descent at Idle Thrust and 300 Knots IAS (see Descent Chart for detailed information).
4. No allowance or reserve made for landing.
5. Change loiter speed when Tip or Pylon Tanks are empty.

Figure A5-4 (Sheet 1 of 2)



CRUISE DATA FOR OPTIMUM LOITER ALTITUDE

ALTITUDE – FT		MACH NO.		IAS KNOTS	TAS KNOTS	%RPM	LB/HR
PRESSURE	INDICATED	TRUE	INDICATED				
PYLON TANKS AND TIP TANKS FUEL REMAINING							
25,000	24,400	.85	.82	355	510	98.0 – 95.0	4420 – 4000
PYLON TANKS EMPTY BUT NOT DROPPED							
29,500	28,900	.88	.85	330	515	98.5 – 96.5	3960 – 3600
TIP TANKS EMPTY BUT NOT DROPPED							
32,000	31,400	.87	.84	315	510	98.0 – 95.0	3530 – 3150
4000 POUNDS OR LESS FUEL REMAINING							
35,000	34,400	.88	.85	295	505	98.0 – 91.5	3150 – 2490

CRUISE DATA FOR LOW FUEL REMAINING VALUES

ALTITUDE – FT		MACH NO.		IAS KNOTS	TAS KNOTS	* %RPM	* LB/HR
PRESSURE	INDICATED	TRUE	INDICATED				
30,000	29,500	.77	.75	285	450	88.0	2400
25,000	24,600	.69	.67	280	415	87.0	2540
20,000	19,700	.61	.59	275	375	86.5	2710
15,000	14,750	.55	.53	270	340	86.0	2940
10,000	9,750	.50	.49	270	320	86.0	3120
5,000	4,800	.46	.45	275	300	86.5	3320
S L	– 200	.43	.42	275	280	87.0	3510

*AVERAGE VALUES

Figure A5-4 (Sheet 2 of 2)

Part 6—Miles per Pound Data

(Refer to T.O. 1F-104A-1)

Part 7—F-104B Aircraft Miles per Pound Data

(Deleted)

Part 8—Descent

(Refer to T.O. 1F-104A-1)

Part 9—Landing

(Refer to T.O. 1F-104A)

Part 10 — Combat Performance

TABLE OF CONTENTS

(Page numbers in bold face denote illustrations)

Maximum Thrust Climb Control **A10-3**
Maximum Thrust Climbing Turn Performance . . **A10-4**
Maximum Thrust Level Flight Turn Performance **A10-9**
Constant Altitude Deceleration **A10-10**

INTRODUCTION.

This part contains the necessary performance data for determining the basic target mission requirements when operating in the supersonic flight regime. Charts presented include climb control, level and climbing turns and deceleration characteristics. The charts are directly applicable to the basic drone configuration, tip tanks. All charts, except the deceleration chart, reflect performance for operation with maximum afterburner. The effect on performance when pylons are retained during acceleration or maneuvering has not been evaluated. It is assumed that the pylons are dropped with the tanks during the subsonic portion of the mission.

MAXIMUM THRUST CLIMB CONTROL.

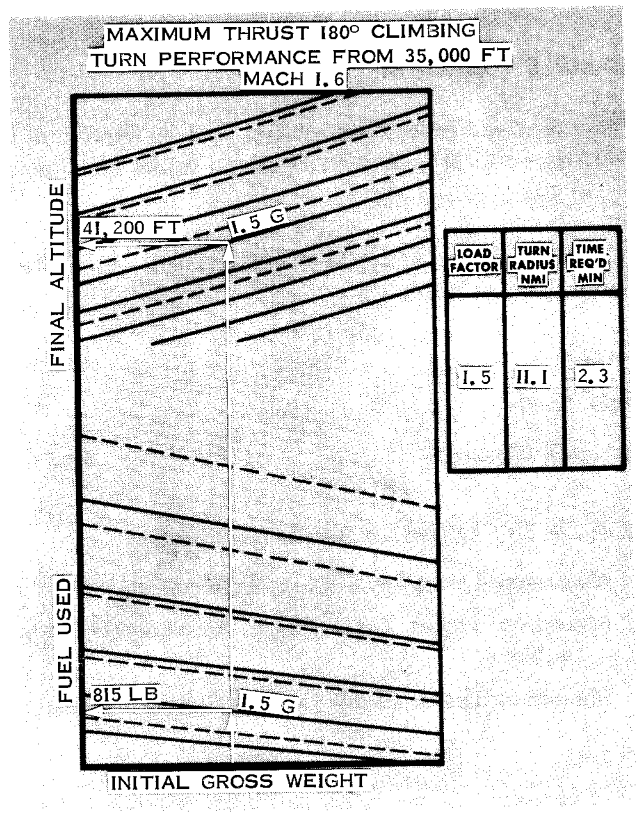
Maximum thrust climb performance with tip tanks at Mach 2.0 is presented in figure A10-1. Climb control at Mach 1.2, 1.4, 1.6 and 1.8 is presented in T.O. 1F-104A-1. The time, distance and fuel used in the climb are computed from a base altitude of 35,000 feet to the combat ceiling. The performance includes weight reduction due to fuel consumption and reflects the increase in rates of climb that result.

MAXIMUM THRUST LEVEL FLIGHT TURN PERFORMANCE.

Maximum thrust level flight turn performance load factor is presented in figure A10-7 for the tip tank configuration. The performance is shown for constant altitude, minimum radius turns where speed is also held constant. Load factor, when used in conjunction with the turning performance chart and Maximum thrust fuel flow chart in T.O. 1F-104A-1, provides turn radius, time for 180 degree turn and fuel used.

MAXIMUM THRUST CLIMBING TURN.

Climbing turn performance from a base altitude of 35,000 feet for the basic drone configuration is presented in figures A10-2 through A10-6. For maximum radius of operation the turn Mach number should be achieved in the acceleration in the outbound heading. The charts reflect full throttle operation.



SAMPLE PROBLEM.

Determine the turning performance for an aircraft in a Mach 1.6, Maximum thrust, 180-degree climbing turn. The initial gross weight is 16,500 pounds. The load factor is to be held constant at 1.5G.

1. Enter figure A10-4 at the initial gross weight of 16,500 pounds and 1.5 load factor. Read:

Fuel Used .... 815 lb
Final Altitude .... 41,200 ft
Turn Radius .... 11.1 nmi
Time Required .... 2.3 min
Bank Angle .... 48°

CONSTANT ALTITUDE DECELERATION.

Figure A10-8 presents level flight deceleration data to 300 knots IAS for various initial Mach numbers. The data are usable for the 15,000 to 17,000 lb weight range and based on the configuration with speed brakes closed and rpm reduced to 90%. Level-flight deceleration data to 450 knots IAS is also included in the altitude range from 50,000 to 55,000 feet to conform to Nullo flight limitations.

SAMPLE PROBLEM.

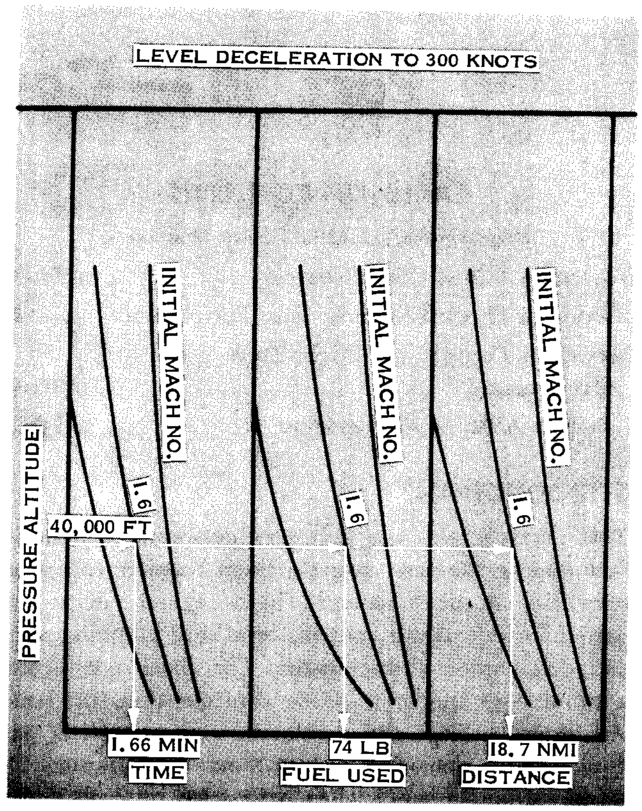
Determine the time, distance and fuel to decelerate to 300 knots IAS at 40,000 feet from an initial Mach number of 1.6.

