T-38(N)-1
Rev A

T-38 FLIGHT MANUAL

Aircraft Operations Division

November 2003

This publication supercedes 1T-38N-1 Basic PCN 2, dated March 2000.

National Aeronautics and
Space Administration
Lyndon B. Johnson Space Center
Houston, Texas

Verify that this is the correct version before use.

AIRCRAFT OPERATIONS DIVISION

INTERIM NASA SUPPLEMENT

Flight Operations: *Original Signed By Kenneth Baker*	**INS Number:** T-38(N)-1NS1
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PURPOSE

If the aircraft is below 181 KEAS, below 9,500 feet MSL, both throttles below 96%, and the gear handle down, the lack of a gear warning tone should be considered a down and locked indication for the nose gear only.

INSTRUCTIONS

1. File INS page 1 in front of the T.O. title page, and on top of any supplements, according to oldest to newest date.
2. Annotate the T.O. title page, page 1-31, and page 3-39 with this INS number.

PAGES AFFECTED

1-31
3-39

DESCRIPTION

On page 1-31, add the warning before the note as follows:

WARNING

The landing gear warning tone should not be considered an independent indication that all landing gear is down and locked. The input for that warning tone is currently processed only from the nose landing gear, and will not provide any indication on main gear position.

On page 3-39, add the warning before the first note as follows:

WARNING

The landing gear warning tone should not be considered an independent indication that all landing gear is down and locked. The input for that warning tone is currently processed only from the nose landing gear, and will not provide any indication on main gear position.

On page 3-39, replace the second bullet of the first note and add the third bullet as follows:

NOTE

- When the gear handle is down, the gear handle light provides an independent means to confirm gear down configuration. The gear should be considered down and locked if the gear handle light is off.
- If the aircraft is below 181 KEAS, below 9,500 feet MSL, both throttles below 96%, and the gear handle down, the lack of a gear warning tone should be considered a down and locked indication for the nose gear only.

<u>REFERENCES</u>

AOD Form 21 Log No. 08-610, dated 12/04/08
PIF 2006-202

T-38 FLIGHT MANUAL

November 2003

Approved By

Original Signed By

William A. Ehrenstrom
T-38N Project Pilot

Original Signed By

Arthur (Ace) Beall
Chief, Flight Operations Branch

Original Signed By

Robert J. Naughton
Chief, Aircraft Operations Division

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
Lyndon B. Johnson Space Center
Houston, Texas

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LIST OF EFFECTIVE PAGES/CHANGE RECORD

Doc. Version	Date	Process Owner/Extension	Description
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SCOPE. This manual contains all the information necessary for safe and efficient operation of the T-38N aircraft. These instructions do not teach basic flight principles, but are designed to provide you with a general knowledge of the aircraft, its flight characteristics, and specific normal and emergency operating procedures. Your flying experience is recognized and elementary instructions have been avoided.

PERMISSIBLE OPERATIONS. The flight manual takes a "positive approach" and normally states only what you can do. Unusual operations or configurations which exceed the limitations as specified in this manual are prohibited unless specifically covered herein. Clearance must be obtained from Director of Flight Crew Operations through established channels before any questionable operation is attempted which is not specifically permitted in this manual.

HOW TO BE ASSURED OF HAVING LATEST DATA. Contact the Flight Operations Branch of the Aircraft Operations Division (AOD).

SAFETY AND OPERATIONAL SUPPLEMENTS. Safety and Operational Supplements are used tc information to you in a hurry. Safety supplements concern safety of flight items. Operational supplements are issued as an expeditious means of reflecting information when mission essential operational procedures are involved. Supplements are issued by printed copy as required. Supplements are numbered consecutively regardless of whether it is safety or operational. File supplements in reverse numerical order in the front of the Flight Manual. The supplements may be removed when specifically covered by a page change to the manual.

CHECKLISTS. The flight manual contains itemized procedures with necessary amplifications. The checklist contains itemized procedures without the amplifications. Whenever a supplement affects the abbreviated checklist, write in the applicable change on the affected checklist page or if a checklist page is included, cut it out and insert it in the checklist.

HOW TO GET PERSONAL COPIES. Each flight crewmember is entitled to a personal copy of the flight manual, supplements, and checklist. The AOD flight manual representative should be contacted to fill your technical order request.

YOUR RESPONSIBILITY TO LET US KNOW. Every effort is made to keep the Flight Manual current. However, we cannot correct an error unless we know of its existence. It is essential that you do your part. Any comments, questions or recommendations should be addressed to the Flight Operations Branch of AOD.

CHANGE SYMBOLS. Changed text/graphics are indicated by a black vertical line in either margin of the page. The Change symbol shows what part has been altered in the current version.

WARNINGS, CAUTIONS AND NOTES. For your information, the following definitions apply to the "Warnings," "Cautions," and "Notes" found throughout the manual.

WARNING

An operating procedure or practice, which if not correctly followed, could result in personal injury or loss of life.

CAUTION

An operating procedure or practice which, if not correctly followed, could result in damage to or destruction of equipment.

NOTE

An operating procedure or condition that is essential to highlight.

GROUP CODING. Aircraft having different or additional systems and equipment have been block coded to avoid listing aircraft serial numbers. The Air Force serial numbers of the aircraft included in each block are as follows:

Block	Air Force Serial Numbers
*20	AF59-1603 thru AF59-1606
25	AF60-547 thru AF60-553
30	AF60-554 thru AF60-561
*35	AF60-562 thru AF60-596
*40	AF61-804 thru AF61-947
45	AF62-3609 thru AF62-3752
*50	AF63-8111 thru AF63-8247
55	AF64-13166 thru AF64-13305
*60	AF65-10316 thru AF65-10475
*65	AF66-4320 thru AF66-4389 and AF66-8349 thru AF66-8404
*70	AF67-14825 thru AF67-14859 and AF67-14915 thru AF67-14958
*75	AF68-8095 thru AF68-8217
*80	AF69-7073 thru AF69-7088
*85	AF70-1549 thru AF70-1591 and AF70-1949 thru AF7O-1956

* Johnson Space Center AOD currently operates aircraft with these block designations.

US NAVY AIRCRAFT. US Navy aircraft are not referenced herein. For information on USN T-38s, see the Air Force T.O. 1T-38A-1.

DESCRIPTION

SECTION I

NOTE

This document describes the avionics upgrade T-38N Block 2 aircraft and its equipment. Block 1 aircraft (NASA 923 and 961) have been modified to near Block 2 status. NASA 912 is a unique evaluation configuration.

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THE AIRCRAFT

The T-38N aircraft, originally produced as the T-38A by the Northrop Corporation, Aircraft Division, is a two-place, twin-turbojet supersonic trainer. Each cockpit contains an individual jettisonable canopy and ejection seat. A cabin air conditioning and pressurization system conditions and pressurizes the air in both cockpits.

The fuselage is an area-rule (coke bottle) shape, with moderately swept-back wings and empennage. The aircraft is equipped with an all-movable horizontal tail. A speed brake is located on the lower surface of the fuselage center section. The tricycle landing gear has a steerable nosewheel. All flight control surfaces are fully powered by two independent hydraulic systems.

The National Aeronautics and Space Administration (NASA) T-38N aircraft has been modified from the original T-38A configuration. These modifications add, augment, or affect the following aircraft systems and equipment:

- Electronic Flight Instrumentation System (EFIS)
- Flight Management System (FMS)
- Communication Equipment
- Weather Radar System
- Air Data Computer System
- Inertial Reference System (IRS)
- Lighting Equipment
- Engine Indicators
- Electrical Power Systems
- Improved Engine Inlets
- Improved Ejectors

Changes to the exterior of the aircraft, aircraft instruments, and aircraft controls are shown in Figures 1-1 through 1-12, and are further identified in the following paragraphs.

AIRCRAFT DIMENSIONS

The overall dimensions of this aircraft with normal tire and strut inflation are:

Length ....44 ft. 2 in.
Wingspan ....25 ft. 3 in.
Height...................12 ft. 11 in.
Tread ....10 ft. 9 in.
Wheelbase............19 ft. 5 in.

AIRCRAFT GROSS WEIGHT

The gross weight of the aircraft fully fueled and including two aircrew is approximately 12,800 pounds.

ENGINES

The aircraft is powered by two J85-GE-5N series, eight-stage, axial-flow, turbojet engines (Figure 1-2). Air enters through the variable inlet guide vanes, which direct the flow of air into the compressor. The automatic positioning of the inlet guide vanes and air bleed valves assists in regulating compressor airflow to maintain compressor stall-free operation. Two turbine wheels and the compressor rotor stages are mounted on the same shaft. The exhaust gases are discharged through a variable area exhaust nozzle. An exhaust gas temperature (T5) sensing system varies the nozzle area to maintain exhaust gas temperature within limits at both MIL and MAX range throttle positions.

ENGINE FUEL CONTROL SYSTEM

Each engine has a main fuel control system and an afterburner fuel control system (Figure 1-3). The main fuel control system consists primarily of a two-stage engine-driven pump, a main fuel control, and an over-speed governor.

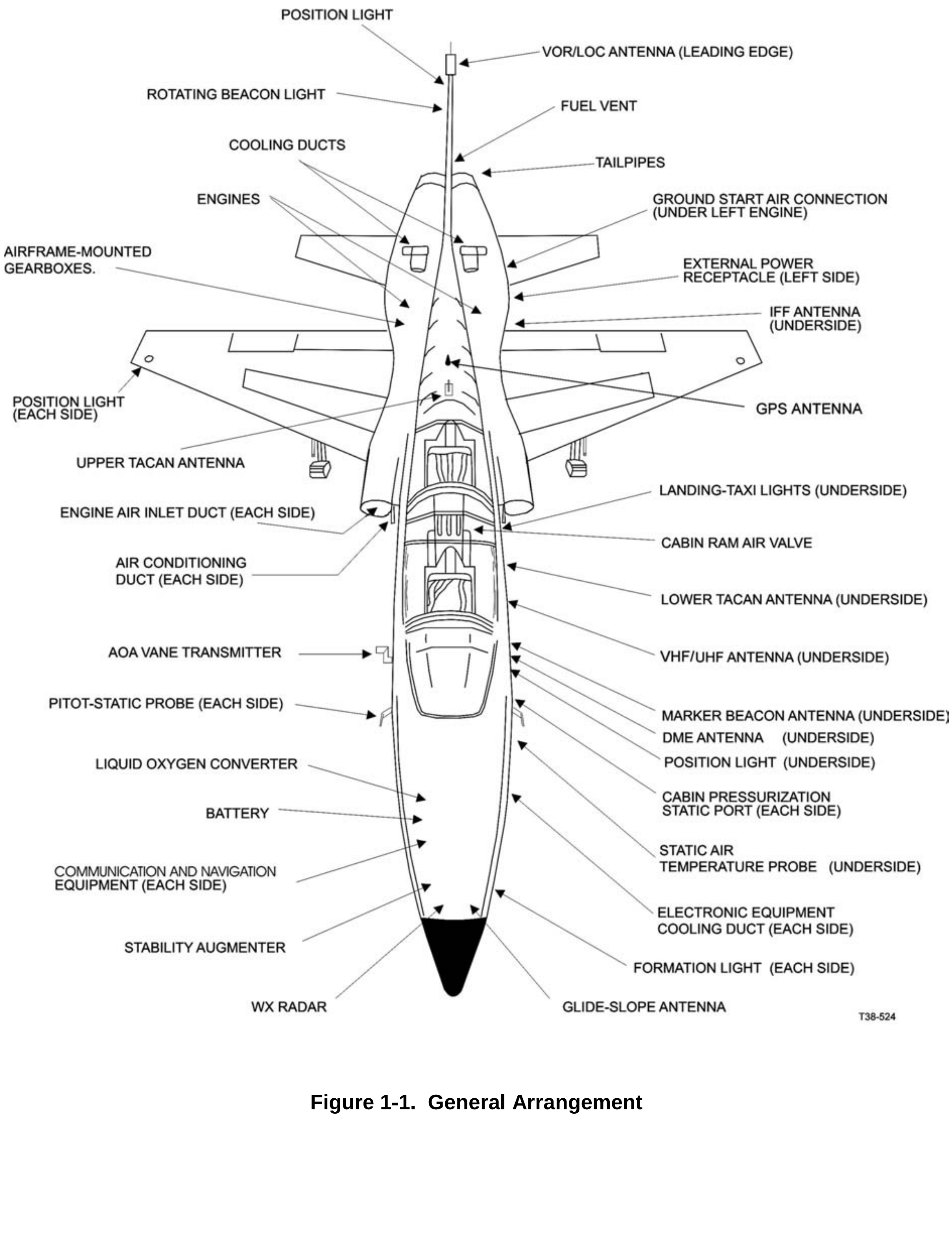


Figure 1-1. General Arrangement

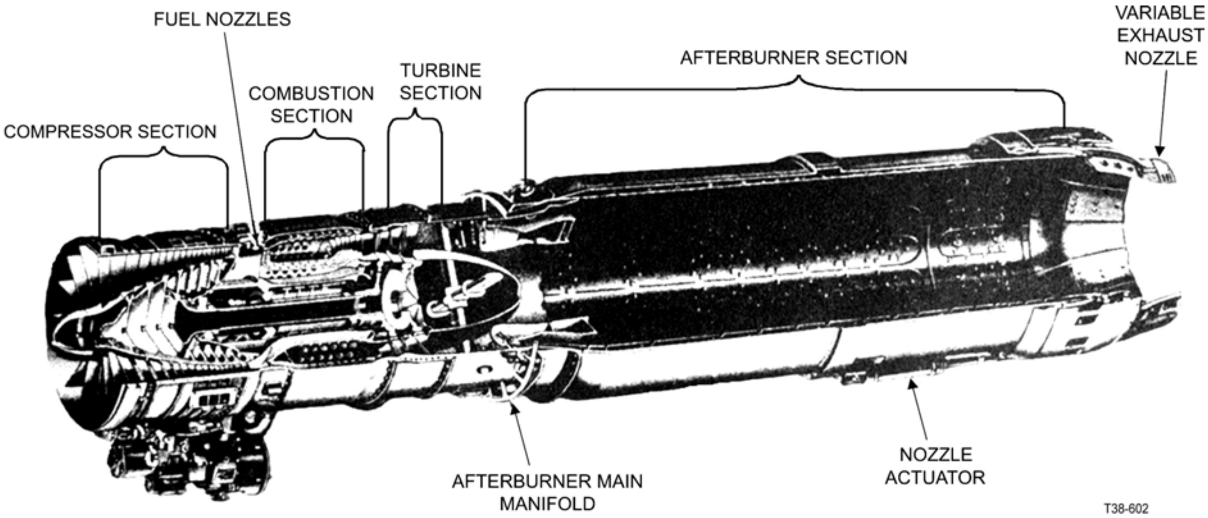


Figure 1-2. J85 – GE-5 Series Engine

MAIN FUEL CONTROL

The main fuel control selects engine power by metering fuel to the main engine combustor as a function of throttle position, engine inlet air temperature, compressor discharge pressure, and engine speed. The control performs the following functions automatically:

a. Regulates engine speed at the selected throttle position, limits engine minimum speed at IDLE and engine maximum speed at MIL and MAX range power.

b. Limits main engine fuel flow to safe levels during starts and during rapid throttle changes, providing protection from overtemperature, stalls, and flameouts.

c. Limits main engine fuel flow to a preset minimum by holding combustor fuel-air ratio at or above the proper level for low power settings and for engine restart during flight.

d. Correctly positions the compressor inlet guide vanes and air bleed valves.

AFTERBURNER SYSTEM

Each afterburner system contains an igniter plug, afterburner pilot manifold, afterburner main manifold, and afterburner fuel pump and control. Afterburner operation is initiated by advancing throttle from the MIL detent into the MAX range. Thrust is variable within MAX range. The total rate of fuel flow at full MAX position for each engine at sea level on a standard day is approximately 7,300 pounds per hour with the aircraft at rest and 11,400 pounds per hour at mach 1.

AFTERBURNER FUEL CONTROL

The primary function of the afterburner fuel control is to initiate and schedule fuel flow to the afterburner main and pilot spraybars. Fuel flow is metered as a function of throttle position and compressor discharge pressure. The control also senses and regulates variable area nozzle position and automatically limits fuel flow to prevent an over-temperature in the case of a nozzle actuating system malfunction or during rapid throttle advances into MAX range.