1. Enter figure A10-8 at 40,000 feet and initial Mach number of 1.6. Read:

Time .... 1.66 min

Fuel Used .... 74 lb

Distance Required .... 18.7 nmi



Refer to T.O. 1F-104A-1 for the following;

Maximum Thrust Level Flight Acceleration

Maximum Thrust Level Flight Acceleration Sample Problem

Maximum Thrust Climb Control Sample Problem

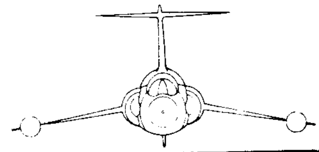
Maximum Thrust Fuel Consumption

Maximum Thrust Fuel Consumption Sample Problem

Maximum Thrust Turning Performance Sample Problem

MAXIMUM THRUST CLIMB CONTROL

CLIMB SPEED MACH 2.0

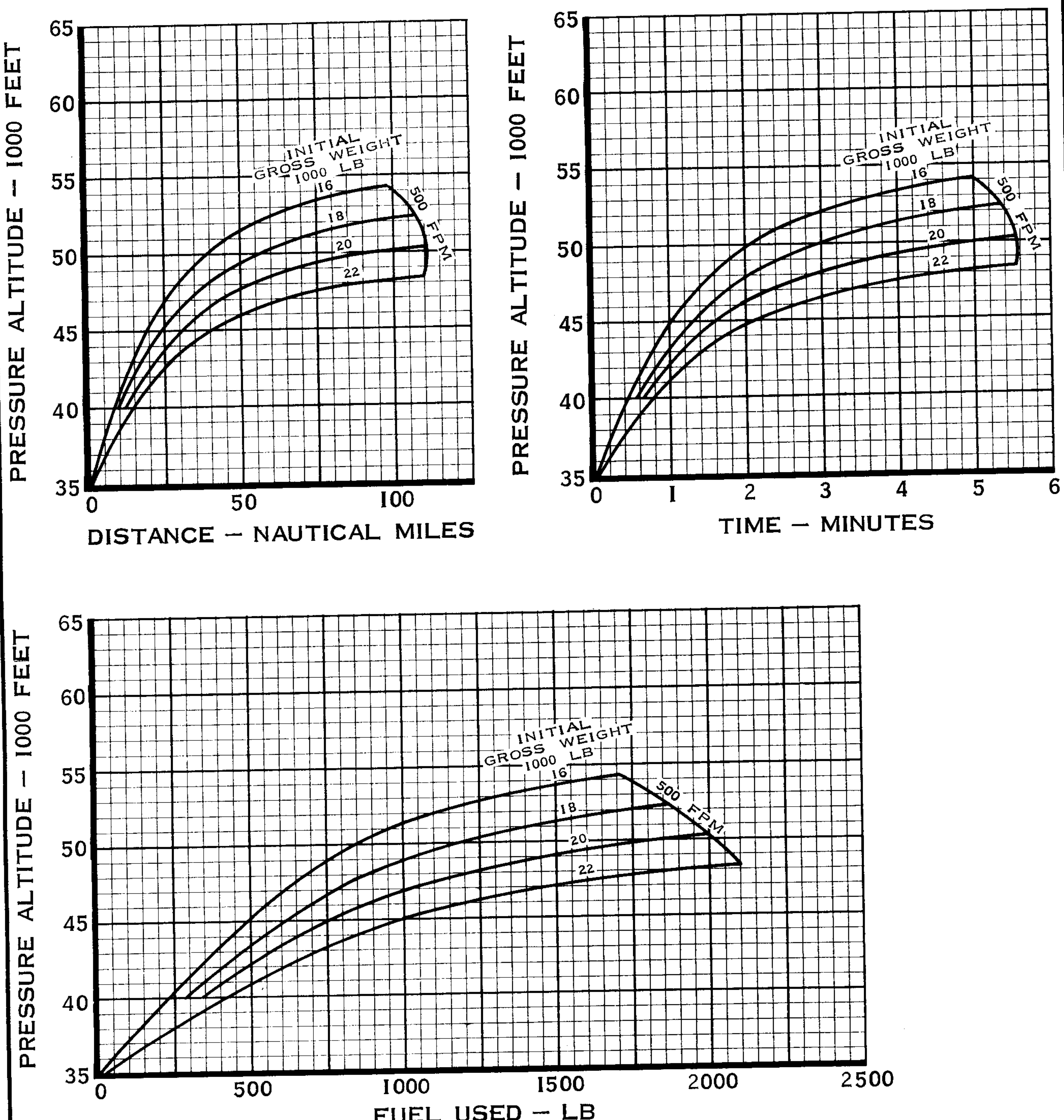


TIP TANKS

Model: QF-104A
Date: 30 June 1966
DATA BASIS: ESTIMATED

Engine: J79-GE-3B
Fuel Grade: JP-4
Fuel Density: 6.5 Lb/Gal

STANDARD DAY



NOTE: TO COMPENSATE FOR NONSTANDARD AIR TEMPERATURE ADD 4000 LB TO AIRCRAFT GROSS WEIGHT PER 5° ABOVE STANDARD. SUBTRACT 4000 LB PER 5° BELOW STANDARD.