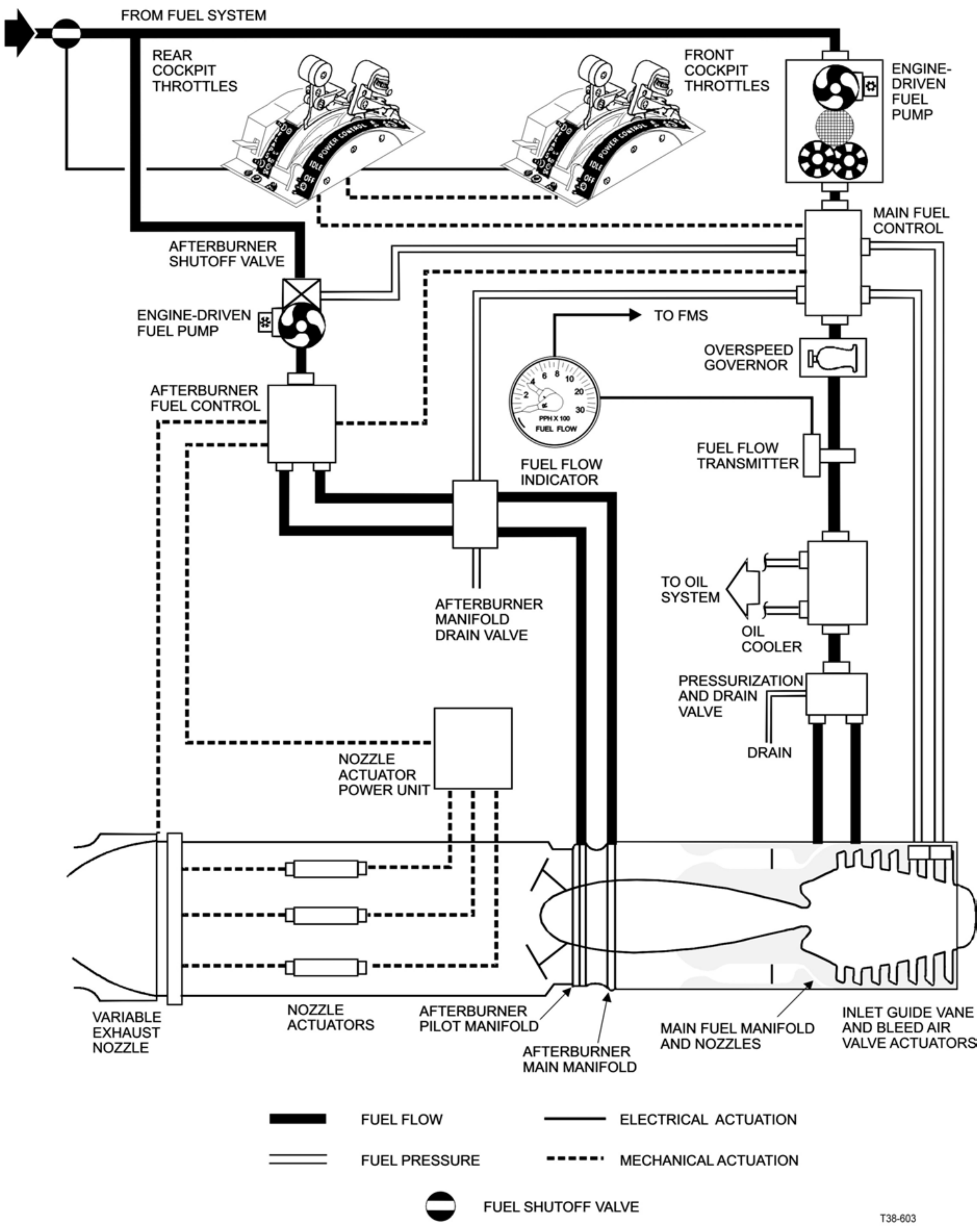


Figure 1-3. Engine Fuel Control System

THROTTLES

The throttles (Figure 1-4) are provided with a roller ramp-type force gradient, which must be overcome to move the throttles from MIL into MAX range or from IDLE to OFF. The throttles in the front cockpit are equipped with fingerlifts which must be raised before the throttles in either cockpit can be retarded past the IDLE roller ramp to OFF. Additionally, after engine start (both throttles must be out of OFF), a retractable throttle gate on the front cockpit throttles may be positioned to prevent inadvertent movement of the throttles to the OFF position. The gate is spring loaded to the unguarded position to allow one-handed disengagement. Throttle friction is ground adjustable by maintenance personnel only. The throttles, when placed at OFF, mechanically shut off fuel to the engine at the main fuel control and electrically shut off fuel to the engines at the fuel shutoff valves.

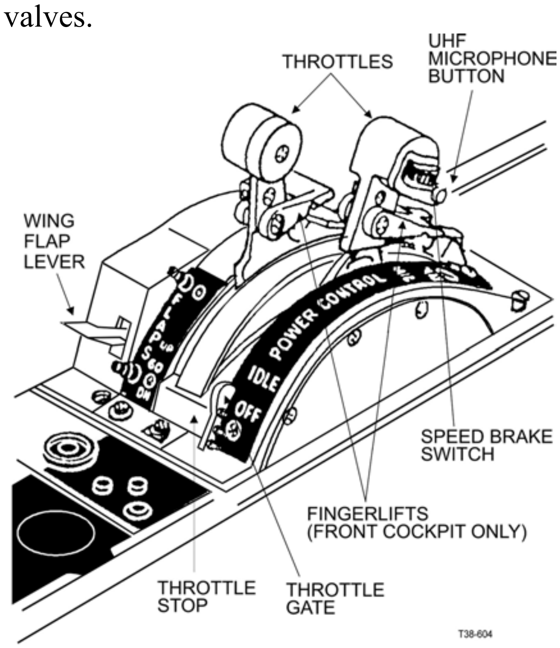


Figure 1-4. Throttle Quadrant

WARNING

Avoid fingerlift actuation to preclude inadvertent engine shutdown when retarding throttle toward idle.

CAUTION

Failure of the throttle gate spring while the throttle gate is engaged will prevent the throttle gate from moving to the unguarded position when released. In this situation, the throttle gate must be manually moved to the unguarded position before the throttle can be moved to cut-off.

NOTE

Throttle movement should be conservative to help minimize blade failures. Abrupt or rapid throttle movements should be avoided. Throttle bursts (throttle movement in 1 second or less) from idle RPM to MIL should be avoided if possible. These procedures will allow the variable exhaust nozzle to keep pace and match the fuel flow and help to minimize the possibility of compressor blade failures.

PNEUMATIC SYSTEM

Air taken from the eighth stage compressor is used for hydraulic reservoir and cabin pressurization, air conditioning systems, canopy defogging, engine anti-icing, and canopy seal inflation.

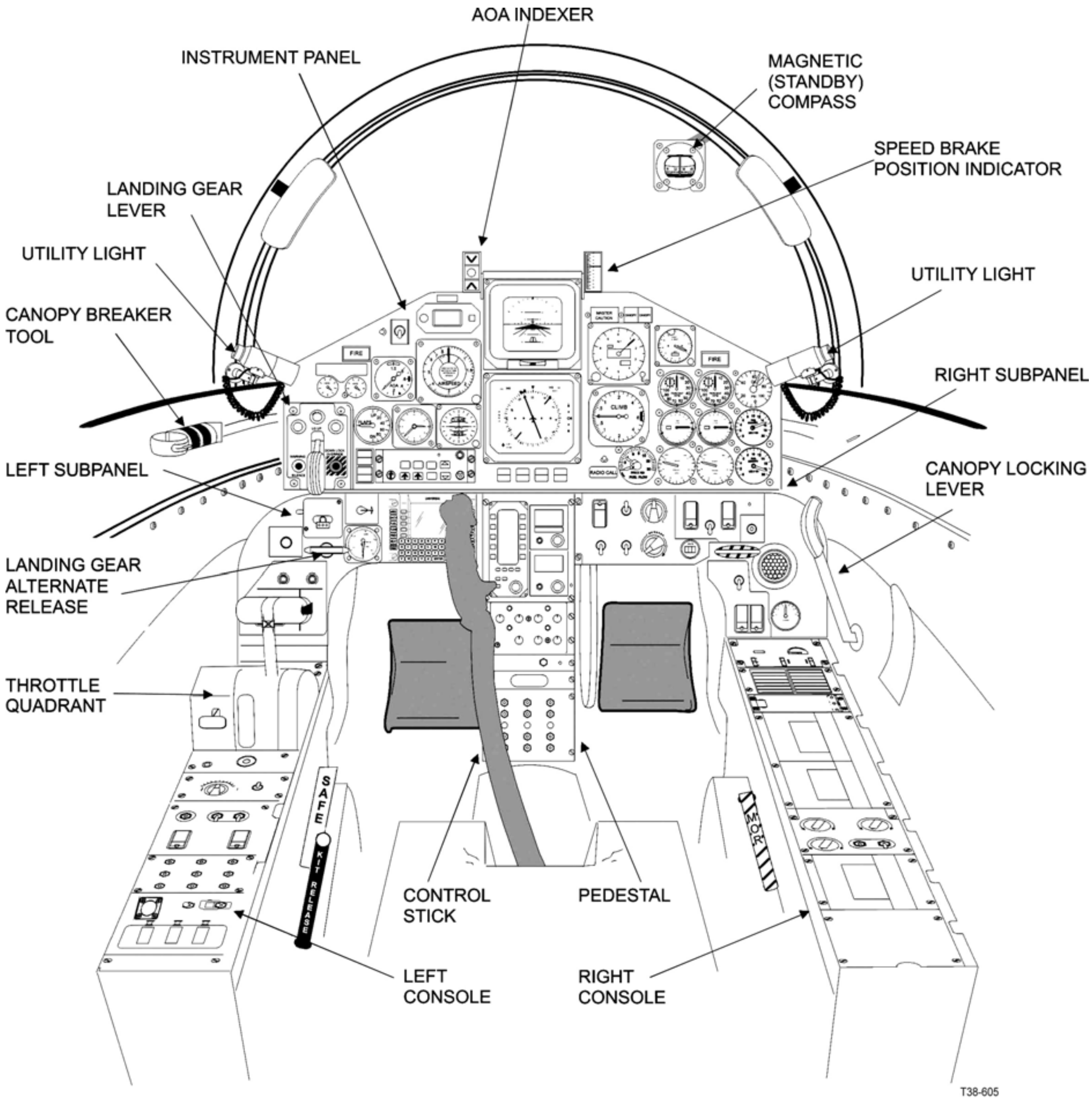


Figure 1-5. Cockpit Arrangement – Front

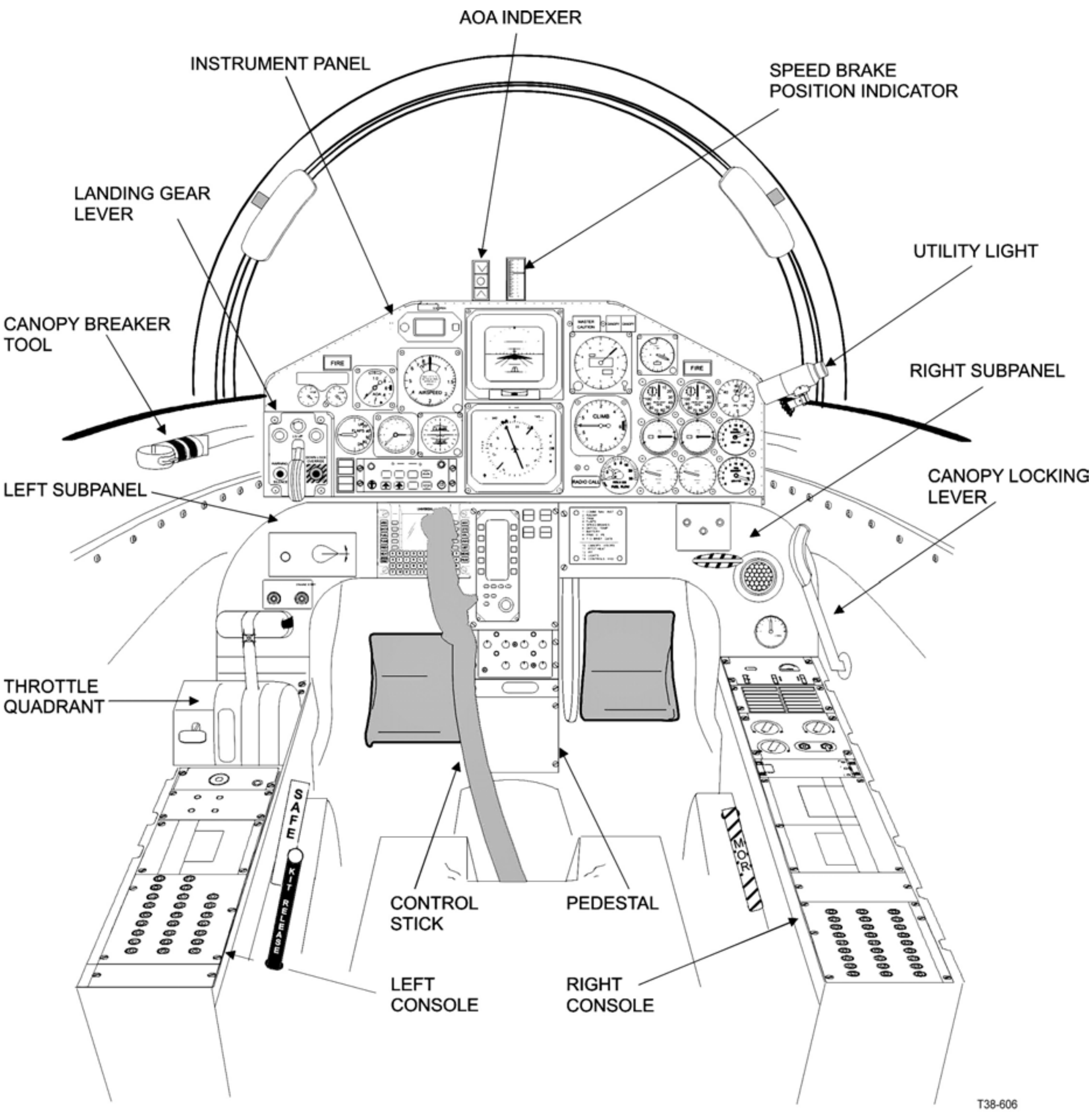
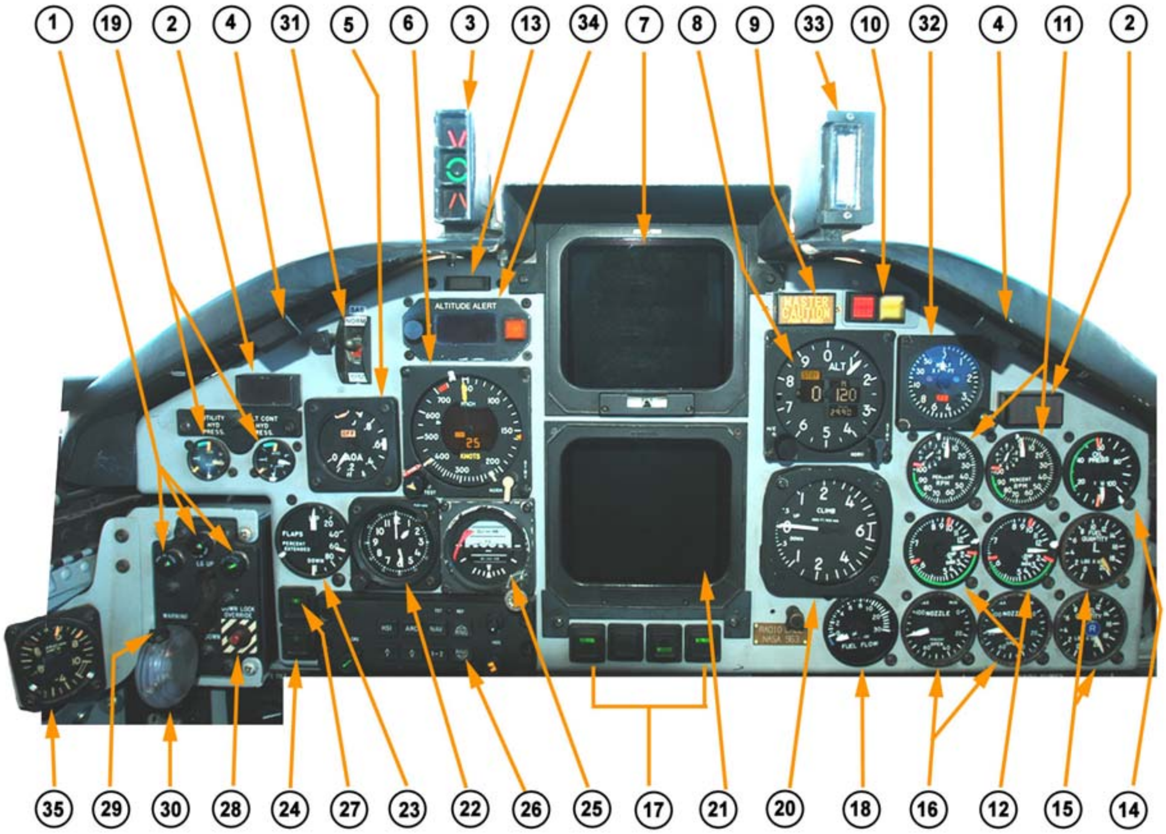


Figure 1-6. Cockpit Arrangement – Rear



1 LANDING GEAR POSITION INDICATOR LIGHTS (3)
2 ENGINE FIRE WARNING LIGHTS (2)
3 AOA INDEXER
4 FLOODLIGHTS (2)
5 AOA INDICATOR
6 AIRSPEED MACH INDICATOR (AMI)
7 ATTITUDE DIRECTOR INDICATOR (ADI)
8 ALTIMETER
9 MASTER CAUTION LIGHT
10 CANOPY/SEAT WARNING LIGHT
11 ENGINE TACHOMETERS (2)
12 EXHAUST GAS TEMPERATURE INDICATORS (2)
13 SPEED BRAKE OPEN LIGHT
14 OIL PRESSURE INDICATOR (DUAL)
15 FUEL QUANTITY INDICATORS (2)
16 NOZZLE POSITION INDICATORS (2)
17 ADI PBIs
18 FUEL FLOW INDICATOR (DUAL)
19 HYDRAULIC PRESSURE INDICATORS
20 VERTICAL VELOCITY INDICATOR (VVI)
21 HORIZONTAL SITUATION INDICATOR (HSI)
22 CLOCK
23 FLAP INDICATOR
24 SG1/SG2 PBI
25 STANDBY ATTITUDE INDICATOR
26 HSI CONTROL PANEL
27 FWD/AFT PBI
28 DOWNLOCK OVERRIDE BUTTON
29 LANDING GEAR WARNING SILENCE BUTTON
30 LANDING GEAR LEVER
31 STABILITY AUGMETER SYSTEM (SAS) DISCONNECT (FCP ONLY)
32 RADAR ALTIMETER
33 SPEED BRAKE POSITION INDICATOR
34 ALTITUDE ALERTER
35 G METER