Figure A10-1

MAXIMUM THRUST 180° CLIMBING TURN PERFORMANCE FROM 35,000 FEET

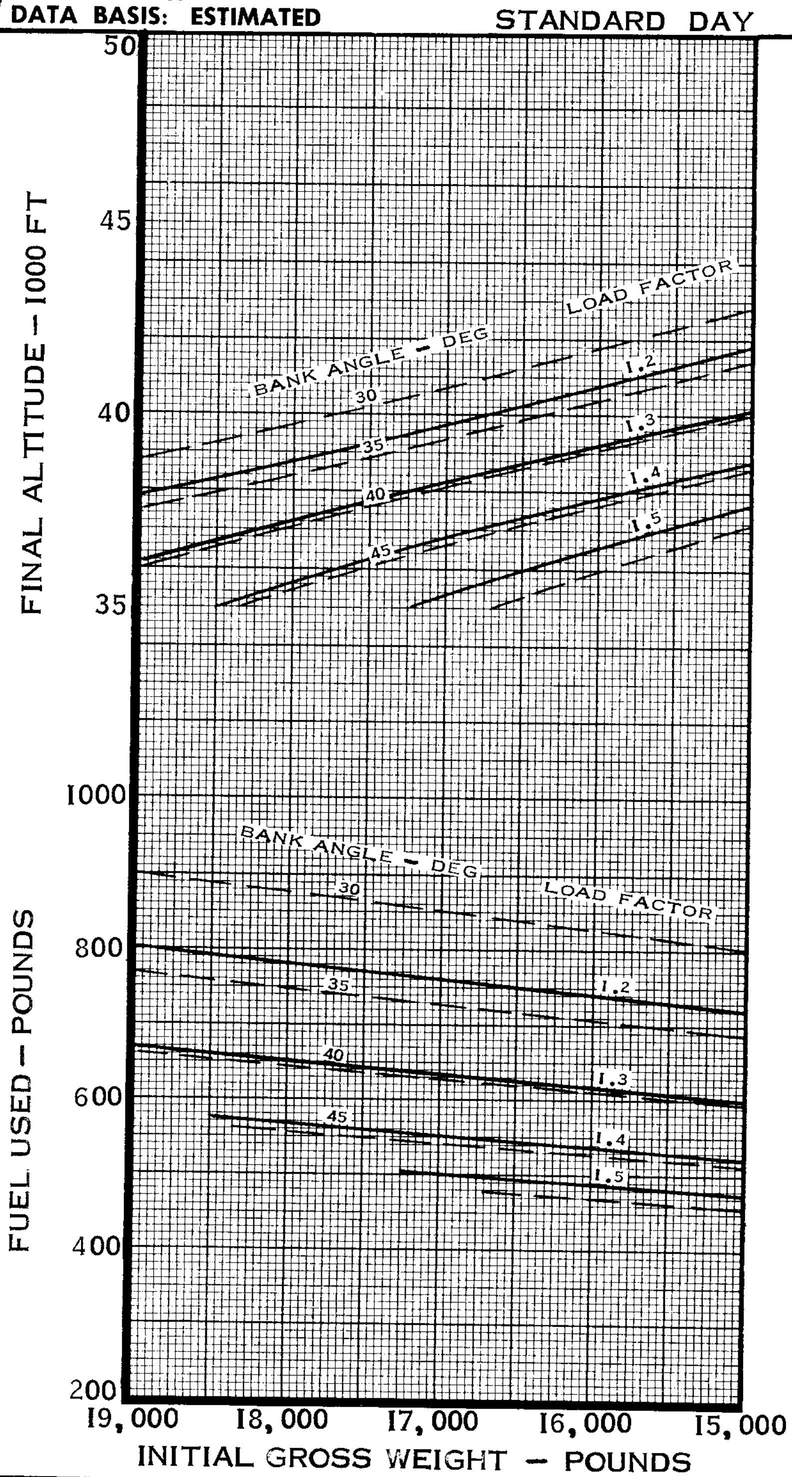
MACH 1.2

TIP TANKS

Model: QF-104A
Date: 30 June 1966
DATA BASIS: ESTIMATED

STANDARD DAY

Engine: J79-GE-3B
Fuel Grade: JP-4
Fuel Density: 6.5 Lb/Gal



LOAD FACTOR – G'S	TURN RADIUS – N MI	TIME REQD – MIN
1.2	10.7	2.8
1.3	8.6	2.2
1.4	6.9	1.9
1.5	6.1	1.7

BANK ANGLE – DEG	TURN RADIUS – N MI	TIME REQD – MIN
30	12.4	3.4
35	9.9	2.7
40	8.2	2.3
45	6.9	1.9

Figure A10-2

MAXIMUM THRUST 180° CLIMBING TURN PERFORMANCE FROM 35,000 FEET

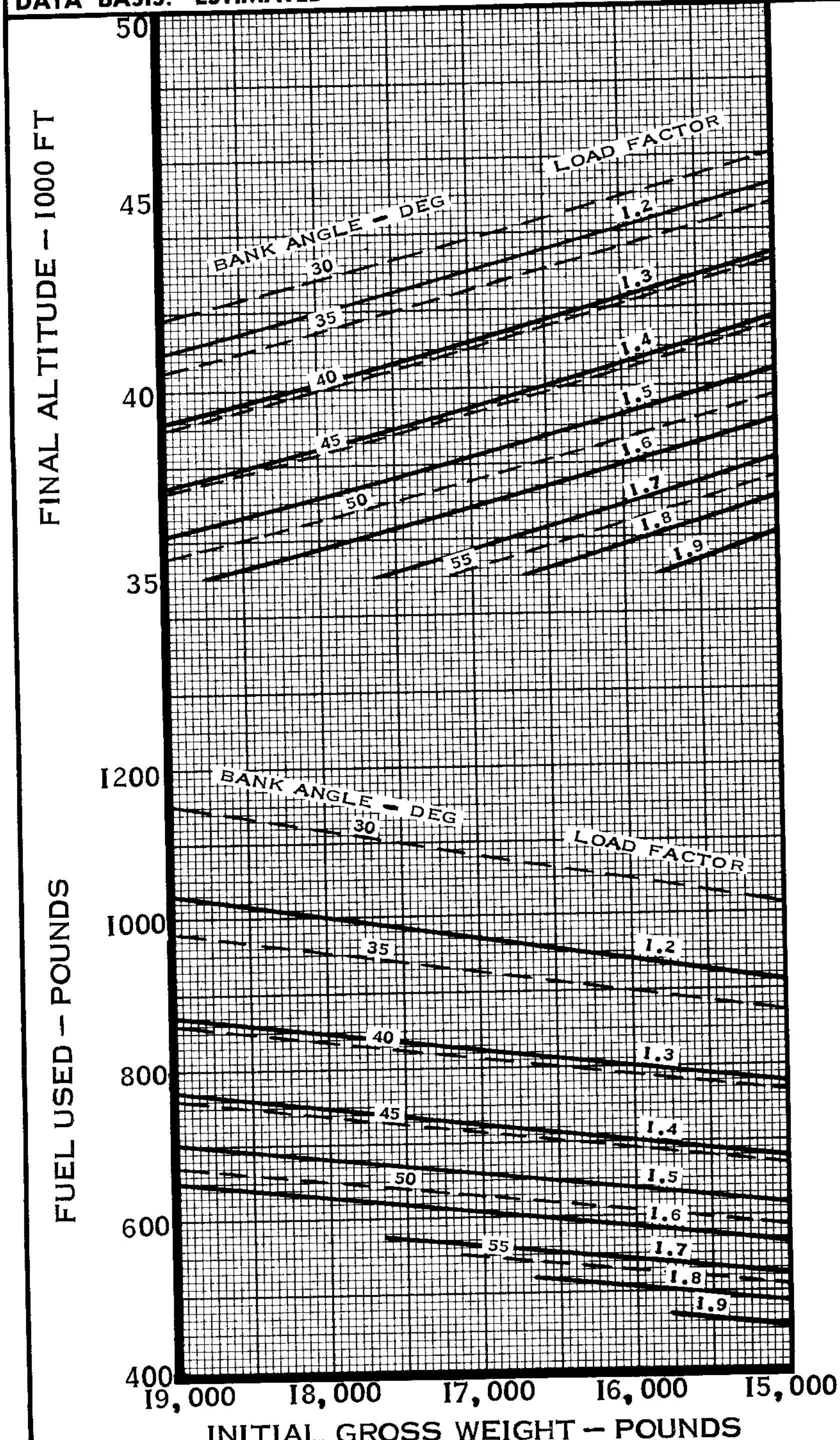
MACH 1.4

TIP TANKS

Model: QF-104A
Date: 30 June 1966
DATA BASIS: ESTIMATED

STANDARD DAY

Engine: J79-GE-3B
Fuel Grade: JP-4
Fuel Density: 6.5 Lb/Gal



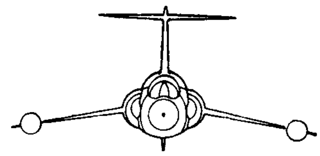
LOAD FACTOR – G'S	TURN RADIUS – N MI	TIME REQD – MIN
1.2	14.4	3.4
1.3	11.6	2.7
1.4	9.7	2.2
1.5	8.3	2.0
1.6	7.6	1.8
1.7	7.0	1.6
1.8	6.4	1.5
1.9	5.9	1.4