Figure 1-7. Instrument Panel – Both Cockpits

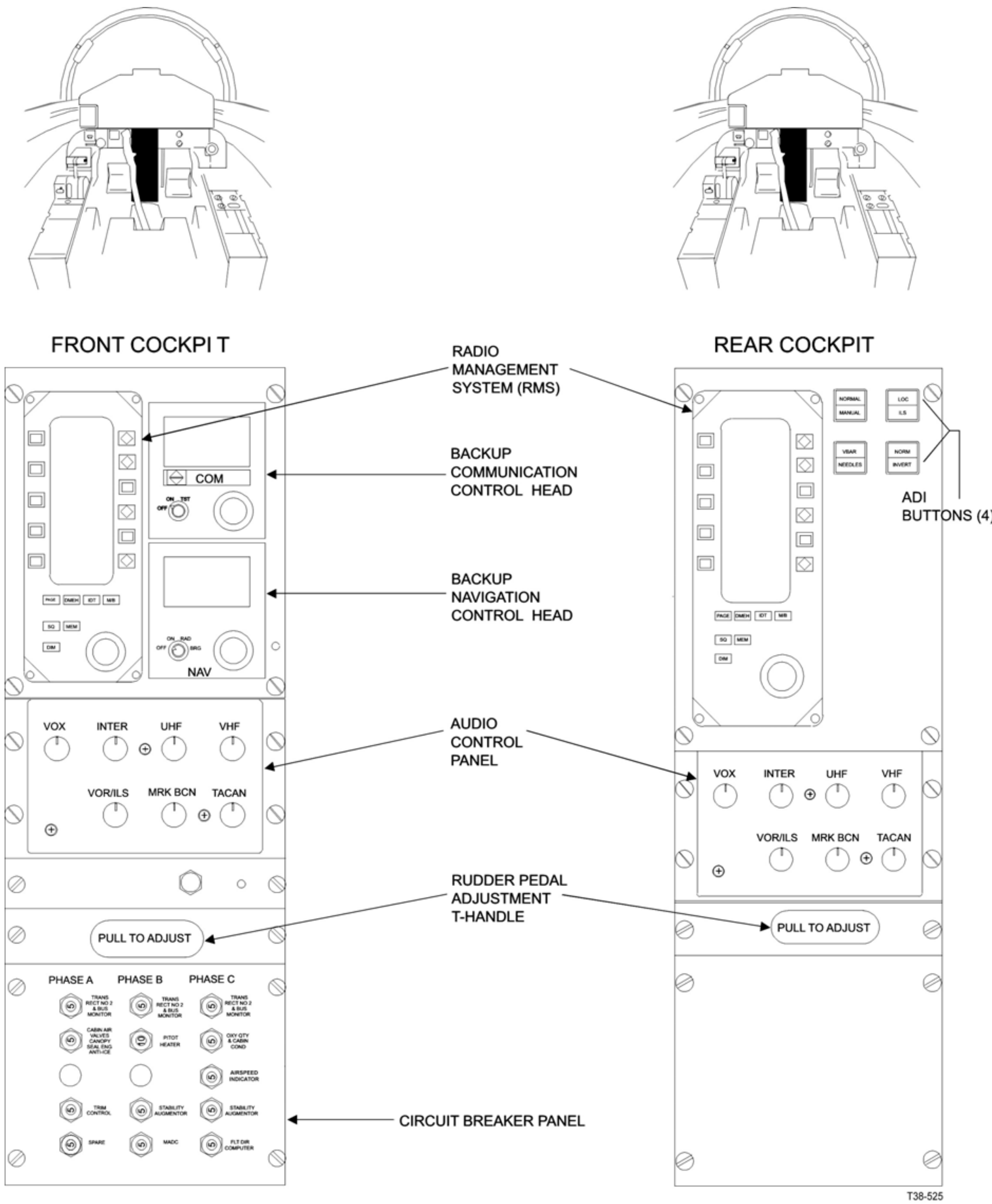


Figure 1-8. Pedestals

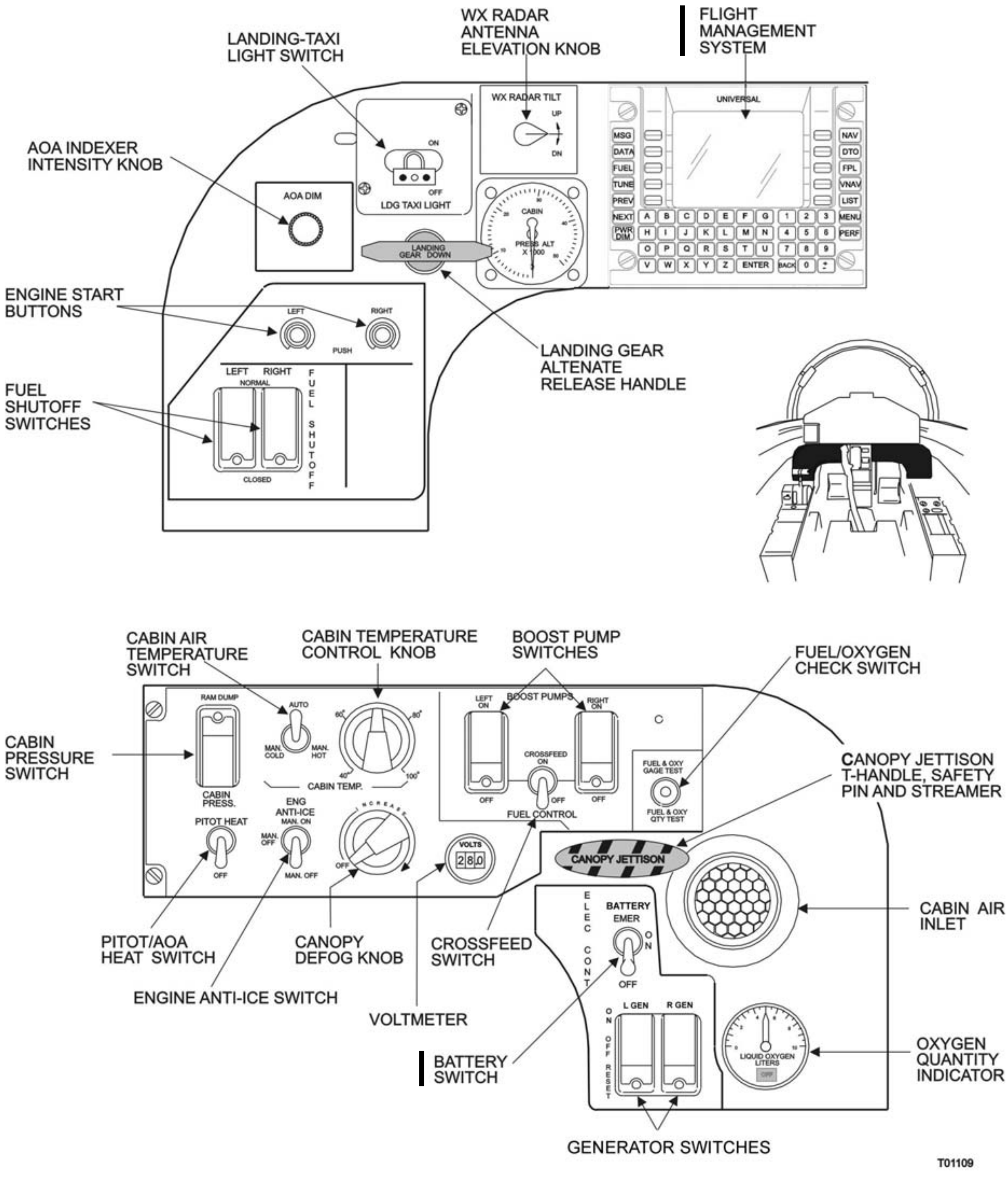


Figure 1-9. Subpanels – Front Cockpit

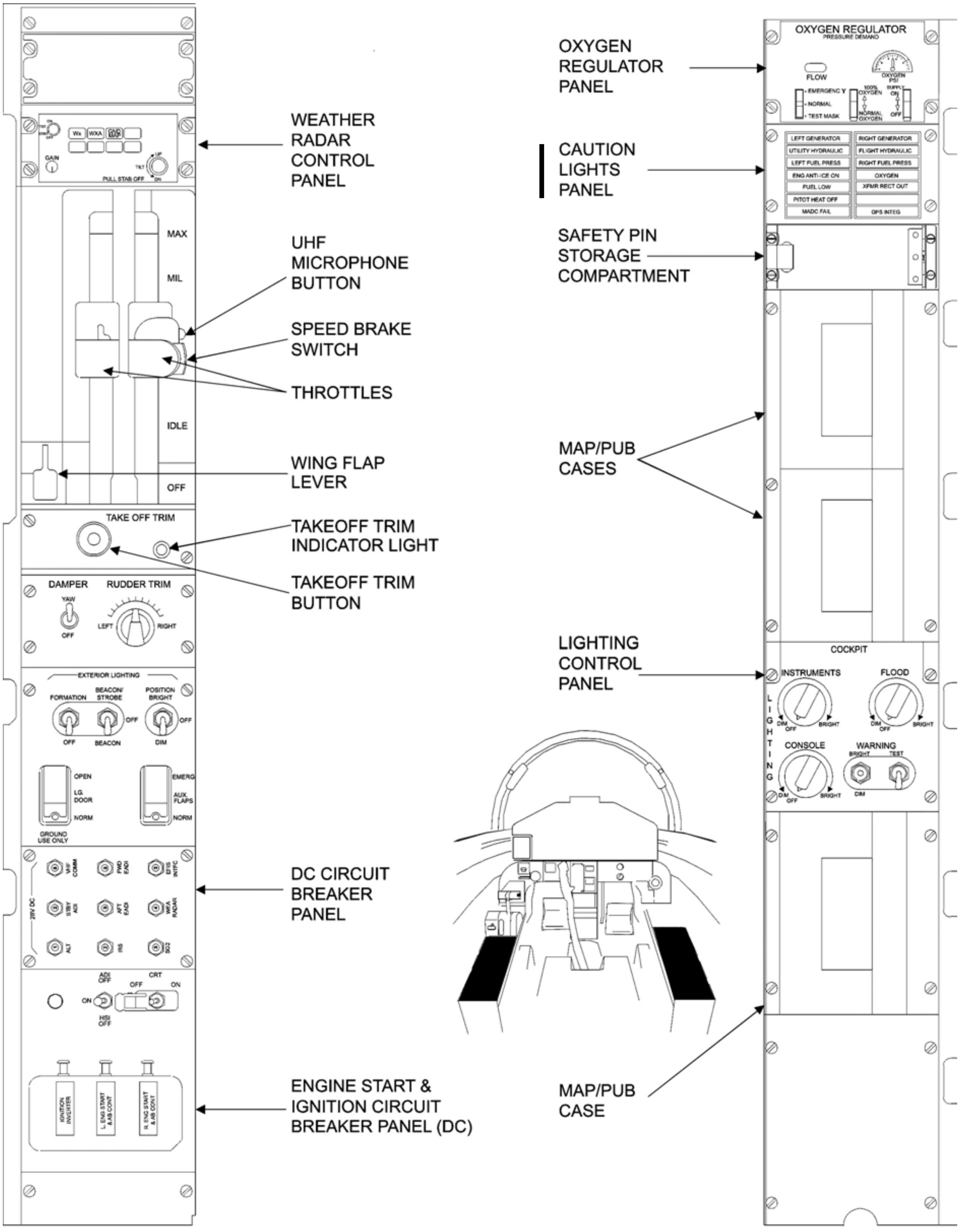


Figure 1-10. Console Panels – Front Cockpit

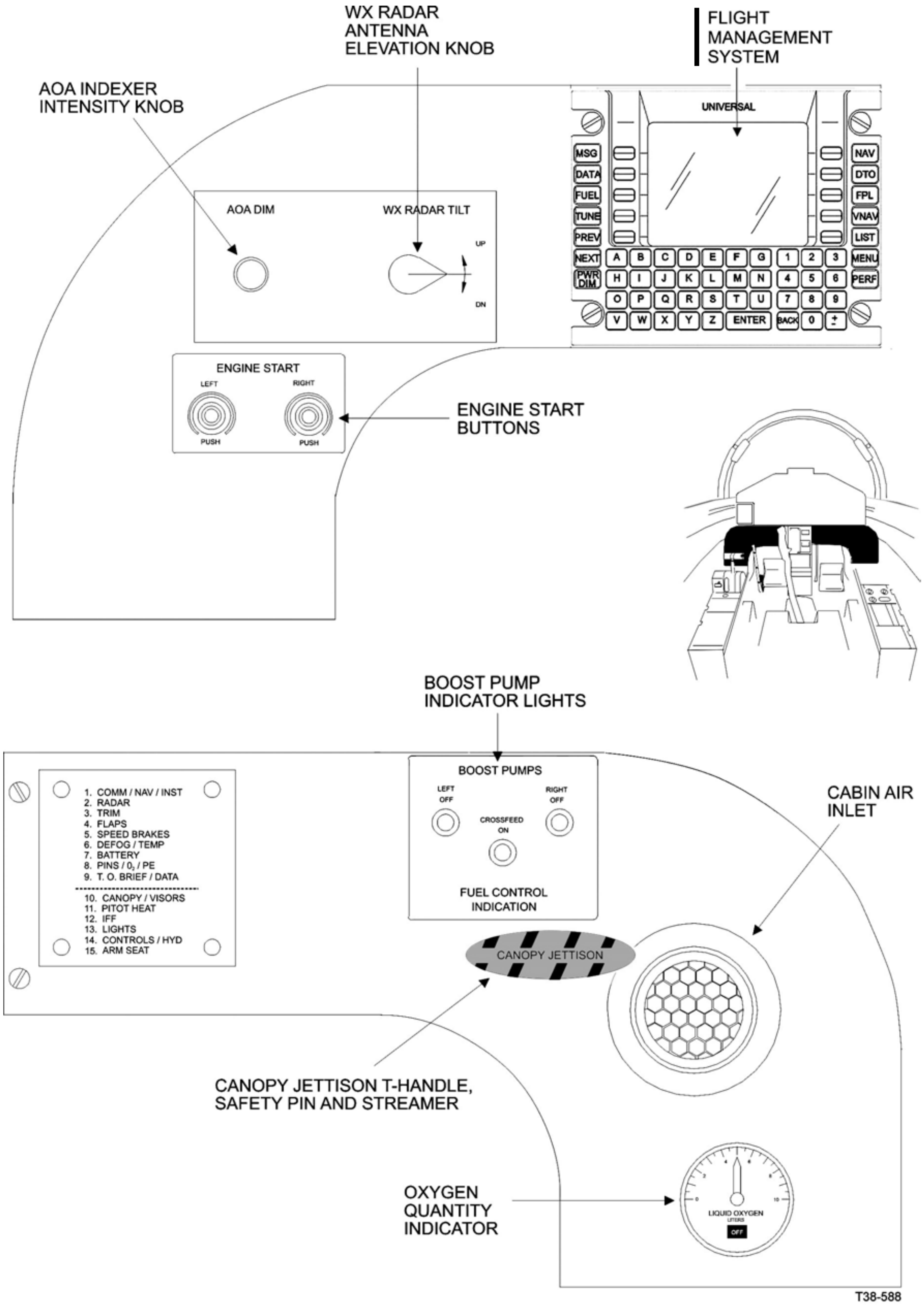


Figure 1-11. Subpanels – Rear Cockpit

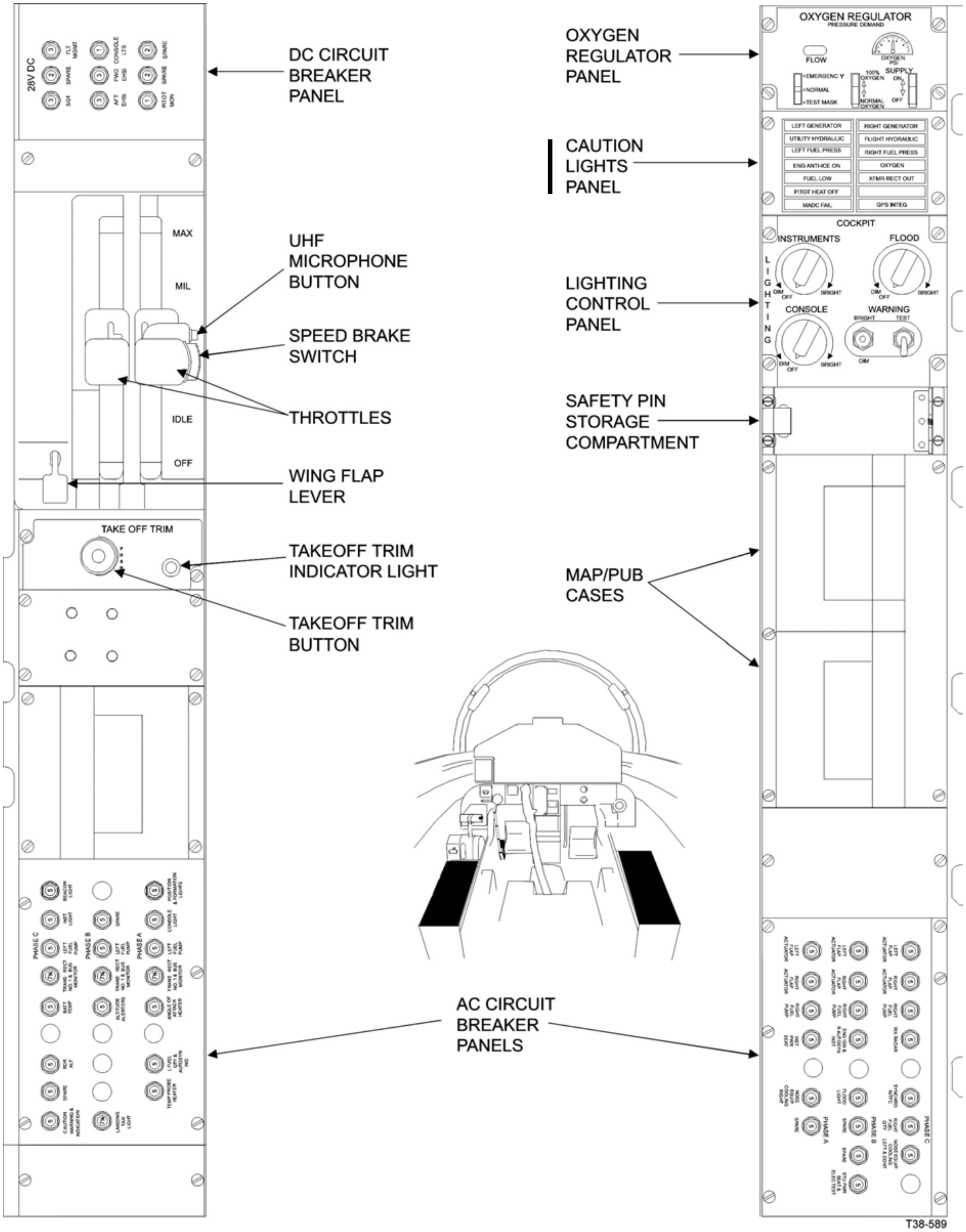


Figure 1-12. Console Panels – Rear Cockpit

ENGINE START AND IGNITION SYSTEM

Engine starts require compressor motoring (low pressure air supply), Direct Current (DC) power to energize the ignition holding relay, and Alternating Current (AC) power for igniter firing. Two engine start pushbuttons (Figures 1-9 and 1-11) are located in the left subpanel of each cockpit. For ground starts only, a diverter valve is automatically positioned to direct air to the selected engine. Momentarily pushing the start button positions the diverter valve and arms the ignition circuit for approximately 30 seconds. Moving the throttle to IDLE energizes the ignition exciter, firing main and afterburner igniters and starting fuel flow to the engine. If the left start button is pressed before the right engine 30-second cycle is completed, the diverter valve will move to the neutral position and will remain at neutral until the right engine 30-second start cycle is completed. The valve will then divert air to the left engine, but only for the time that is remaining on the left engine start cycle, which started when the left engine start button was pushed. The resulting air supply loss may cause an overtemperature condition. Any delay in moving the throttle to IDLE after pushing the start button will decrease the available ignition time from the 30 second cycle by an equal amount. Momentarily pressing the start button again during a 30 second cycle will not reset the ignition timer and start another cycle since the first actuation locks-in the cycle (holding relay energized) until the timer expires. Without any start button ignition cycle operating, moving the throttle to the MAX range energizes the main and afterburner igniters for a 30 second cycle. Subsequently retarding the throttle out of MAX range at any time during the 30 second cycle will stop the igniters from firing, reset the timer (bypassing the ignition holding relay), and enable the ignition system for a new cycle. The throttle must be retarded from MAX to below MIL to reset the timer and returned to MAX to provide another 30 second cycle. However, pressing the start button within 30 seconds after selecting MAX will only provide ignition for the duration of the first 30 second ignition cycle selected and disables the MAX ignition reset feature until the first selected (start button or MAX) 30 second ignition cycle has expired. With the throttle at IDLE or above, the igniters may be energized at any time for longer than 30 seconds by selecting and holding the appropriate start button. AC power from a battery operated static inverter may be used for ground (one engine) or air starts (either engine). For battery start, the right engine should be started first, as the static inverter supplies AC power for the right engine instruments during the start cycle.

ENGINE INSTRUMENTS

A full complement of engine instruments is provided in each cockpit. The front cockpit indicators are primary. The rear cockpit Exhaust Gas Temperature (EGT) indicators repeat the pointer positions of those in the front cockpit. Hydraulic indicators represent an independent reading from a single, air-frame mounted transmitter for each system. Oil pressure, nozzle position, fuel flow, and tachometer indicators represent independent readings from a single transmitter for each system on each engine. Engine oil pressure and fuel flow are displayed on dual indicating gauges for each system. The outer needle of each dual gauge indicates data for the right engine. Tachometers are powered independently of the aircraft electrical system. Nozzle position indicators require DC power only. All other engine and quantity indicating instruments require AC power from their respective buses. The right engine instruments may also receive AC power from a battery powered static inverter which is activated upon initiation of the engine start sequence when normal AC power is not available.

NOTE

Some front cockpit indicators contain an ON or OFF flag system which operates when AC power is applied.

OIL SYSTEM

Each engine has an independent integral oil supply and lubrication system. The reservoir has a normal oil capacity of 4 quarts and an air expansion space of 1 quart. Heat from the engine oil is dissipated through a fuel-oil cooler. Oil consumption through engine operation and overboard venting caused by condensation and acrobatic flight should not exceed 1 pint per hour. See Figure 1-22 for oil specification. See Figure 5-1 for oil pressure indicator scale and operational limits.

FUEL SYSTEM

The aircraft has an independent fuel system for each engine (Figure 1-13), interconnected by a DC electrically operated crossfeed valve. The left and right system fuel cells are in the fuselage. The left engine is supplied by the forward fuselage cell and the forward and aft dorsal cells; the right engine, by the center and aft fuselage cells. A single AC electrically driven fuel boost pump in each system supplies fuel under pressure to the engine-driven fuel pump during normal operation. The left system boost pump is in the inverted flight compartment of the forward fuselage cell, and the right system boost pump is in the inverted flight compartment of the aft fuselage cell. Without the aid of the boost pump, each engine can be supplied with fuel by gravity flow from its respective system. Normally, sufficient fuel will flow by gravity to maintain MAX power from sea level up to approximately 25,000 feet; however, by specifications, gravity flow is guaranteed only to 6,000 feet, and flameouts have occurred as low as 15,000 feet. Through crossfeed operation, both systems may supply fuel to either engine with or without boost pump pressure (one engine off, crossfeed on, boost pumps functioning or failed). Also, one system under boost pump pressure will supply fuel to both engines (both engines operating, crossfeed on, one boost pump off). Caution lights indicate fuel low level and low pressure conditions. See Figure 1-20 for fuel specification and for fuel quantity data. Refer to fuel management, Section VII, for proper crossfeed operation.

BOOST PUMP SWITCHES

Two guarded boost pump switches (Figure 1-11), one for each fuel system, are located on the right subpanel of the front cockpit. All fuel pump circuit breakers (Figure 1-15) should be closed before operating boost pumps.

BOOST PUMP INDICATOR LIGHTS

Two boost pump indicator lights (Figure 1-11), one for each boost pump, are located on the right subpanel of the rear cockpit. An indicator light illuminates when the corresponding boost pump switch is placed at OFF.

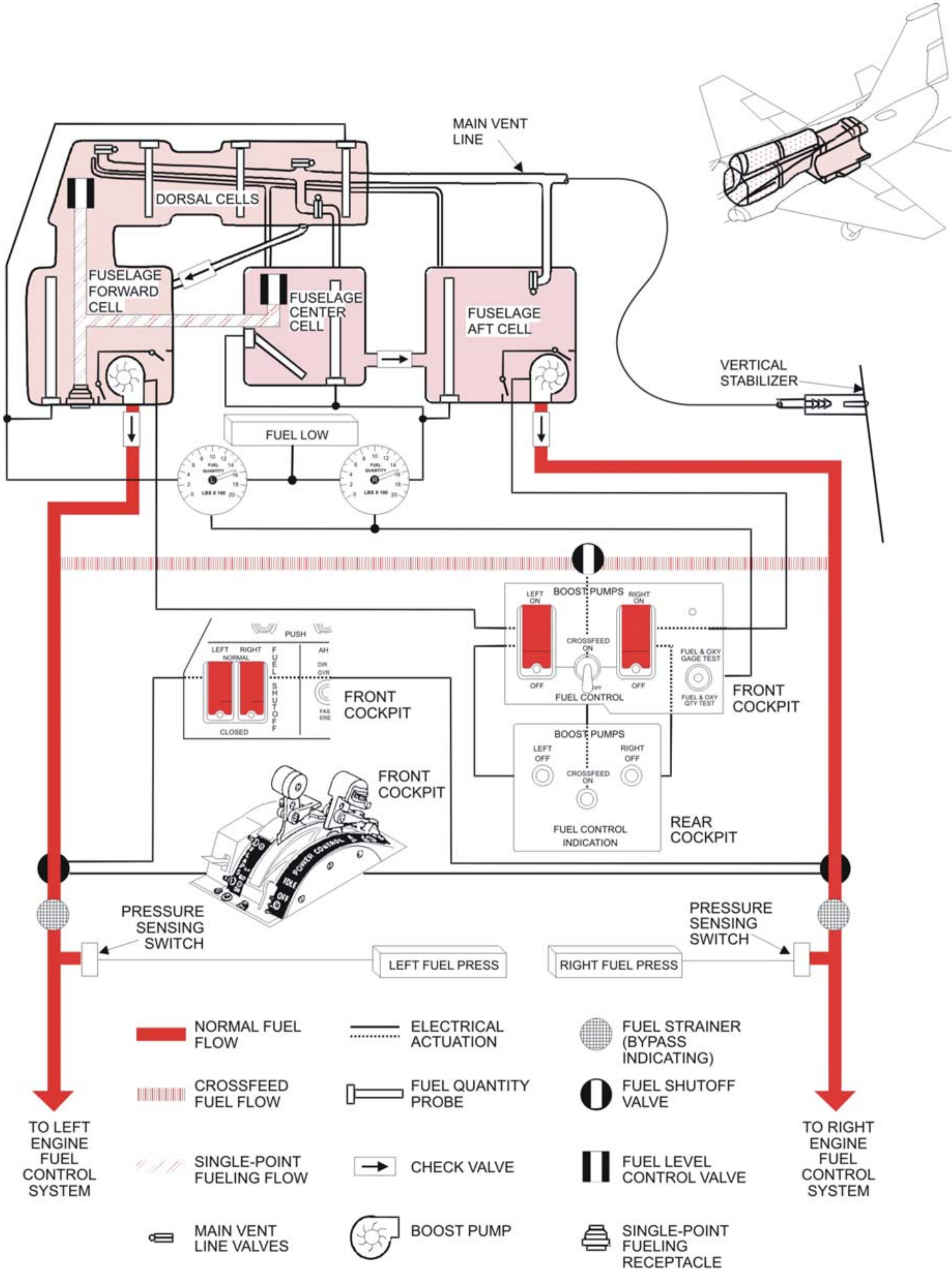


Figure 1-13. Fuel System

FUEL PRESSURE CAUTION LIGHTS

Two fuel low pressure caution lights, placarded LEFT FUEL PRESS, RIGHT FUEL PRESS (Figure 1-16), are located on the right console of each cockpit. The caution light will illuminate when the warning system detects a low-pressure condition and will remain illuminated as long as the low-pressure condition exists. Fuel low-pressure caution lights may be used to determine if boost pumps are operating. Low pressure lights are the only valid indications of boost pump output with crossfeed OFF, the corresponding fuel shutoff switch NORMAL, and throttle out of OFF. The caution lights may blink when afterburner power is selected. Various other conditions may cause the lights to blink; this blink is not an indication of boost pump failure.

CROSSFEED SWITCH

A crossfeed switch (Figure 1-9), operating on DC, is located on the right subpanel of the front cockpit. The switch is used to electrically open and close the crossfeed valve in the crossfeed fuel manifold that connects the two fuel systems. The switch is placed at ON to use the fuel from both systems to supply one engine, or to operate both engines on fuel from one system under boost pump pressure.

WARNING

With the crossfeed switch ON and either both boost pumps ON—or both boost pumps OFF—a rapid fuel imbalance can occur.

CROSSFEED INDICATOR LIGHT

An amber crossfeed indicator light (Figure 1-11) is located on the right subpanel of the rear cockpit. When the crossfeed switch in the front cockpit is placed at ON, the crossfeed indicator light illuminates.

FUEL SHUTOFF SWITCHES

Two guarded fuel shutoff switches (Figure 1-9), one for each engine, are located on the left subpanel of the front cockpit. The fuel shutoff valves (DC operated) are normally controlled by the throttles, with the fuel shutoff switches in the NORMAL position. Placing either or both of these switches at the CLOSED position shuts off fuel flow to either or both engines in approximately 1 second without using the throttles.

CAUTION

The switches should be used only in an emergency, as damage to the engine-driven fuel pumps and main fuel control may occur.

FUEL QUANTITY INDICATORS

The two fuel quantity indicators (Figure 1-7), one for each fuel system, are stacked on the right side of the instrument panel. The upper indicator displays the fuel quantity in the left fuel system. The indicators operate on AC and indicate in pounds the total usable fuel quantity in each fuel supply system. Rear cockpit indicators repeat fuel quantity readings from the front indicators.

FUEL QUANTITY CAUTION LIGHT

A fuel quantity low-level caution light, placarded FUEL LOW, is located on the right console of each cockpit (Figure 1-16). The caution light will illuminate after a 7.5-second delay when a fuel quantity indicator reads below 275 to 225 pounds. The left and right system fuel quantity indicators must be checked to determine which system is low.

FUEL/OXYGEN CHECK SWITCH

Fuel and oxygen quantities and indicator operation can be checked by a switch on the right subpanel of the front cockpit (Figure 1-9). The three-position switch is spring-loaded to the unmarked OFF position. With external or generator AC power, fuel and oxygen quantities are indicated when the switch is in the OFF position. To check operation of fuel and oxygen quantity indicators, the switch is held at the FUEL & OXY GAGE TEST position. Indicator pointers should move counterclockwise. When the switch is released, each indicator pointer will return to indicate the fuel and oxygen quantities. With battery power only, the switch is held at the FUEL & OXY QTY CHECK position to read the fuel and oxygen quantities onboard the aircraft. (The static inverter supplies AC power to the indicating circuits when the switch is actuated.)

CAUTION

- If fuel indicating problems are suspected, land as soon as practical. Use alternate means, such as the FMS, to estimate fuel state.
- A fuel quantity indication system can fail, but the fuel quantity gauge may still test good using the fuel/oxygen quantity test switch.

AIRFRAME-MOUNTED GEARBOX

An airframe-mounted gearbox for each engine operates a hydraulic pump and an AC generator. A shift mechanism keeps AC generator output between 320 and 480 cycles per second. Gearbox shift occurs in the 65% to 70% RPM range.

ELECTRICAL SYSTEMS

A diagram of the electrical system is shown in Figure 1-14. Two alternating current (AC) systems and one direct current (DC) system supply electrical power to the aircraft. This figure lists the equipment to which power is supplied by each of the four aircraft power buses. The 115/200-volt AC power supply systems consist of two identical engine-driven AC generating systems and an external power receptacle. The DC power supply system consists of two DC buses (normal and emergency) powered nominally by two 28-volt DC transformer-rectifiers or by a 24-volt 13-ampere-hour lead-acid battery. The circuit breaker panels located in the front and rear cockpits are shown in Figures 1-8, 1-10, 1-12, and 1-15. A circuit breaker is open (off) when its pushbutton protrudes outward and a white ring is visible around the pushbutton. It is closed (on) when the pushbutton is depressed and the white ring is not visible. The number on the pushbutton indicates the current rating of the circuit breaker in amperes. The primary purpose of the circuit breakers is overcurrent protection. Manual operation should be necessary only for maintenance purposes.

AC POWER SYSTEM

AC power is normally obtained from two engine-driven AC generators. The power distribution is divided into a right system and a left system. The generators are cut in individually when engine speed accelerates to approximately 43% to 48% RPM. If one generator should fail or is turned off, the functioning generator will automatically supply electrical power to both systems through the bus contactor relay.

Generator Switches and Caution Lights

Two guarded generator switches (Figure 1-9), one for the left and one for the right generator, are located on the right sub-panel of the front cockpit. Generator caution lights, placarded LEFT GENERATOR and RIGHT GENERATOR (Figure 1- 16), are located on the right console of each cockpit. A caution light will illuminate when its generator switch is placed at OFF or when a generator malfunction occurs. A switch RESET position permits resetting the generators.

DC POWER SYSTEM

Normal DC power is obtained through two transformer-rectifiers which convert AC to DC power. Whenever AC power is supplied (ground or internal), the normal DC bus is powered. If one transformer-rectifier fails, the other automatically supplies all DC requirements. If both transformer-rectifiers fail, the MASTER CAUTION light on the instrument panel and the XMFR RECT OUT light on the right console light matrix will illuminate. Under this condition, the DC bus will revert to battery power.

NOTE

> The XMFR RECT OUT and MASTER CAUTION light may blink due to surge current developed by a high battery voltage overriding the DC bus voltage. This is a normal condition and does not indicate a failure.