BANK ANGLE – DEG	TURN RADIUS – N MI	TIME REQD – MIN
30	16.9	4.0
35	13.4	3.2
40	11.2	2.6
45	9.4	2.2
50	7.9	1.9
55	6.6	1.6

Figure A10-3

MAXIMUM THRUST 180° CLIMBING TURN PERFORMANCE FROM 35,000 FEET

MACH 1.6

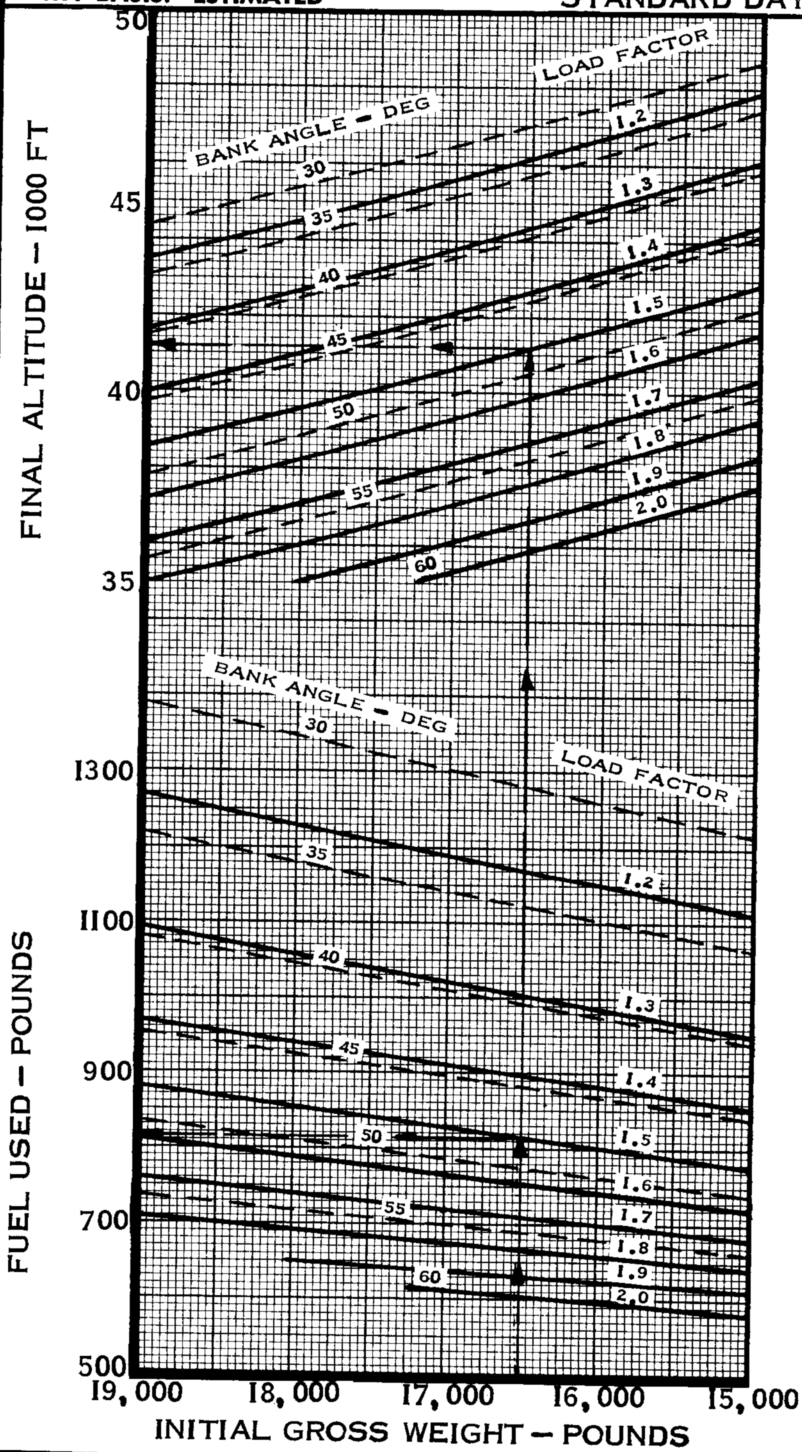


TIP TANKS

Model: QF-104A
Date: 30 June 1966
DATA BASIS: ESTIMATED

STANDARD DAY

Engine: J79-GE-3B
Fuel Grade: JP-4
Fuel Density: 6.5 Lb/Gal



LOAD FACTOR – G'S	TURN RADIUS – N MI	TIME REQD – MIN
1.2	18.7	3.8
1.3	15.0	3.1
1.4	12.5	2.6
1.5	11.1	2.3
1.6	10.0	2.0
1.7	9.0	1.8
1.8	8.3	1.7
1.9	7.7	1.6
2.0	7.1	1.5

BANK ANGLE – DEG	TURN RADIUS – NI MI	TIME REQD – MIN
30	22.0	4.5
35	17.5	3.6
40	14.6	3.0
45	12.3	2.5
50	10.3	2.1
55	8.6	1.8
60	7.1	1.5

Figure A10-4

MAXIMUM THRUST 180° CLIMBING TURN PERFORMANCE FROM 35,000 FEET

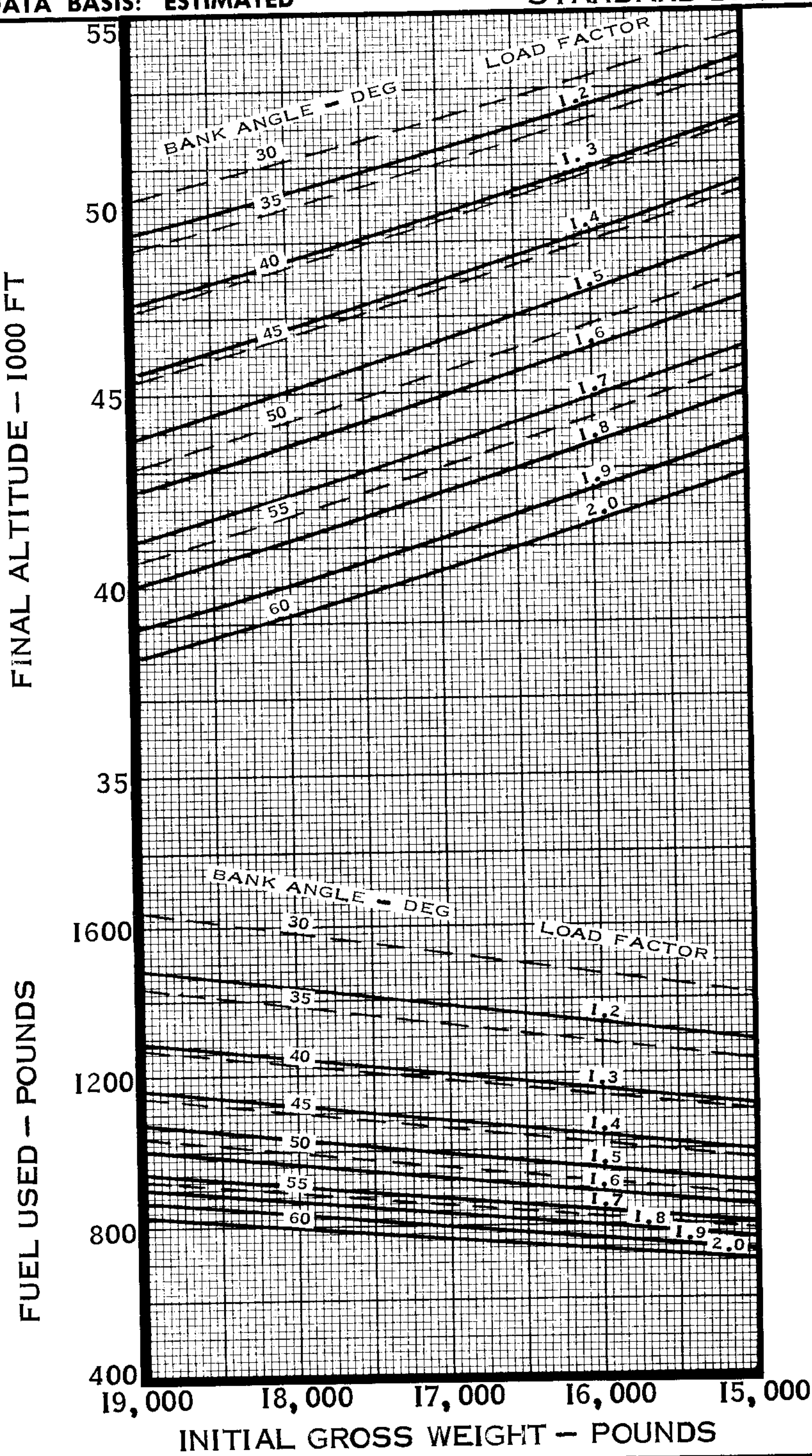
MACH 1.8

TIP TANKS

Model: QF-104A
Date: 30 June 1966
DATA BASIS: ESTIMATED

STANDARD DAY

Engine: J79-GE-3B
Fuel Grade: JP-4
Fuel Density: 6.5 Lb/Gal



LOAD FACTOR — G'S	TURN RADIUS — N MI	TIME REQD — MIN
1.2	23.3	4.3
1.3	18.7	3.4
1.4	15.7	2.9
1.5	13.9	2.5
1.6	12.4	2.3
1.7	11.3	2.1
1.8	10.3	1.9
1.9	9.6	1.8
2.0	9.0	1.7

BANK ANGLE — DEG	TURN RADIUS — N MI	TIME REQD — MIN
30	27.9	5.1
35	22.2	4.1
40	18.6	3.4
45	15.5	2.8
50	13.0	2.4
55	10.9	2.0
60	9.0	1.7

Figure A10-5

MAXIMUM THRUST 180° CLIMBING TURN PERFORMANCE FROM 35,000 FEET

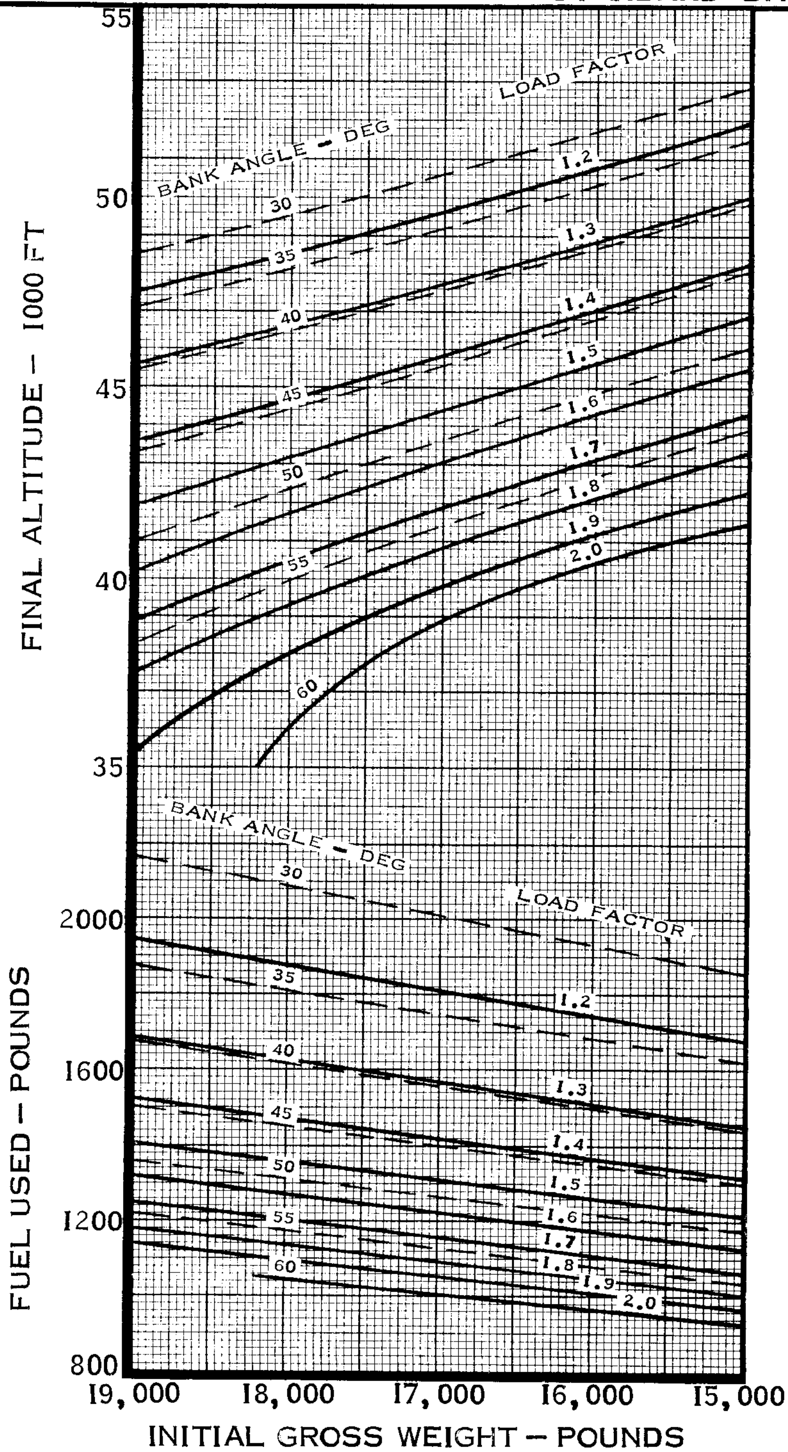
MACH 2.0

TIP TANKS

Model: QF-104A
Date: 30 June 1966
DATA BASIS: ESTIMATED

STANDARD DAY

Engine: J79-GE-3B
Fuel Grade: JP-4
Fuel Density: 6.5 Lb/Gal



LOAD FACTOR – G'S	TURN RADIUS – N MI	TIME REQD – MIN
1.2	29.0	4.8
1.3	23.7	3.8
1.4	19.7	3.2
1.5	17.4	2.8
1.6	15.6	2.5
1.7	14.2	2.3
1.8	13.0	2.1
1.9	12.0	1.9
2.0	11.1	1.8

BANK ANGLE – DEG	TURN RADIUS – N MI	TIME REQD – MIN
30	34.4	5.6
35	27.4	4.5
40	22.8	3.7
45	19.2	3.1
50	16.1	2.6
55	13.4	2.2
60	11.1	1.8