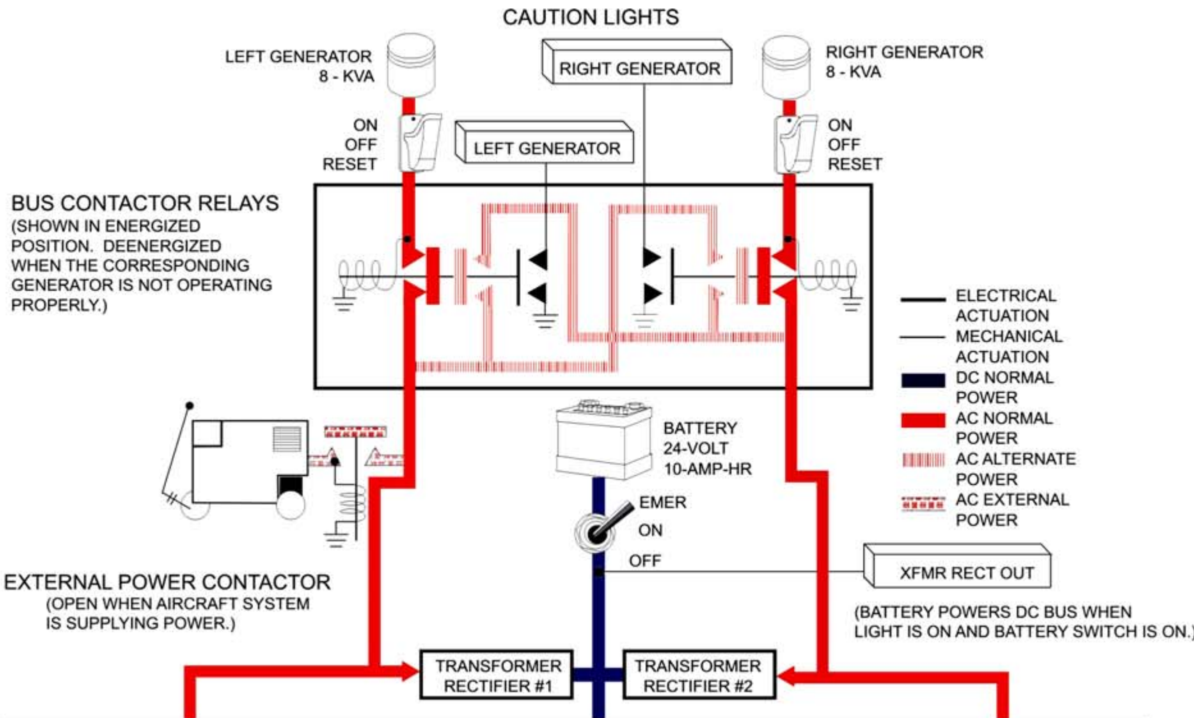
Voltmeter

A red LED voltmeter located on the front cockpit right subpanel operates from the DC bus whenever the battery switch is in ON or EMER. With the battery switch in ON and with generators operating or external power connected, the voltmeter indicates transformer-rectifier voltage to the DC bus. When the battery switch is in EMER, the voltmeter indicates the battery voltage.

Battery Switch

The battery switch (Figure 1-9) is located on the right subpanel of the front cockpit. The switch has positions OFF, ON, and EMER. A minimum battery voltage of 18 volts is required to close the battery relay.

- Without operating generators or external power connected: With the switch in OFF, battery power is removed from both busses. Placing the switch to ON permits the battery to power all DC components on the normal and emergency busses. Without external power, the battery switch must be ON for engine start to energize the engine start circuitry. With the battery switch in EMER, essential DC components on the emergency bus are powered by the battery while the components on the normal DC bus are unpowered.
- With operating generators or external power connected: Placing the switch to OFF disconnects the battery from the DC busses and removes DC power from the emergency bus. Placing the battery switch to ON permits the transformer-rectifiers to power both the normal and emergency DC bus and charge the battery. Although the battery is not required for engine start when external power is used, the switch should be ON for Intercom System (ICS) and Very High Frequency (VHF) radio operations while starting. With the battery switch in EMER, the normal DC bus is powered by the transformer - rectifier and the emergency bus is powered by the battery. Battery charging from the transformer-rectifier does not take place with the battery switch in



LEFT 115/200 - VOLT AC BUS

- AIR TEMPERATURE SENSOR HEATER
- ALTITUDE ALERTER
- AOA VANE HEATER
- BATTERY HEATER
- CAUTION, WARNING, & IND LIGHTS DIM
- CONSOLE LIGHTS
- EXHAUST GAS TEMP INDICATION – LEFT
- FORMATION LIGHTS
- FUEL BOOST PUMP – LEFT
- FUEL FLOW INDICATION – LEFT
- FUEL LOW WARNING
- FUEL QUANTITY INDICATOR – LEFT
- HYDRAULIC PRESSURE INDICATION
- INSTRUMENT LIGHTS
- LANDING – TAXI LIGHT ILLUMINATION
- OIL PRESSURE INDICATION – LEFT
- POSITION LIGHTS (6-VOLT AC)
- RADAR ALTIMETER
- ROTATING BEACON/STROBE
- RUDDER TRIM CONTROL
- SYNCHRO INTERFACE UNIT (PHASE A)

28 - VOLT DC BUS

- AIR DATA COMPUTER
- CANOPY WARNING
- CAUTION, WARNING, & INDICATOR LIGHTS (BRIGHT)
- CONSOLE LIGHTS
- DC BUS MONITOR & CURRENT DETECTOR
- DME
- EADI – FRONT AND REAR
- EFIS INTERFACE (CEU)
- EHSI – FRONT AND REAR
- ENGINE NOZZLE POSITION INDICATOR
- ENGINE START & IGNITION CONTROL
- FLAP CONTROLS
- FLAP POSITION INDICATORS
- FMS – FRONT AND REAR
- FUEL CROSSFEED VALVES
- FUEL (FIREWALL) SHUTOFF VALVES
- FUEL/OXYGEN QUANTITY TEST
- IGNITION INVERTER
- LANDING GEAR AUDIBLE WARNING SIGNAL
- LANDING GEAR CONTROL & SAFETY CIRCUITS
- LANDING/TAXI LIGHT EXTENSION CONTROL
- LEFT ENGINE START & AB CONTROL
- NAVIGATION MANAGEMENT UNIT
- NOSEWHEEL STEERING CONTROL
- PITOT HEAT MONITOR
- RIGHT ENGINE START & AB CONTROL
- RMS – FRONT AND REAR
- SEAT ADJUSTMENT
- SPEED BRAKE CONTROL
- STATIC INVERTER
- SYMBOL GENERATORS 1 & 2
- TACAN TRANSCEIVER
- UHF RADIO
- VOR BACKUP CONTROL HEAD
- VOR/ILS RECEIVER
- WEATHER RADAR & CONTROL PANEL

EMERGENCY BUS

- AIRSPEED
- AIR SPEED/MACH INDICATOR – FRONT & REAR (IF AC FAILS)
- ALTIMETER – FRONT & REAR (IF AC FAILS)
- FIRE DETECTORS
- FLOODLIGHTS (IF AC FAILS)
- INTERCOM
- INERTIAL REFERENCE SYSTEM
- STANDBY ATTITUDE INDICATOR – FRONT & REAR
- TRANSPONDER
- VHF COMM RADIO
- VHF COMM BACKUP CONTROL HEAD
- VOLTMETER

RIGHT 115/200 - VOLT AC BUS

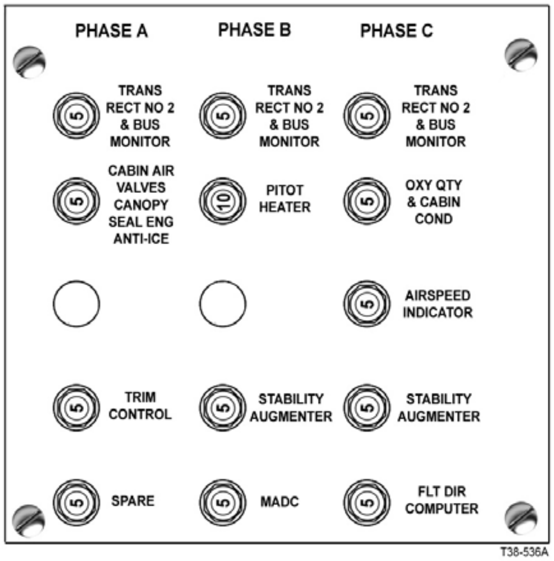
- AIR SPEED/MACH INDICATOR – FRONT & REAR
- ALTIMETER – FRONT & REAR
- CABIN AIR CONDITIONING
- CANOPY SEAL
- ELECTRICAL TEST
- ENGINE ANTI-ICE
- EQUIPMENT COMPARTMENT COOLING
- EXHAUST GAS TEMP INDICATION – RIGHT
- FLAP MOTORS
- FLIGHT DIRECTOR COMPUTER
- FLOODLIGHTS (NORMAL)
- FUEL BOOST PUMP – RIGHT
- FUEL FLOW INDICATION – RIGHT
- FUEL LOW WARNING – RIGHT
- FUEL QUANTITY INDICATOR – RIGHT
- HYDRAULIC PRESSURE INDICATION – RIGHT
- IGNITION EXCITERS
- OIL PRESSURE INDICATION – RIGHT
- OXYGEN QTY & LOW-LEVEL WARNING CIRCUIT
- PITOT HEATER
- SEAT ADJUSTMENT
- STABILITY AUGMENTER
- SYNCHRO INTERFACE UNIT (PHASE C)
- TRIM CONTROL & LIGHT
- WEATHER RADAR (REF SIGNAL)

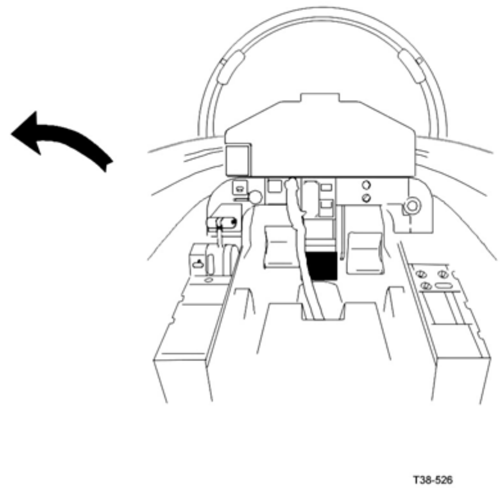
T38-607

Figure 1-14. Electrical System

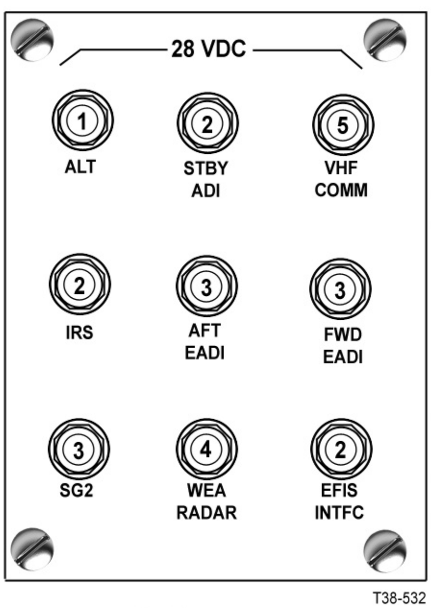
FRONT CB PANELS

PEDESTAL – FRONT COCKPIT





LEFT CONSOLE – FRONT COCKPIT



LEFT CONSOLE – FRONT COCKPIT

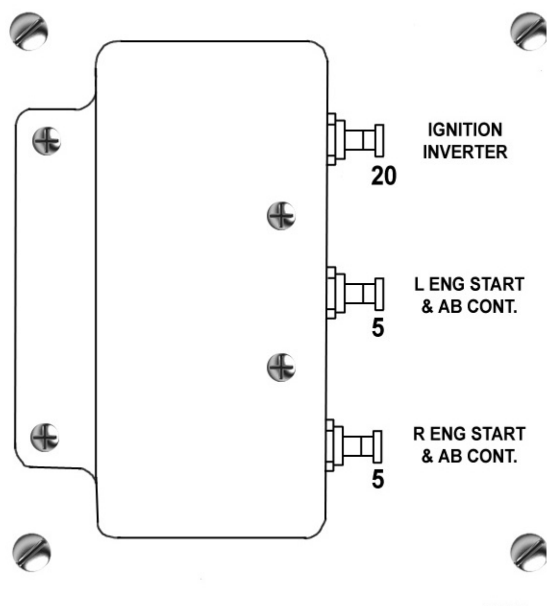


Figure 1-15. AC Circuit Breaker Panels (Sheet 1 of 2)

REAR CB PANELS

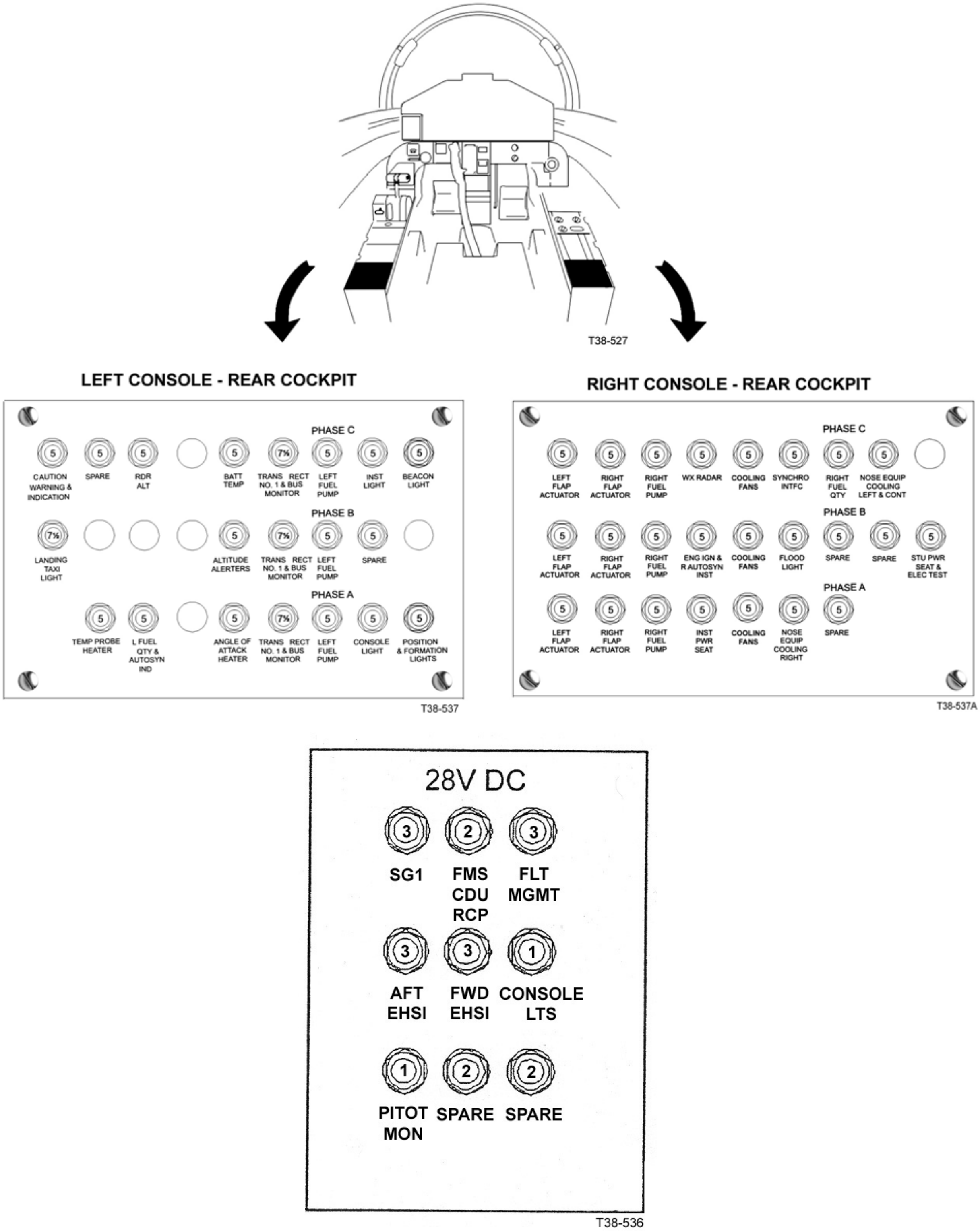


Figure 1-15. AC Circuit Breaker Panels (Sheet 2 of 2)

the OFF or EMER position. Under normal flight conditions, the battery switch should remain in the ON position to permit the battery to charge and maintain emergency DC bus operation.

CAUTION

With operational transformer-rectifiers, placing the battery switch to OFF will result in loss of all emergency DC bus equipment (to include intercom, all communication radios, and the IRS) and battery charging.

NOTE

Battery life depends on many conditions and cannot be accurately predicted. Emergency DC operating time is approximately 2 hours on a fully charged battery. Operation of both DC busses from the battery prior to selecting EMER significantly reduces this time to as little as 14 minutes.

STATIC INVERTER

A static inverter, powered by the DC bus, converts the DC bus voltage to 115 Volts Alternating Current (VAC). The inverter, when activated, provides an alternate source of AC power for the following:

a. Starting first engine on the ground or during flight.
b. Operation of right engine instruments during start of right engine.
c. Fuel and oxygen quantity indicators.

On the ground, with DC power only, the inverter is activated when either engine start button is pushed for engine start, or when the fuel/oxygen check switch is held at FUEL & OXY GAGE TEST or FUEL & OXY QTY CHECK position. During flight, with DC power only, the inverter is activated when either engine start button is pressed or either throttle is moved into MAX range for engine restarts, or when the fuel/oxygen check switch is held at FUEL & OXY GAGE TEST or FUEL & OXY QTY CHECK position. With normal AC/DC power or DC power only, an operational check of the static inverter can be accomplished by positioning the fuel/oxygen check switch to FUEL & OXY GAGE TEST and observing counterclockwise movement of fuel and oxygen quantity indicator pointers.

CAUTION, WARNING, AND INDICATOR LIGHT SYSTEM

CAUTION LIGHT PANEL

A 14-capsule caution light panel (Figure 1-16) on the right console of each cockpit is provided to alert the crewmember of individual system malfunction or status changes. All capsule caution lights are yellow. Each caution light except the ENG ANTI-ICE ON light will remain illuminated as long as the malfunction exists or system status is unchanged. The caution lights will not go out if the master caution light is rearmed. The ENG ANTI-ICE ON light will illuminate when the engine anti-ice switch is turned on. Refer to the description of aircraft systems for operation of the applicable caution lights.