Figure A10-6

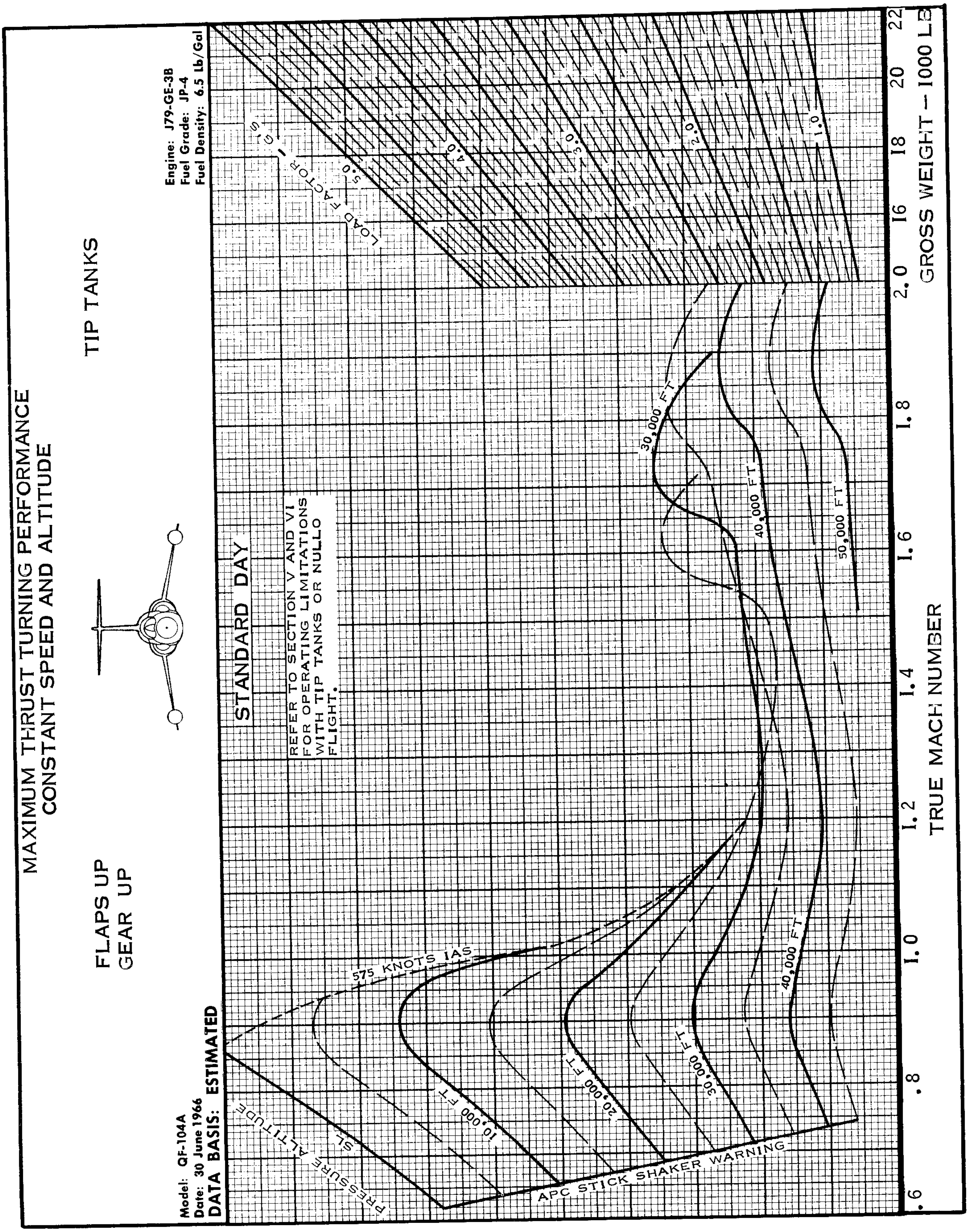

MAXIMUM THRUST TURNING PERFORMANCE
CONSTANT SPEED AND ALTITUDE
TIP TANKS
FLAPS UP
GEAR UP
STANDARD DAY
REFER TO SECTION V AND VI FOR OPERATING LIMITATIONS WITH TIP TANKS OR NULLO FLIGHT.
Model: QF-104A
Date: 30 June 1966
DATA BASIS: ESTIMATED
Engine: J79-GE-3B
Fuel Grade: JP-4
Fuel Density: 6.5 Lb/Gal
LOAD FACTOR - G
6.0
5.0
4.0
3.0
2.0
1.0
575 KNOTS IAS
SL
PRESSURE ALTITUDE
10,000 FT
20,000 FT
30,000 FT
40,000 FT
50,000 FT
APC STICK SHAKER WARNING
TRUE MACH NUMBER
.6
.8
1.0
1.2
1.4
1.6
1.8
2.0
GROSS WEIGHT — 1000 LB
16
18
20
22

Figure A10-7

LEVEL DECELERATION TO 300 KNOTS

Gross Weight Range
15,000 Lb — 17,000 Lb

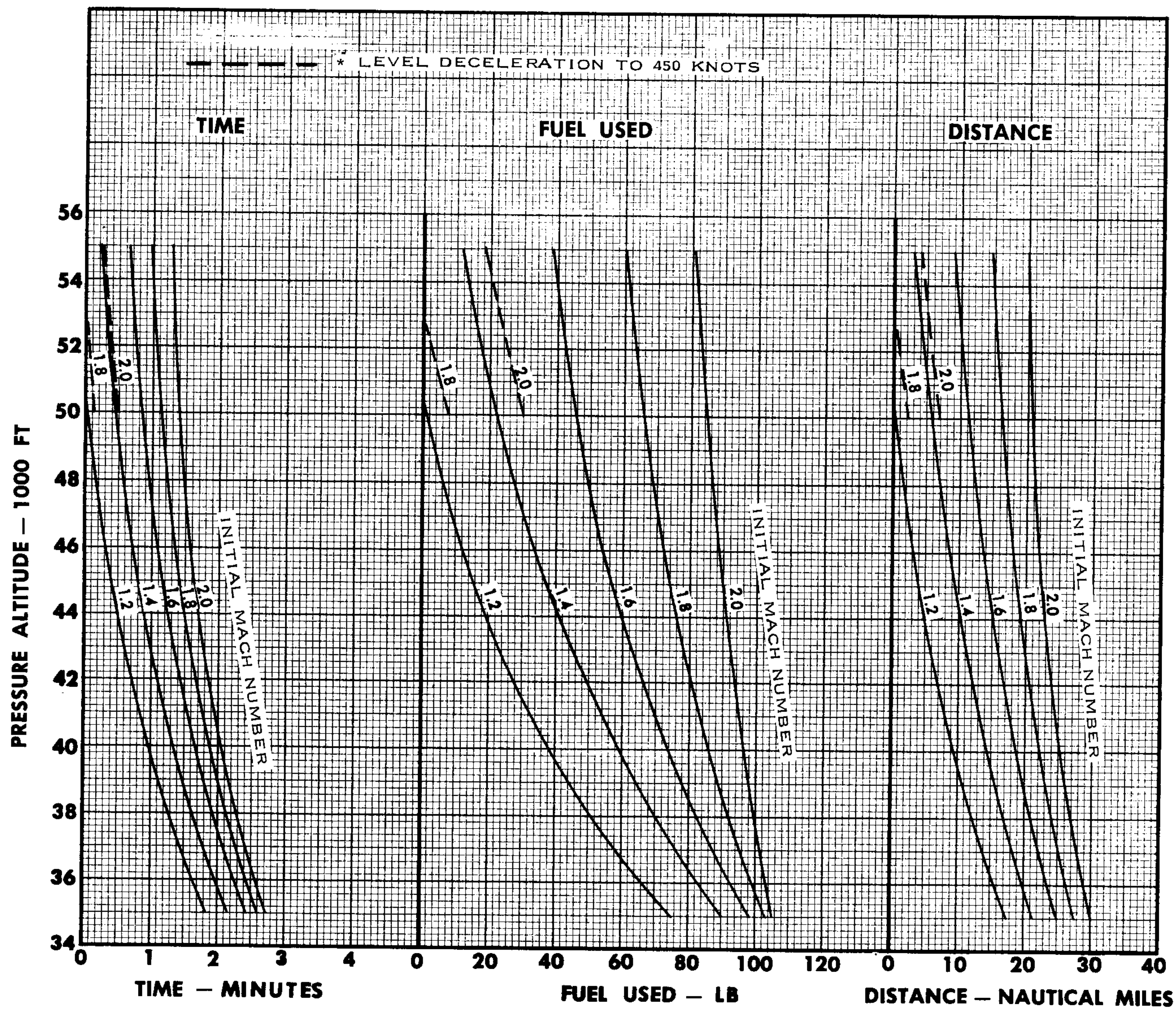
SPEED BRAKES CLOSED

90% RPM

Tip Tanks

Model: QF-104A
Date: 30 June 1966
DATA BASIS: ESTIMATED

Engine: J79-GE-3B
Fuel Density: 6.5 Lb/Gal
Fuel Grade: JP-4



*NULLO FLIGHT LEVEL DECELERATIONS LIMITED TO 450 KNOTS IAS IN THE ALTITUDE RANGE FROM 50,000 TO 55,000 FEET. SEE SECTION III, PART 6.