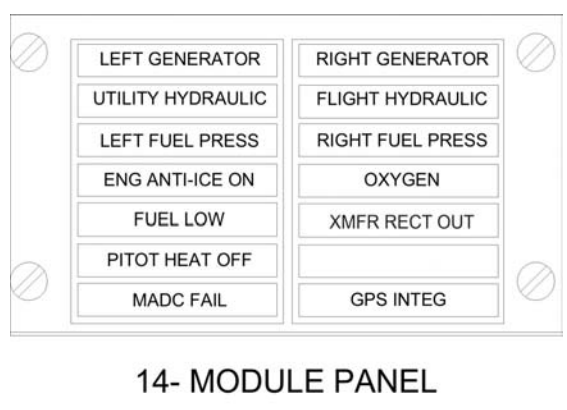


Figure 1-16. Caution Light Panel

MASTER CAUTION LIGHT

A master caution light (Figure 1-7), placarded MASTER CAUTION, is located on each instrument panel. When a light illuminates on the caution light panel, the master caution light will also illuminate. When the condition is corrected, the master caution light will automatically go out. If the condition cannot be corrected, the master caution light may be pressed, causing it to go out and rearming it to provide warning of subsequent malfunctions.

CAUTION, WARNING, AND INDICATOR LIGHT BRIGHT/DIM SWITCH

A three-position switch (Figures 1-10 and 1-12) spring-loaded to the neutral unmarked position is provided on the right console of each cockpit to dim all caution, warning, and indicator lights except the fire warning and takeoff trim indicator. With the instrument light control out of the OFF (detent) position, momentarily placing the switch in the DIM position will switch the power source from DC to AC, thus providing the DIM setting in that cockpit. Placing the switch momentarily to BRIGHT or placing the instrument light control to OFF will return the lights to bright.

CAUTION, WARNING, AND INDICATOR LIGHT TEST SWITCH

The landing gear audible warning signal, the fire detection system, the Angle-of-Attack (AOA) indexer lights, and all caution, warning, and indicator lights except the takeoff trim indicator light, may be tested by placing the spring-loaded switch on the right console lighting control panel in each cockpit (Figures 1-10 and 1-12) at the TEST position.

NOTE

If the warning test switches in both cockpits are actuated simultaneously, all fire warning lights will illuminate. The landing gear audible warning signal will not come on in either cockpit.

ICE DETECTION LIGHT

An ice detection light is installed so that ice buildup will be visible at night at the base of the front wind screen.

FIRE WARNING AND DETECTION SYSTEM

The fire warning and detection system is provided to give a warning of a fire or overheat condition in either engine bay. Heat detectors are located in the forward engine bay and boattail area for each engine. The system responds to an overall average temperature or to highly localized temperatures caused by impinging flame or hot gas. Operation of the system in each engine compartment is independent of the other except when testing the system using the caution, warning, and indicator test switch. Placing either cockpit test switch at TEST checks all system detectors and fire warning light bulbs (4) in each cockpit. For test purposes only, each bulb is connected to a detector. However, any fire or overheat condition in either engine compartment will illuminate both bulbs of the respective fire warning lights in both cockpits.

NOTE

An illuminated fire warning light may be a valid fire indication even though the test circuit may be inoperative.

ENGINE FIRE WARNING LIGHTS

Two red fire warning lights (Figure 1-7), placarded FIRE, one for each engine, on the instrument panel in each cockpit, are provided to warn of an overheat or fire condition in either engine compartment. When the fire detection system senses an overheat condition or fire, the warning light for the respective engine will come on. This light will remain on until the condition is corrected and then will go out. Should the overheat condition or fire recur, the light will again come on. Each fire warning light contains two bulbs.

HYDRAULIC SYSTEMS

The aircraft hydraulic power supply systems (Figure 1-17) include the 3,000 psi utility system powered by the left engine and the 3,000 psi flight control system powered by the right engine. Under normal circumstances there is no interchange between systems. Separate pressure indicators and caution lights are provided for each system. Refer to Figure 1-22 for the hydraulic fluid specification.

HYDRAULIC PRESSURE INDICATORS

Two AC-powered hydraulic pressure indicators (Figure 1-7), one for each hydraulic system, are located on the left front instrument panel, above the gear handle in each cockpit.

HYDRAULIC CAUTION LIGHTS

An amber caution light for each hydraulic system, placarded UTILITY HYDRAULIC and FLIGHT HYDRAULIC, is located on the right console of each cockpit (Figure 1-16). The lights illuminate at approximately 1,500 psi to indicate a low-pressure condition. The lights go out when a pressure of approximately 1,800 psi is restored. The lights will also illuminate when the hydraulic fluid has excessively high temperatures. To determine which condition has caused the lights to illuminate, the hydraulic pressure indicators must be observed.

FLIGHT CONTROL SYSTEM

A hydraulically powered, irreversible flight control system is provided (airloads on the control surfaces cannot cause control stick or surface movement). Conventional aerodynamic “feel” in the control stick is provided artificially by springs and bob weights. The springs progressively resist control stick displacement and the bob weight mechanism further resists aft stick travel during maneuvering flight. Lateral and longitudinal trim is provided by electric motors which change the neutral reference point of the feel springs and control stick position. Each control surface is moved by two hydraulic cylinders; one is powered by the utility system, the other by the flight hydraulic system.

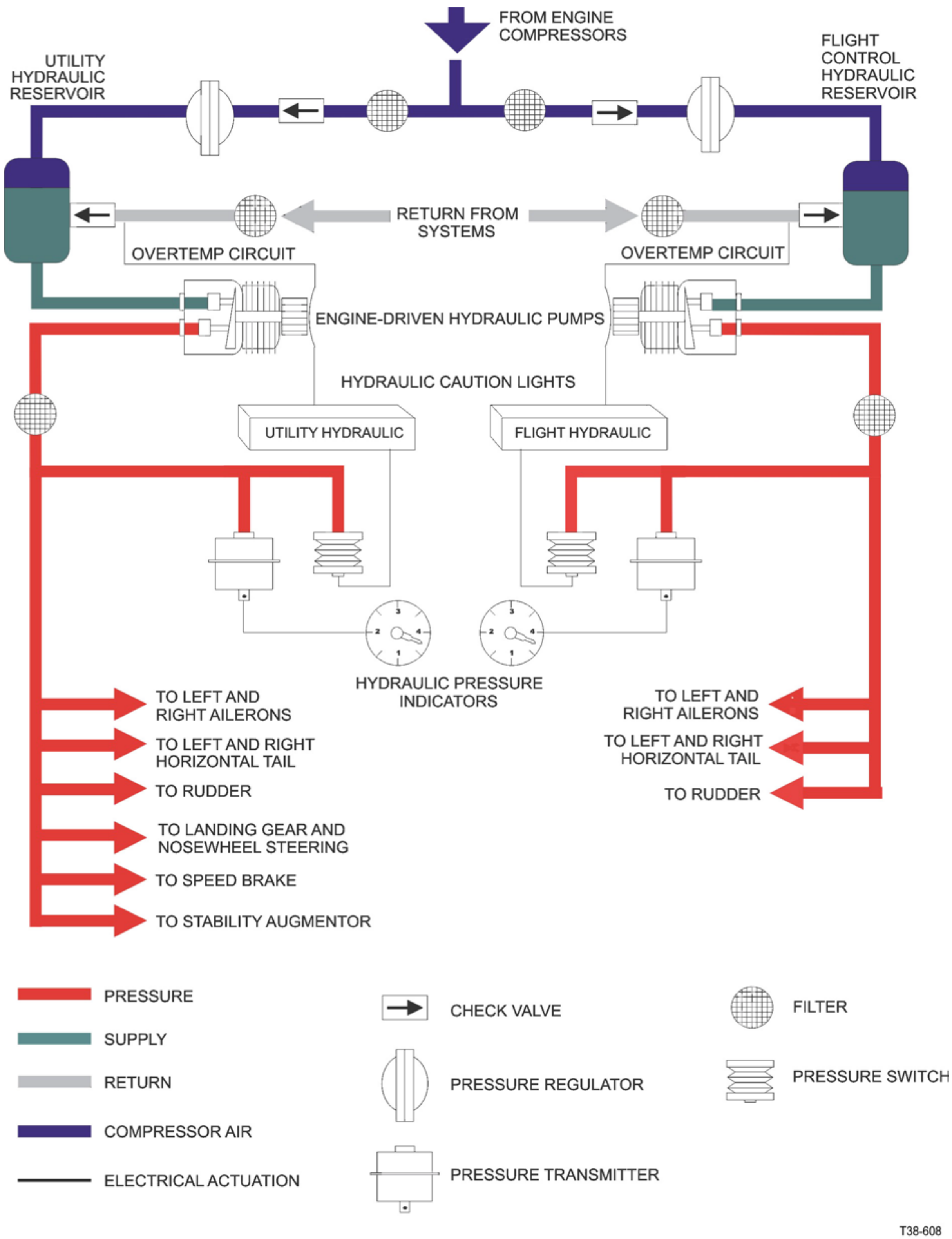


Figure 1-17. Hydraulic Systems

CONTROL STICK

Each cockpit has a control stick with a standard stick grip (Figure 1-18), which contains a flight trim switch, a nosewheel steering button, a VHF microphone button, and an Identification Friend or Foe (IFF) "ident" button.

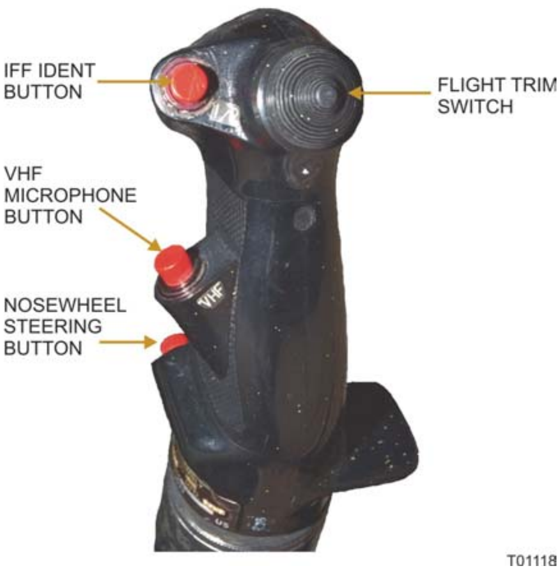


Figure 1-18. Control Stick

RUDDER PEDAL ADJUSTMENT T-HANDLE

A mechanical rudder pedal adjustment T-handle (Figure 1-8) is located on the pedestal of each cockpit. To adjust rudder pedals, pull T-handle out and hold until pedals are repositioned. Return the T-handle to the stowed position manually to lock the pedals in place.

CAUTION

Allowing the handle to snap back may trip or damage pedestal circuit breakers or audio panel control knobs, and cause the cable to kink and wear excessively.

TAKEOFF TRIM SYSTEM

A takeoff trim system is installed to allow positioning of the horizontal tail for the optimum takeoff setting. The system uses the normal longitudinal trim system along with a push button and indicator light (Figures 1-10 and 1-12) installed on the left console in both cockpits. When the button is pushed and held, the trim motor moves the control stick and horizontal stabilizer to the required position at which point the motor stops and a green indicator light illuminates in the left console. The aircraft has external markings to visually confirm proper takeoff trim horizontal tail position.

FLIGHT TRIM SYSTEM

A conventional aileron/elevator trim switch is located on each stick grip. Operation of the switch (Figure 1-18) causes operation of an AC motor, causing appropriate movement of the control stick. Limit switches are installed in the system which limit the range of stick travel obtainable through use of the trim system. Cutout switches interrupt horizontal tail trim when stick force is exerted against the direction of trim. These two systems limit the effects of "runaway trim," since the aircraft can be flown with the control stick at either of the trim limit cutout positions; however, very heavy stick forces may be encountered.

RUDDER TRIM KNOB

An AC electrical rudder trim knob (Figure 1-10) on the left console of the front cockpit provides the means of trimming the rudder. The yaw damper switch must be turned on before the rudder will assume the selected trim position.

RUDDER LIMITER SYSTEM

Deflection of the rudder is limited by a mechanical linkage between the rudder control system and the nose gear trunnion. When the nose gear is extended 3/4 or less, rudder deflection is limited to six degrees from neutral in either direction. When the nose gear is more than 3/4 extended, full rudder deflection of 30 degrees from neutral in either direction is available. The rudder limiter cannot be overcome by either crewmember.

STABILITY AUGMENTER SYSTEM

The stability augmenter system uses utility hydraulic pressure to position the rudder to reduce yaw oscillations. Manual rudder trim is accomplished through the yaw damper. A yaw damper switch is located on the left console of the front cockpit (Figure 1-10). The switch is spring-loaded to the OFF position and is held in the YAW position by AC power. The yaw damper is disengaged by returning the switch to OFF. The augmenter will disengage automatically in the event of AC power failure or certain system malfunctions.

STABILITY AUGMENTATION DISCONNECT SWITCH

The Stability Augmentation System (SAS) disconnect switch is located on the front cockpit instrument panel, as shown in Figure 1-7. The switch allows the pilot to completely disconnect the SAS in an emergency situation where control of the aircraft is degraded due to an SAS malfunction. The switch has two positions: NORM and DISC. In the NORM position, stability augmentation (yaw damper) and rudder trim are controlled through the yaw damper switch and rudder trim knob on the SAS control panel, as previously discussed. Placing the yaw damper switch to OFF disengages the yaw damper (and inhibits rudder trim) but leaves the SAS control panel powered. Placing the SAS disconnect switch to the DISC position removes all power from the SAS control panel (thereby disabling yaw damper and rudder trim) in the same manner as pulling both front cockpit SAS circuit breakers.

CAUTION

> If the SAS disconnect switch is placed in DISC during flight, it should not be returned to the NORM position during the remainder of the flight.

WING FLAP SYSTEM

The primary purpose of the flaps is to provide increased lift for takeoff and landing. The flaps should not be used in high AOA or acrobatic maneuvering. The flaps are electrically (DC) controlled by the flap lever switch in the front cockpit. The flaps are operated by two AC electric motors and are interconnected by a rotary flexible shaft. If one flap motor fails, both flaps are actuated through the rotary shaft. Flap extension time will be much longer than normal with one motor failed.

WING FLAP-HORIZONTAL TAIL (FLAP-SLAB) INTERCONNECT SYSTEM

Flap operation changes the aerodynamic properties of the aircraft. The flap-slab interconnect system compensates for these aerodynamic changes and maintains essentially the same aircraft handling qualities, regardless of flap position.

To provide the required compensation, the flap position is mechanically transmitted to the horizontal tail operating mechanism through an interconnect cable. As the flaps are moved, the interconnect system provides the following:

a. The horizontal tail is automatically repositioned to essentially eliminate the pitch changes caused by flap movement.

b. As the flaps are extended, the interconnect system increases the amount of horizontal tail travel available in the nose down direction.

c. The interconnect system changes the pitch authority of the control stick by increasing the amount of horizontal tail deflection per inch of stick travel.

The majority of the compensation occurs in the first 35 percent of flap deflection.

If the interconnect system fails with flaps extended, the pilot should expect the following:

a. A spring mechanism will rapidly remove all flight control compensation and reposition the horizontal tail to the zero percent flap position.

b. The aircraft will always pitch up, and moderate to heavy forward stick forces (probably beyond the forward trim limit) will be required to maintain controlled flight. Greater than normal control stick movements will be required to affect pitch response.

c. When flaps are retracted following an uncommanded pitch up, the aircraft will have a pronounced tendency to settle, and a large aft stick movement will be required to maintain level flight.

d. Normal handling qualities will be obtained only when the flaps are retracted to the up position.

WING FLAP LEVER AND POSITION INDICATOR

A wing flap lever (Figure 1-4) is located on the throttle quadrant of each cockpit. The two levers are mechanically interconnected by cables; however, the lever in the front cockpit actuates the electrical switch that operates the two flap motors. Sensing switches stop the flaps at 60% when the flap lever is placed in the 60% detent. When operating in the emergency mode, the flaps can be stopped at any position by placing the flap lever in the 60% detent. When UP or DOWN is selected, flap movement is stopped by limit switches at the fully retracted or extended position. The flap position indicator, which operates on DC, is located on the left side of the instrument panel of each cockpit (Figure 1-7). Flap extension is indicated as a percentage of full flap travel.

NOTE

> If the wing flap lever is between the 0 – 60% position or the 60 – 100% position, the flaps will not extend or retract.

AUXILIARY FLAP CONTROL SWITCH

The auxiliary flap control switch is located in the front cockpit (Figure 1-10) on the left console. It is a two-position switch. In the normal position, flap positions of full up, 60% down, and full down can be selected. In the emergency position, flaps can be set at any selection from full up to full down. In this mode of operation, flap extension or retraction is stopped by moving the lever to the 60% detent, which then functions as an OFF position when flaps have reached the desired position, or by limit switches when the flaps have fully extended or retracted.

SPEED BRAKE SYSTEM

A DC electrically controlled, hydraulically activated dual surface aluminum speed brake is located on the lower surface of the fuselage center section. The activation system permits selection of intermediate speed brake positions between closed and fully extended. A lighted speed brake position indicator is mounted on the glareshield in each cockpit. The linear scale indicates UP, DN, and a percentage of open speed brake from 10 to 90 percent. An S B OPEN light is located above the Altitude Alerter in each cockpit (Figure 1-7). The light illuminates any time the speed brake is not up and locked, and flashes when the speed brake is not up and locked and the throttles are at 96% or above. The indicator light is controlled by the COCKPIT INSTRUMENTS light rheostat. The S B OPEN light can be dimmed in conjunction with dimming other caution, warning, and indicator lights.

SPEED BRAKE SWITCH

A conventional three-position (UP-OFF-DOWN) speed brake switch (DC) is installed on the right throttle in each cockpit (Figure 1-4). The switch in the front cockpit has positive detents in each position. The switch in the rear cockpit has the capability to override the position selected in the front cockpit and is spring-loaded to the center OFF position. Intermediate speed brake positions can be obtained by positioning the switch to the desired direction of movement and then returning it to the OFF position. Speed brake creep will occur with the switch in the OFF position. Following override, control of the speed brake system is regained in the front cockpit by moving the switch to OFF. To prevent creep following actuation from the rear cockpit, the front cockpit switch should be placed in the position selected by the rear cockpit.

MODIFIED SPEED BRAKE

The larger high-drag Modified Speed Brake (MSB) can be bolted onto the existing speed brake for shuttle chase and low L/D training. A special hydraulic relief valve allows the MSB to "blow-back" to a trail position in the event of a complete utility hydraulic failure.

LANDING GEAR SYSTEM

Extension and retraction of the landing gear and gear doors are powered by the utility hydraulic system and electrically controlled by the landing gear levers. Landing gear extension or retraction normally takes approximately 6 seconds. The normal landing gear cycle may be reversed at any time. The normal extension sequence is doors open, gear extends, doors close. The retraction sequence is doors open, gear retracts, doors close.

LANDING GEAR LEVER, WARNING SYSTEM, AND SYSTEM SILENCE BUTTON

A landing gear lever (Figure 1-7) is located on the instrument panel of each cockpit. The two levers are mechanically interconnected. A warning system consisting of an intermittent tone (beeper), audible through the headset of each crewmember, and a red light within the wheel-shaped end of each landing gear lever will be activated if the landing gear is not down and locked and the following conditions exist:

a. The airspeed is 180 Knots Equivalent Airspeed (KEAS) or less.
b. The altitude is 9,500 feet or below.
c. Both throttles are below 96% RPM.

NOTE

See T-38(N)-1NS1.

> Power required under single engine conditions may be in excess of that required to activate the landing gear warning system.

When airspeed is decreasing, the system is activated at 180 KEAS. With the system activated and the aircraft accelerating, the light and tone will not go out until the aircraft reaches 181 KEAS. With the gear handle in the UP position and the system not activated, a red light in the landing gear lever indicates that the landing gear doors are not up and locked. The audible warning signal is not activated by an unlocked gear door condition. A landing gear warning silence button (Figure 1-7) is located on the instrument panel of each cockpit. Pressing either button silences the audible warning signal for 40 seconds at which time the beeper will sound again if the condition which triggered it is still present. The timer is activated each time the warning is silenced.

CAUTION

Front cockpit pilot should not place the left foot outboard of the rudder pedal due to the possibility of striking the landing gear handle interconnect linkage causing uncommanded landing gear retraction.

Landing Gear Lever Downlock Override Button

A landing gear lever downlock override button (Figure 1-7) on the instrument panel of each cockpit enables either crewmember to raise the landing gear lever to the LG UP position if the locking solenoid fails to release the landing gear lever from the LG DOWN position. With button pressed, the landing gear lever can be raised to the LG UP position during flight or on the ground. The rear cockpit downlock override button operates electrically; the front cockpit downlock override button operates mechanically.

LANDING GEAR POSITION INDICATOR LIGHTS

Three landing gear position indicator green lights (Figures 1-7) on each instrument panel illuminate when the gear is down and locked.

CAUTION

Cross-threading of the light assembly could result in the light sticking in the press to test position, after pressure is removed, giving an erroneous green light. When pressing to test, the pilot must ensure that the light is spring loaded to the out position.

NOTE

- There are separate contacts on the landing gear down lock switches for each cockpit green indicator light. A good light in either cockpit assures that gear is safe.
- With DC failure, the rear cockpit nose gear light will not illuminate due to gear relay wiring.

LANDING GEAR ALTERNATE RELEASE HANDLE

A landing gear alternate release handle (Figure 1-9) on the left subpanel of the front cockpit permits gear extension without hydraulic pressure or electrical power. When the handle is pulled, the normal landing gear hydraulic and electrical systems are deenergized, and the gear uplocks and gear door locks are mechanically released, permitting the gear to extend by its own weight. No portion of the landing gear structure is under hydraulic pressure after extension by the alternate system. The handle must be held in the fully extended position (approximately 10 inches) until all three gears are unlocked. Extension of the main and nose landing gear will require approximately 15 seconds, but may take up to 35 seconds. If gear alternate extension was accomplished with the gear lever at LG UP, the lever must be placed at LG DOWN and then returned to LG UP to reactivate the normal system. After an alternate extension, the main gear doors will remain open and nosewheel steering will not be available until the system is reactivated. The nosewheel door assumes a spring-loaded closed position after alternate extension. A landing gear reset lever, located outboard of the left rudder pedal in the front cockpit, may be used to reset the landing gear switches.

NOTE

- During preflight, if the striker plate in the nose gear well is found in the extended position, check the reset lever in the RESET (up) position. This resets all gear switches, but will not raise the striker plate. The striker plate will remain extended until the nose gear retracts after takeoff.
- If the gear is lowered by the alternate release handle with the landing gear in the LG UP position, the red light in the landing gear lever will remain illuminated. In this situation, the illuminated red light indicates the gear door open condition normally associated with the gear retraction cycle. The landing gear green indicator lights will be illuminated and the warning signal silent, indicating a positive gear down and locked condition.

LANDING GEAR DOOR SWITCH

A guarded landing gear door switch is provided on the left console of the front cockpit (Figure 1-10). With electrical and hydraulic power available, this switch permits opening and closing the landing gear doors when the landing gear lever is at LG DOWN. If the gear is extended in flight with the gear door switch at OPEN, the gear doors will remain open until the gear is retracted or the gear door switch is placed at NORMAL.

NOSE WHEEL STEERING SYSTEM

The nosewheel steering system provides directional control and shimmy damping. Hydraulic pressure for the system is supplied by the utility hydraulic system. Nose wheel steering is controlled by rudder pedal action and may be activated only when the weight of the aircraft is on the nosewheel. If the nosewheel position does not correspond to the position of the rudder pedals when steering is activated, the nosewheel will turn to correspond to the rudder pedal position.

NOSE WHEEL STEERING BUTTON

Nose wheel steering is electrically controlled by the nosewheel steering button on the control stick (Figure 1-18) in either cockpit. Steering is available only while the button is held pressed. With the button pressed, nosewheel steering is deactivated when one or both throttles are advanced to MAX range and restored when both throttles are retarded below MAX range. Whenever the weight of the aircraft is not on the nose gear, the system automatically deactivates.

NOSE WHEEL CENTERING MECHANISM

A nosewheel centering cam mechanically streamlines the nosewheel whenever the nose gear strut is fully extended. Air pressure in the strut mechanism ensures that the nose gear strut remains fully extended during gear retraction.

WHEEL BRAKE SYSTEM

The main gear wheel brakes are the segmented rotor type and are powered by a separate, completely self contained hydraulic system. The brake pedals are the conventional toe-operated type. Each brake pedal controls a hydraulic master cylinder. Control of the brakes transfers to the crewmember applying the greater pedal force.

PITOT-STATIC SYSTEM

See Section IV.

CANOPY

Each cockpit contains a manually operated clamshell type canopy. The canopy is locked closed or unlocked by an individual locking lever in each cockpit, or by individual locking handles outside the left side of the front cockpit (Figure 1-19). Each canopy is counter-balanced throughout its travel limits. The canopy opening mechanism is protected against excessive loads by a hydraulic canopy damper, which also restricts canopy opening and closing speeds. An inflatable pressurization seal installed on each canopy is inflated when both canopies are locked, the cockpit pressure switch is in the CABIN PRESS position, and an engine is operating. The rear canopy external locking handle has an alignment stripe visible through a hole in the door which aligns with a mark on the door when the rear canopy is locked.

CAUTION

- Canopy movement from the full open or closed and locked position must be initiated by the external or internal locking handle. Actual raising or lowering of the canopy must be done by hand pressure on the canopy frame. Do not apply pressure on the locking handle to raise or lower the canopy, as damage to the mechanism may result.
- Use caution when opening the canopy under high or gusty wind conditions to avoid rapid canopy fly up.
- If an open canopy has been exposed to high winds or jet blast, it should be checked for normal operation, i.e., fully closed before taxi. If the canopy will not close, the aircraft should not be taxied or towed until cleared by qualified maintenance personnel. Aircraft movement may result in canopy separation.
- Damage and possible loss of canopy may occur if the instrument hood is bunched between the canopy breakers and canopy, and the seat is raised to the near full up position.

FRONT CANOPY FRACTURING SYSTEM

The Canopy Fracturing System (CFS) is initiated as the seat moves up the rails during the ejection sequence after approximately 0.35 inches of travel. The CFS is composed of the initiator, the donor and acceptor, and canopy-mounted Mild Detonating Cord (MDC). Dual redundant initiation of the CFS occurs when the seat moves up the rails, actuating a firing pin that initiates a dual percussion primer. The signal is passed through a redundant metal sheathed explosive core to the donor, which transfers the signal across the aircraft/canopy interface to the acceptor by way of dual donor pistons fired into the acceptor percussion primer. The signal is transmitted to the canopy-mounted MDC by metal sheathed explosive core. The MDC is routed on the canopy in such a manner to cut out a diamond pattern and split the canopy in half lengthwise. When severed, the canopy pieces are propelled outwards from the cockpit by the impulse of the cord

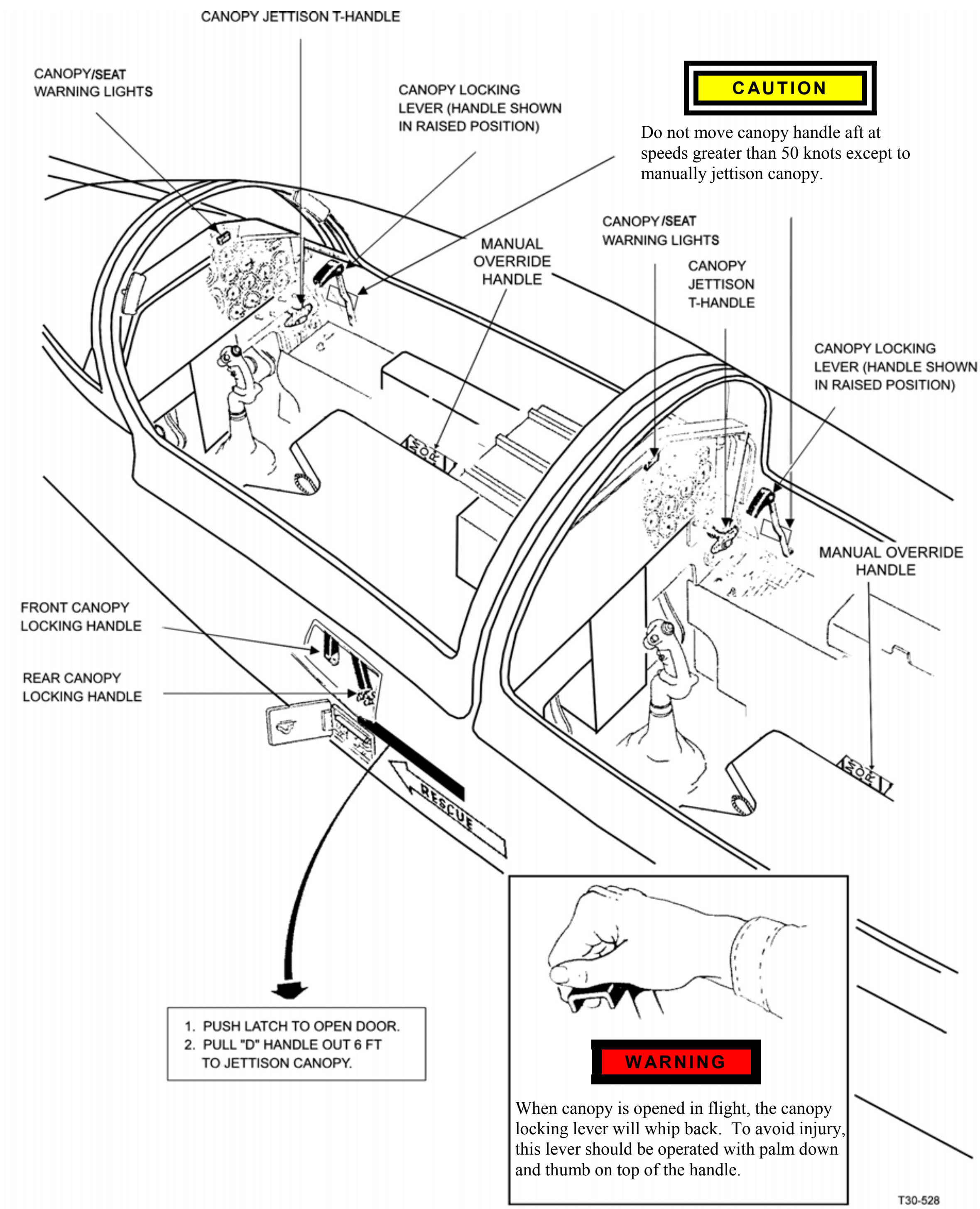


Figure 1-19. Canopy Controls

detonation, providing clearance for the head and torso. The signal cannot be transferred to the canopy unless the canopy is closed. Do not initiate ejection while the canopies are open.

CANOPY JETTISON SYSTEM

The canopy jettison system permits jettisoning each canopy individually from inside the cockpit or both canopies from outside the cockpit. From inside the cockpit, the canopy of the respective cockpit may be jettisoned independent of seat ejection by pulling the T-handle (Figure 1-19) on the right subpanel of each cockpit. A safety pin is provided for each canopy jettison T-handle to prevent inadvertent jettison of the canopy. A spring clip on the bottom of the T-handle must be overcome to pull the T-handle out. To jettison the canopies from outside the cockpit, a canopy jettison D-handle (Figure 1-19) is located externally on each side of the front cockpit, indicated by the RESCUE decal. Opening either access door and pulling the D-handle jettisons both canopies. The front canopy jettisons first when the D-handle is pulled, followed one second later by jettison of the rear canopy. The canopy jettison system will function properly only with the canopy closed and locked. With the aircraft at rest and the canopy in the fully open position, the canopy may not separate from the hinges if jettisoned. If the jettison system is activated with the canopy in a position other than fully open, the canopy will move to the full open position and probably separate from the aircraft.

WARNING

- Do not initiate ejection while either canopy is open. Neither the front canopy fracturing system nor the rear canopy jettison system will clear the escape path when the canopies are open.
- If in dual cockpit operations, consider the canopy configuration of the other cockpit. The seat warning light will be lit if in a dual mode (both or forward) and either canopy is open when either seat is armed.

The rear cockpit canopy also jettisons during the rear cockpit ejection sequence.

CANOPY BREAKER TOOL

A canopy breaker tool (Figures 1-5, 1-6, and 3-1) is stowed on the left canopy frame in each cockpit. The tool is used to break the canopy glass if other methods of opening the canopy fail.

EJECTION SYSTEM

The US16LN-1 (front cockpit) and US16LN-2 (rear cockpit) ejection seats (Figures 1-20 and 1-21) are two catapult, lightweight seats operated by cartridges with the aid of a rocket motor. The ejection seats give safe escape for most values of the aircraft's height, velocity, attitude, and flight path (within the envelope from zero height at zero velocity in a near level attitude, and the limits of the aircraft's maximum velocity, between zero and maximum height).

An inter-seat sequencing system can be selected to let either aircrew start the ejection sequence for both aircrews. Time delay cartridges make sure that the rear seat always ejects first, with an automatic time interval before the front seat ejects. A solo mode can also be selected; this gives the shortest possible time for front seat ejection.

Ejection is started when an aircrew pulls a seat-firing handle on the front of the seat bucket between the aircrew's thighs.