Figure A10-8

Part 11 — Mission Planning

(Refer to T.O. 1F-104A-1)

Alphabetical Index

A

Abort Takeoff 3-3
AC Electrical Power Supply 1-6
—Emergency 1-6
Acceleration Limitations 5-1
Acceleration Limits and Maximum Allowable Airspeed 5-2*
After Disengagement 3-2
After Landing 2-17, 2-31
After Takeoff Climb 2-12, 2-21
After Starting 2-33
Afterburner
—Climb 2-21
—Failure 3-4
—Operation 2-13, 2-25
Air-to-Air Landings 2-30
Aircraft Check, Preflight 2-19
Airplane 1-1
—Check 2-10
—3-View . . . . . vi*
Airspeed and Acceleration Limits, Maximum Allowable 5-2*
Airspeed Limit Warning 3-5
Airspeed on Throttle 2-24
Airstart and Idle Gate Operation 2-24
All Flights, Normal Procedures 2-1
All Weather Operation 9-1, 9-2
AN/AKT-7, Telemetry Set 4-1
AN/APW-20, Radar Guidance System 4-1
AN/ARC-66, UHF Command Radio and Interphone System 4-2
AN/ARN-31, Glideslope Receiver 4-2
AN/ARW-64, Radio Command System 4-1
AN/DPN-50, C-Band Beacon 4-2
Antenna and Camera Location Diagram 4-14*
Approach 2-26
Armament 1-1
ARW Carrier Failure 3-4
Augmentation System, X- and L-Band 4-17
ATO (Automatic Takeoff) 2-20
—Failure 3-3
—Lift-Off and Completion 2-20
—Sequence Failure 3-3
Asymmetrical Load, Flight with 6-4
Automatic (DSCE) Flight 6-1
Automatic Pitch Control (Kicker) System 1-13
Automatic Start 2-7
Automatic Takeoff 4-21
Automatic Takeoff, Typical (ATO) 2-22*
Auxiliary Equipment 1-23, 4-1
Auxiliary Fuel Cells 1-6
Auxiliary Systems Operation 4-20

B

Balance and Weight 2-2
Base, Approach 2-26
Base Leg, Before Landing 2-14
Battery Start 2-8
Before Entering Cockpit 2-2
Before Exterior Inspection 2-2
Before Landing 2-13
—Base Leg 2-14
—Downwind 2-13
—Final 2-14
—Initial 2-13
Before Leaving Aircraft 2-17, 2-31, 2-41, 2-42
Before Starting Engine 2-6
Before Takeoff 2-10, 2-19
Before Taxiing 2-10, 2-17
Both Generators Out 3-1
Boundary Layer Control 2-14
Brake System, Wheel 1-22

C

C-Band Beacon, AN/DPN-50 4-2
Camera and Antenna Location Diagram 4-14*
Camera Scoring System 4-17
Carrier Failure, Total (ARW and APW) 3-5
Carrier Recovery Sequence 4-23
Circuit Breaker Panels 1-16*
Circuit Breakers 1-11
Climb 2-12, A3-1, A3-2
—After Takeoff 2-12
Climb Control, Maximum Thrust A10-1, A10-3*
Climb from Takeoff to 4000 Feet (After Completion of ATO) 2-21
Climbing Turn, Maximum Thrust A10-1
Climbing Turn Performance, Maximum Thrust. . A10-4*
Climbs, Zoom 6-1
Cockpit Check, Final 2-36
Cockpit—Left Side 1-8*
—Right Side 1-9*
Combat Performance A10-1
Communications and Associated Electronic Equipment 4-1, 4-12*

PAGE NUMBERS WITH ASTERISKS (*) DENOTE ILLUSTRATIONS

Completion of ATO, Climb from Takeoff to 4000 Feet After 2-21
Control Equipment, Drone Stabilization and—General Arrangement 4-4*
Control Stick 1-13
—Controls 4-13
—Grip 1-23*
Constant Altitude Deceleration A10-2, A10-10*
Crew Duties 8-1
Crosswind Landing 2-15
Crosswind Takeoff 2-12
Cruise 2-12, 2-24
Cruise Altitude, 4000 Feet to (Military Thrust Climb) 2-21
Cruise Data at 300 Knots IAS A4-1

D

DC Electrical Power Supply 1-10
DC Power Supply, Emergency 1-10
Dead-Stick Landing 3-4
Deceleration, Constant Altitude A10-2, A10-10*
Descent 2-13, 2-25, 2-38
Descent to Pattern Altitude 2-26
Destruct System 4-19
Destructor Package—Installation of 4-18*
—Post Installation of 4-19*
Direct Throttle 2-25
Disengagement 3-2
Distance to Clear a 50 Foot Obstacle, Total A2-1, A2-2
Downwind—Approach 2-26
—Before Landing 2-13
Drag Chute System 1-23
Drag Chute, Wheel Brakes and 4-20
Drone
—Conversion 1-1
—Equipment, Manuals Describing 1-4
—Recovery 2-40
—Stabilization and Control Equipment (DSCE) 4-3
—Stabilization and Control Equipment—General Arrangement 4-4*
DSCE
—Approach and Land Pattern 2-28*
—Automatic Sequences 4-21
—Commands, Summary of 4-8*
—Components 4-3
—Controls 4-7
—Controls and Indicators 4-6*
—Guidance Emergencies 3-2
—Indicators 4-15
—In-Flight Engagement 2-25
—Malfunctions 3-2
—Pre-Nullo Check 2-31
—Pre-Nullo Check Exterior Inspection 2-32
—Pre-Nullo Check Interior Inspection 2-32
—Runway Check 2-20
DT-33 and MRW-5 Control Panel Arrangements 4-10*

E

Electrical Power Distribution 1-14*
Electrical Power Supply, DC 1-10
Electrical Power Supply Systems 1-6
Electronic Equipment, Communications and Associated 4-1, 4-12*
Emergency
—AC Power Supply 1-6
—DC Power Supply 1-10
—DSCE Guidance 3-2
—Manned Flight 3-1
—Procedures 3-1
—Unmanned Flight 3-3
Endurance A5-1
—Data Presented A5-1
Engine 1-5
—Check 2-10, 2-34
—Check, Preflight 2-19
—Cutoff 3-6
—Failure During Flight 3-4
—Ignition System 1-5
—Shutdown 2-17, 2-31, 2-41, 2-42
—Start 2-33
EOD Check 2-37
Establishing Level Flight 2-24
Exterior Inspection 2-2, 2-3*
—DSCE Pre-Nullo Check 2-32
External Indicator Lights 4-20
External Stores Jettison 3-5
External Tanks 1-6

F

Failure of DSCE to Disengage 3-2
Failure of Gear to Retract After ATO 3-3
Failures, Hardover 3-2
False or Hanging Start Procedure 2-8
Final—Approach 2-26
—Approach Speed, Takeoff Flaps, Forward Center-of-Gravity 6-3*
—Cockpit Check 2-36
Flameout Plus Carrier Failure and Telemetry Failure 3-5
Flameout, Sustained 3-4
Flight
—Characteristics 2-13, 2-25, 6-1
—Control System 1-13
—Controls 6-1
—Planning 2-1
—Restrictions 2-1
—With Asymmetrical Load 6-4

PAGE NUMBERS WITH ASTERISKS (*) DENOTE ILLUSTRATIONS

Forward Center-of-Gravity Final Approach Speed, Takeoff Flaps 6-3*
Forward Main Cell 1-6
Forward Panel—Left 1-10*
—Right 1-11*
Fuel Allowances, Transition Time and A3-1, A3-2
Fuel Control Panel 1-12*
Fuel Quantity Data 1-13*
Fuel Supply System 1-6
Full Power Irreversible Control System 1-13

G

G Switch and Stabilizer Rate Disconnect Check 2-24
Gear Retraction Failure After ATO 3-3
General Arrangement 1-2*
Generators Out, Both 3-1
Glideslope Receiver, AN/ARN-31 4-2
Glossary iv
Go-Around 2-16, 2-30
Ground Checks 2-31
Ground Operation 2-8
Gross Weight 1-1
Guidance Emergencies, DSCE 3-2

H

Hanging or False Start Procedure 2-8
Hardover Failures 3-2
Heavyweight Landing 2-15, 6-4
Hydraulic Power Supply System, No. 1 and No. 2 1-12
Hydraulic Power Supply Systems 1-12
Hydraulic Pressure Failure, Total 3-6
Hydraulic System 1-20*

I

Icy Runway 2-16
Ignition System, Engine 1-5
In-Flight Engagement, DSCE 2-25
Initial, Before Landing 2-13
Interior Check 2-2
Interior Inspection, DSCE Pre-Nullo Check 2-32
Installation of Destructor Package 4-18*
Instrument Panel 1-7*
Instrument Power Supply 1-11
Instruments 1-23, 1-24
Irreversible Control System, Full Power 1-13

J

J-4 Directional Indicator System 4-20

L

Land Pattern, DSCE and Approach 2-28*
Landing 2-14, 2-30
—Before 2-13
—Crosswind 2-15
—Data Cards, Takeoff and 2-2
—Gear 4-20
—Gear Lever 1-19
—Gear, Main 1-19
—Gear, Nose 1-19
—Gear System 1-19
—Heavyweight 2-15, 6-4
—Minimum Run 2-15
—Normal 2-15
—On Slippery Runways 2-16
—Technique 2-14
—Touch-and-Go 2-16, 2-27
—Wheel Brakes, Use of 7-1, 7-2
Lateral Control 4-7
Launch 2-37
Left Forward Panel 1-10*
Level Flight
—Characteristics 6-3
—Establishing 2-24
—Turn Performance, Maximum Thrust A10-1, A10-9*
Lift-Off and Completion, ATO 2-20
Lighting Equipment 4-20
Longitudinal Control 4-5
Loss of Afterburner During Takeoff 3-4
Luneberg Lens 4-19

M

Mach on Pitch (Cruise-Climb) 2-24
Mach on Throttle 2-24, 2-25
Main Landing Gear 1-19
Maneuvers, Prohibited 5-1
Manned DSCE Flights, Normal Procedures 2-17
Manned Flight (Either Metal Stick or Remote Control) 3-2
Manned Flight Emergencies 3-1
Manned Flight Normal Procedures 2-10
Manual Start 2-8
Manuals Describing Drone Equipment 1-4
Maximum Allowable Airspeed and Acceleration Limits 5-2*
Maximum Endurance Profile Charts A5-2*
Maximum Thrust
—Climb Control A10-1, A10-3*
—Climbing Turn A10-1
—Climbing Turn Performance A10-4*
—Level Flight Turn Performance A10-1, A10-9*
Metal Stick Flight 4-3
Military Thrust Climb (4000 Feet to Cruise Altitude) 2-21
Minimum Run Landing 2-15
Minimum Run Takeoff 2-12
Miss Distance Indicator Equipment 4-15
Mission Planning A11-1, A11-2

PAGE NUMBERS WITH ASTERISKS (*) DENOTE ILLUSTRATIONS

Mission Profile Charts A4-2*
MRW-5 Control Panel Arrangements, DT-33 and 4-10*

N

Navigation Equipment 4-20
No. 1 and No. 2 Hydraulic Power Supply System 1-12
Normal Landing 2-15, 2-30
Normal Procedures 2-1
—All Flights 2-1
—Manned DSCE Flights 2-17
—Nullo Flights 2-31
Normal Takeoff 2-11
Nose Gear Switch Failure on Landing, Weight on 3-6
Nose Landing Gear 1-19
Nosewheel Steering System 1-19
Nullo Flight 4-5
—Envelope 6-2*
—Near Steady Ceiling 6-3
—Normal Procedures 2-31

O

Obstacle Clearance Takeoff 2-12
Oil Low Pressure Warning 3-5
Oil Supply System 1-6
Operating Limitations 5-1
Optimum Maximum Endurance Profile Charts ... A5-4*
Optimum Return Profile Charts A4-8*
Override Switches 4-14

P

Parami System 4-15
—Operation 4-16*
Pattern Altitude, Descent to 2-26
Performance Capabilities 6-1
Pitch Attitude 5-1
Pitch, Yaw, and Roll 1-13
Pitot Pressure and Static Systems 1-23, 1-24
Post Installation of Destructor Package 4-19*
Pre-Nullo Flight Check 2-31
Preflight
—Aircraft Check 2-19
—Check 2-2
—Engine Check 2-19
Preparation for Flight 2-1
Profile 2-37
Profile Charts
—Maximum Endurance A5-2*
—Mission A4-2*
—Optimum Maximum Endurance A5-4*
—Optimum Return A4-8*
Prohibited Maneuvers 5-1

R

Radar Control 4-17
Radar Guidance System, AN/APW-20 4-1
Radio Command System AN/ARW-64 4-1
Range A4-1
—Data Presented A4-1
—Safety 3-5, 4-21
Recovery Sequence, Carrier 4-23
Remote Checkout 2-35
Remote Control Panel 4-9
Right Forward Panel 1-11*
Roll, Pitch, and Yaw 1-13
Rudder 6-1
Rudder Lock Fails to Unlock When Gear is Down .. 3-1
Rudder Pedals 1-13
Runway Check, DSCE 2-20

S

Safety Pilot Flight 4-5
Scope and Arrangement A1-1, A1-2
Servicing 1-23, 1-24
Skid Mode, Yaw Damper Failure in 3-2, 3-6
Slippery Runways, Landing on 2-16
Smoke 3-5
Smoke System 4-21
Speed Brake System 1-19
Speed Brakes 4-21
Stabilizer Rate Disconnect Check and G Switch ... 2-24
Stability Augmenters 6-1
Stability Control Panels, Trim and 1-22*
Standby Compass 1-23, 1-24
Starting Engine 2-6
Static Systems and Pitot Pressure 1-23, 1-24
Steering System, Nosewheel 1-19
Summary of DSCE Commands 4-8*
Supplement Summary i
Strange Field Procedures 2-17
Sustained Flameout 3-4
Systems Operation 7-1, 7-2

T

Table of Communications and Associated Electronic Equipment 4-12*
Take Off Flaps, Forward Center-of-Gravity Final Approach Speed 6-3*
Takeoff 2-11, A2-1, A2-2
—Abort 3-3
—Before 2-10
—Crosswind 2-12
—Loss of Afterburner During 3-4
—Minimum Run 2-12
—Normal 2-11
—Obstacle Clearance 2-12
Takeoff and Landing Data Cards 2-2

PAGE NUMBERS WITH ASTERISKS (*) DENOTE ILLUSTRATIONS

Takeoff Planning and Charts A2-1, A2-2
Taxi Check 2-35
Taxiing 2-10, 2-18
Telemetry Failure 3-5
Telemetry Set, AN/AKT-7 4-1
Throttle 1-5
—Handle Controls 4-13
—Linkage 1-5
—Quadrant 1-5*
Thrust Control 4-7
Total Carrier Failure (ARW and APW) 3-5
Total Distance to Clear a 50 Foot Obstacle A2-1, A2-2
Total Hydraulic Pressure Failure 3-6
Touch-and-Go Landing 2-16, 2-27
Transition Time and Fuel Allowances A3-1, A3-2
Transonic Flight 6-3
Trim and Stability Control Panels 1-22*
Turn Performance
—Maximum Thrust Climbing A10-4*
—Maximum Thrust Level Flight A10-1, A10-9*
Typical Automatic Takeoff (ATO) 2-22*

U

UHF Command Radio and Interphone System, AN/ARC-66 4-2
Unmanned Flight 3-3
—Emergencies 3-3
Use of Landing Wheel Brakes 7-1, 7-2

W

Warning Light System 1-23, 1-24
Weight and Balance 2-2
Weight on Nose Gear Switch Failure on Landing . . 3-6
Wheel Brake System 1-22
Wheel Brakes and Drag Chute 4-20
Wing Flap Lever 1-19
Wing Flap System 1-19
Wing Flaps 4-20

X

X- and L-Band Augmentation System 4-17

Y

Yankee Airborne Remote Pilot 2-35
Yaw Damper Failure in Skid Mode 3-2, 3-6
Yaw, Roll, and Pitch 1-13

Z

Zoom Climbs 6-1
Zulu Airborne Remote Pilot 2-35

PAGE NUMBERS WITH ASTERISKS (*) DENOTE ILLUSTRATIONS