1. Safety Pin (Seat Firing Handle)
2. Seat Survival Kit Connectors
3. Harness Release Fitting
4. Head Pad
5. Harness Lift Webs
6. Parachute Assembly (Headbox)
7. Secondary Cartridge
8. Emergency Oxygen Handle
9. Harness Locking Lever
10. Safe/Arm Handle
11. Leg Line Release Lever
12. Leg Restraint Lines and Garters
13. RH Seat Initiator

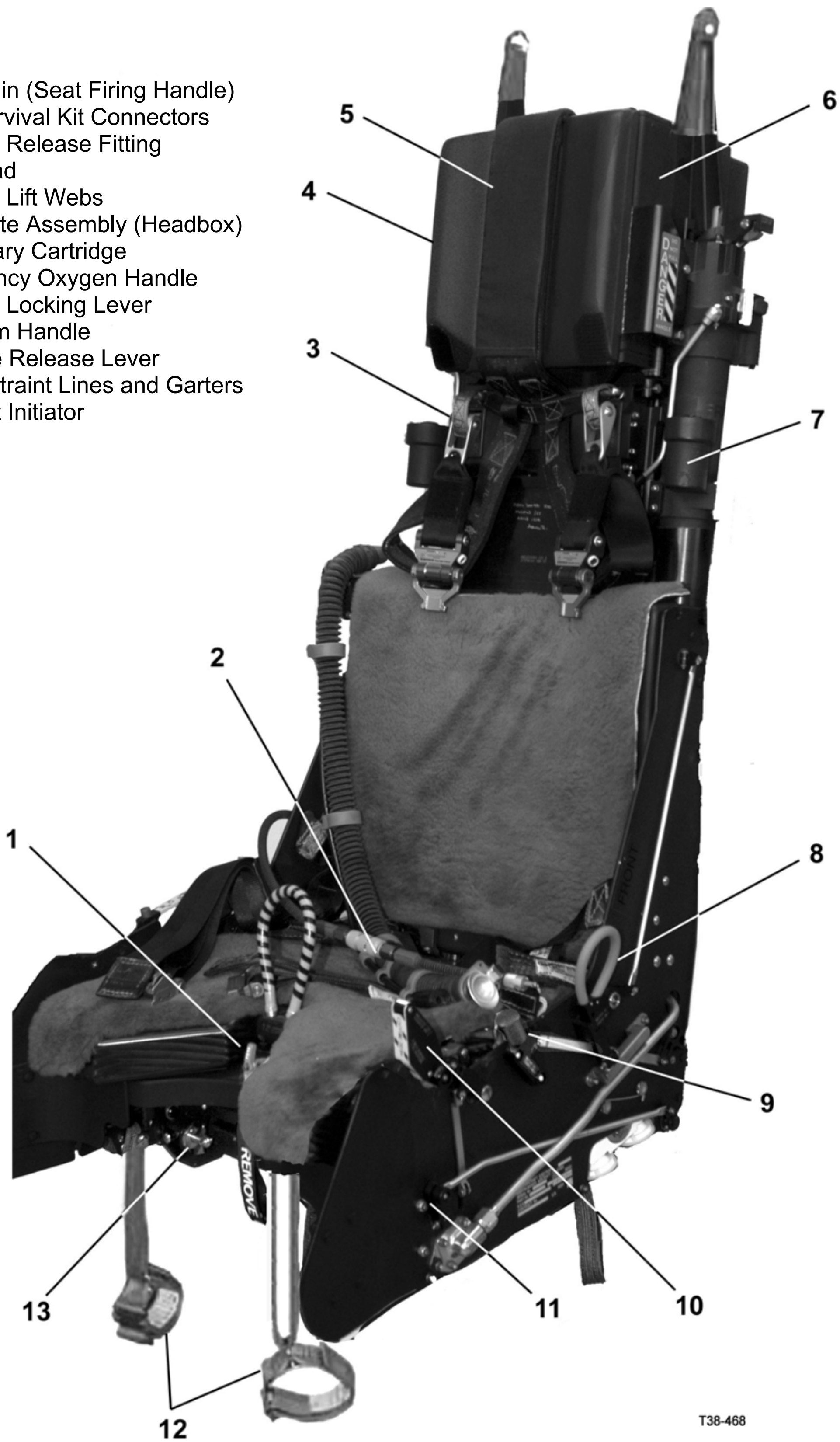


Figure 1-20. Ejection Seat – Front LH View

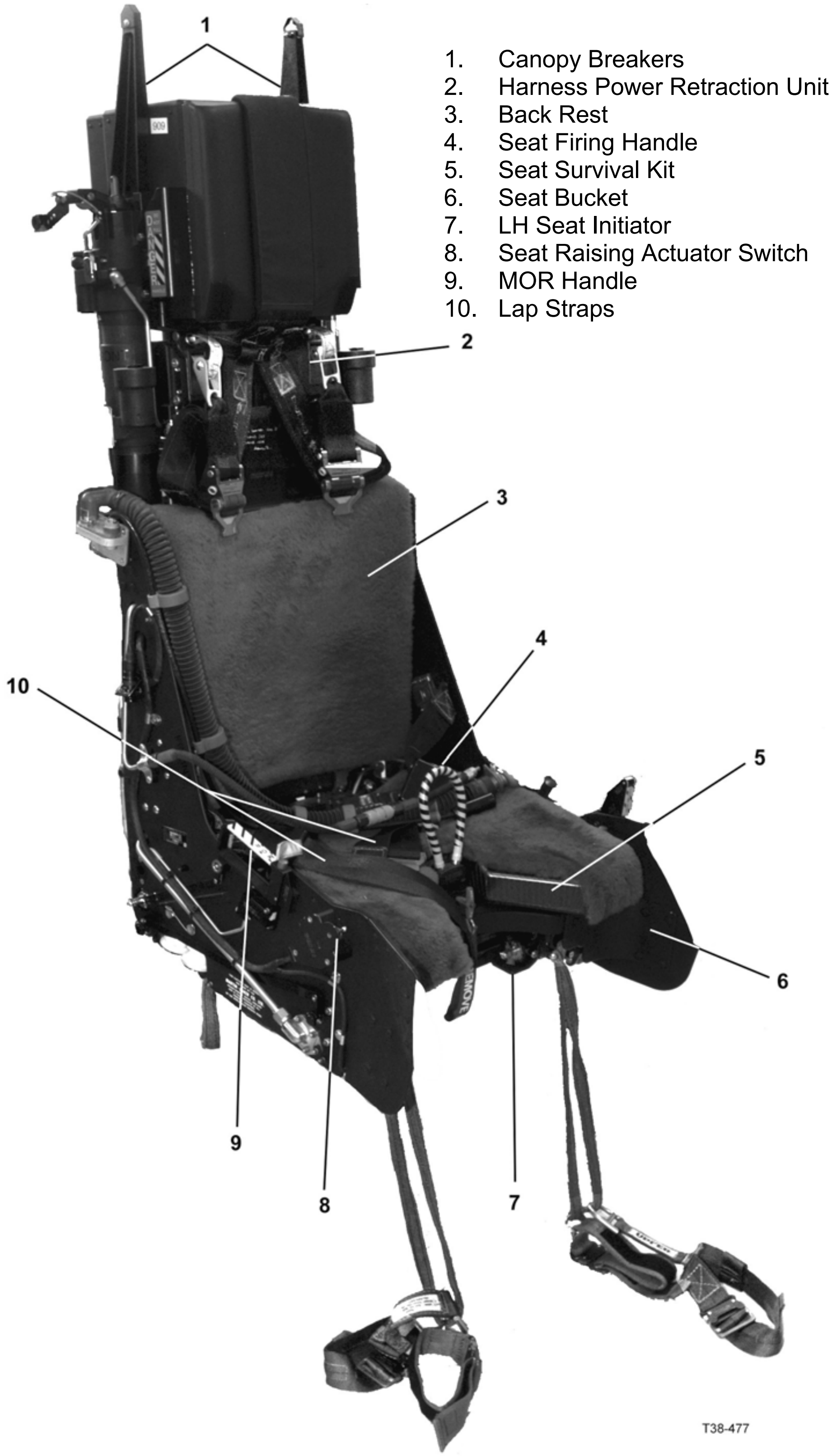


Figure 1-21. Ejection Seat – Front RH View

A canopy jettison system jettisons the rear canopy immediately before rear seat ejection. If the canopy jettison system does not operate, the canopy breakers on the parachute container will break the canopy and let the rear seat eject safely through the canopy. A canopy fracturing system fractures the front canopy during front seat ejection. If the canopy fracturing system does not operate, the canopy breakers on the parachute container will break the canopy and let the front seat eject safely through the canopy.

A harness power retraction unit (HPRU) pulls and locks the aircrew in the correct posture for ejection before the time delay cartridges cause initiation of the catapult primary cartridge. A leg restraint line attached to two garters (ankle and thigh) for each leg restrains movement during ejection to minimize injury.

Gas pressure supplied to the two telescopic catapults ejects the seat. An underseat rocket motor (USRM) fires when the catapult is at the top of its stroke. The added thrust of the USRM carries the seat to a safe height for the parachute to deploy.

After ejection, a drogue and bridle system makes the seat stable and decreases forward velocity. A barostatic time-release unit (BTRU) mechanism prevents parachute deployment until altitude and forces caused by ejection at high velocity are satisfactorily low. An automatic back-up unit (ABU) mechanism backs up the BTRU. The ABU timer runs for 3.5 seconds, or longer, subject to its barostatic interdictor. A personal parachute then automatically deploys and the aircrew automatically separates from the seat. A manual override (MOR) system can be used to start parachute deployment and the separation sequence if the automatic system and automatic back-up system fails.

EJECTION SEAT CONTROLS

Inter-seat Sequencing System Mode Selector

The Inter-seat Sequencing System (ISS) mode selector is located in the front cockpit where the console joins the aft bulkhead. The mode selector lets the aircrew select one of three modes to fire the ejection seats: SOLO, FWD, or BOTH.

The mode selector has a control handle that can be moved in a quadrant between the three modes and has yellow and black stripes. The control handle has a spring-loaded knob. Pull the knob out against the spring to move the control handle in the quadrant. At each of the three positions, the knob can be released into a hole in the quadrant that keeps it locked. To move the knob into the SOLO position, a plunger on the forward side of the quadrant must also be depressed to access the appropriate hole. The ejection sequence in each mode is as follows:

- **Control handle in SOLO mode (forward position)**
  - When the front ejection handle is pulled, it is ejected with a 0.00 second delay and the rear seat is not ejected.
  - When the rear ejection handle is pulled, it is ejected with a 0.40 second delay and the front seat is not ejected.
- **Control handle in FWD mode (middle position)**
  - When the front ejection handle is pulled, the rear seat will eject after a 0.40 second delay and the front seat after a 0.77 second delay.
  - When the rear ejection handle is pulled, it is ejected after a 0.40

second delay and the front seat is not ejected.

- **Control handle in BOTH mode (aft position)**
  - When the front ejection handle is pulled, the rear seat will eject after a 0.40 second delay and the front seat after a 0.77 second delay.
  - When the rear ejection handle is pulled, it is ejected after a 0.40 second delay and the front seat after a 0.77 second delay.

CAUTION

- Verify the ISS control handle is properly seated in the ISS valve body. When not seated, the black inner handle is recessed in the yellow and black exterior. When seated properly, the inner and outer handle components are flush.
- Failure to properly locate the ISS control handle in one of the three modes may result in loss of seat sequencing.

Seat Firing Handle

The seat firing handle is located on the front of the seat bucket and has yellow and black stripes. Pulling the seat firing handle starts the ejection sequence. A safety pin attached to a red streamer can be put through the handle to prevent movement of the Safe/Arm handle to the ARMED position. Similarly, the safety pin cannot be installed into its receptacle in the seat firing handle if the seat is armed.

SAFE/ARM Handle

The SAFE/ARM handle is located on the left hand side of the seat bucket. In the SAFE position the handle is white, and has SAFE written on it in black letters. To put the handle in the SAFE position, lift the handle up and push it forward. In this position, the seat firing handle is locked and the safety pin receptacle is exposed to allow insertion of the safety pin. In the ARMED position, the handle has black and yellow stripes and has ARMED written on it in black letters. To put the handle in the ARMED position, squeeze the lever with SAFE written on it and pull the lever backward and down. In this position the firing handle can be pulled to initiate the ejection sequence and the receptacle for the safety pin is blocked. The SAFE/ARM handle cannot be put into the ARMED position with the seat firing handle safety pin installed.

CANOPY/SEAT Warning Lights

A two-capsule CANOPY/SEAT warning light is provided to verify the position of the canopies and the appropriate mode for the ejection arming handles. The CANOPY light illuminates when either or both canopies are open and extinguishes when both canopies are closed and locked.

If either canopy is unlocked and either or both throttles are advanced above the 96% quadrant position, a warning horn powered from the 28 Volts DC (VDC) bus will sound. The horn is deactivated when the throttles are below 96% and inhibited while airborne.

The SEAT light illuminates to indicate either or both seats are in an unsafe mode.

During ground operations with either or both canopies open, the ejection seats should be in SAFE mode with the SEAT light extinguished. If either or both seats are ARMED with either or both canopies open, the SEAT light will illuminate.

During dual flight operations (ISS mode handle in FWD or BOTH) with both canopies closed and locked and the CANOPY light extinguished, both seats should be ARMED. If either or both seats are in SAFE mode, the SEAT warning light will illuminate.

For solo flight operations (ISS mode handle in SOLO), only the front seat need be ARMED to extinguish the SEAT light. Also, if the ISS mode handle is in SOLO when the aircraft has two occupants, the SEAT light will illuminate with both canopies closed and locked and both seats ARMED indicating the ISS mode handle is in an incorrect position.

Adjustable Seat Back

The seat back has two positions—forward and aft—to better accommodate aircrews of various heights and weights. To adjust the seat, pull out the locking handle on the left side of the seat back and pull up on the seat back strap located under the sheepskin seat backpad to release the two pins at the base of the seat back from their receptacles. Once free, the seat back can then be aligned over the top of the pin receptacles in the alternate position and the seat back then lowered into position. Once properly seated, the locking handle can then be stowed to secure the seat back in the new position.

CAUTION

- Verify the seat locking handle is properly seated into the side of the seat back. If not, a warning pin extends beyond the end of the handle. When properly locked, the warning pin is flush with the handle.
- Maximum aircrew weight for the seat back in the forward position is 174 pounds. Maximum buttock-knee length in the forward position is 27.2 inches in the front seat and 29.0 inches in the rear seat.

Leg Restraint System

The leg restraint system keeps the legs of the aircrew near to the seat bucket during ejection to minimize the possibility of leg injuries. The system has two leg restraint lines (one for each leg) with break rings, two leg restraint line locks, two snubbers, two lower leg garters (one on the lower calf of each of the aircrew's legs, immediately above the boot) and two upper leg garters (one on the thigh of each of the aircrew's legs, immediately above the knee). Each garter has a velcro adjustable strap to ensure proper fit.

The snubber release knobs let the aircrew pull the leg restraint lines through the snubbers to adjust the length of the leg restraint lines. The snubber knobs are attached to the front left and right hand faces of the seat bucket. The snubber release knobs are spring-loaded to the locked position and must be turned to free the leg restraint lines. Turn the left hand snubber knob counter-clockwise to release the left leg restraint line and the right hand snubber knob clockwise to release the right leg restraint line.

The leg line release lever is on the outside face of the left hand side of the seat bucket. Pulling the lever to the rear or aft releases the leg restraint line taper plugs from the leg restraint locks to allow the garters to be released from the leg restraint line. This can facilitate emergency egress from the aircraft with the garters still attached.

Seat Survival Kit

The seat survival kit (SSK) is installed in the seat bucket. The seat cushion is attached to the top of the sitting platform, which is designed to give maximum support and comfort to the aircrew. The SSK has a fabric container which stores the survival aids. Attached to the SSK is the automatic deployment unit (ADU). The ADU has an AUTO/MANUAL selector knob located at the top of the ADU on the right hand side of the SSK. To set the ADU, pull up the mode selector, against spring pressure, and rotate it so that the arrow points towards AUTO or MANUAL on the ADU body. A static line connects the ADU to the seat. As the aircrew is pulled from the seat, the static line releases the firing pin, which, if the ADU is set to AUTO, fires a 4-second delay cartridge. After the 4-second delay, the cartridge gas pressure opens the seat pan, deploys the raft, and turns the emergency location beacon on. If the ADU is set to MANUAL, a mechanism prevents the firing pin from firing the cartridge and the aircrew must manually deploy the SSK by pulling the kit release handle, located on the front left hand side of the SSK. With the left hand, find the location of the kit release handle on the left hand side of the SSK, adjacent to the left thigh. Push the thumb button at the forward end of the SSK release handle and pull the handle fully up to release the SSK. The handle will come away in your hand. Discard the handle. The SSK will fall and hang on a lowering line 12 feet below the aircrew.

WARNING

Failure to connect both SSK fittings to the torso harness could cause an unacceptable contact with the aircrew during ejection resulting in serious injury or death.

Emergency Oxygen

The emergency oxygen cylinder is installed behind the seat back on the inner left hand side of the seat bucket. The system supplies the aircrew with oxygen for a short period automatically during ejection or manually when selected by the aircrew using the green emergency oxygen handle located on the rear left hand side of the seat bucket. A pressure gauge for the oxygen bottle is visible through a window in the upper left hand corner of the seat back. To view the gauge, release the seat back cover velcro connector on the top left hand side of the seat back to expose the window.

NOTE

The emergency oxygen cylinder will supply aircrew with oxygen for approximately 10 minutes and cannot be turned off.

Harness Locking Lever

The harness locking lever is on the left hand side of the seat bucket. To operate the lever, the aircrew must lift the lever, move it along the quadrant and lower it in one of the two positions in the quadrant, where a spring-loaded plunger engages in the quadrant backplate. The lever can be put in one of two positions in the quadrant. In the aft position, the lever locks the harness to prevent forward movement of the aircrew. In the forward position, the harness is released and the aircrew can move freely forward and backward.

Seat Adjustment Switch

The DC-powered seat adjustment motor is operated by a switch on the front right hand side of the seat bucket and enables the seat bucket to be raised or lowered. The AC-powered switch is spring-loaded to the center OFF position. Push the switch forward/down to LOWER the seat bucket. Pull the switch backward/up to RAISE the seat bucket. The front seat has an actuator stroke length of 4.4 in. and the rear seat 7.4 in.

CAUTION

Do not operate the seat raising actuator for more than 1 minute every 5 minutes. This will cause the motor to overheat.

Manual Override Handle

The manual override (MOR) handle will cause aircrew/seat separation if the automatic sequence or automatic back-up system has not operated. The MOR handle is located on the right hand side of the seat bucket and has yellow and black stripes. Push and hold the thumb button down at the front of the handle and pull up the MOR handle. This will cause the head box to fire, deploying the parachute and initiate seat man separation.

NOTE

The MOR handle cannot be operated before the seat has been ejected.

Barostatic Time-Release Unit

The barostatic time-release unit (BTRU) prevents parachute deployment until altitude and forces caused by ejection at high velocity are satisfactorily low. The criteria for BTRU operations are as follows:

- Above 15,000 ft. the main barostat capsules prevent the operation of the BTRU. When the aircrew has descended in the seat, stabilized by the drogue, to an altitude of 15,000 ft. the BTRU will operate.
- Below 15,000 ft., but above 12,000 ft., the barostat controlled G-switch prevents the operation of the BTRU until the G-load is less than 3.25 G.
- Below 12,000 ft., the barostat controlled G-switch prevents the operation of the BTRU until the G-load is less than 6.20 G.

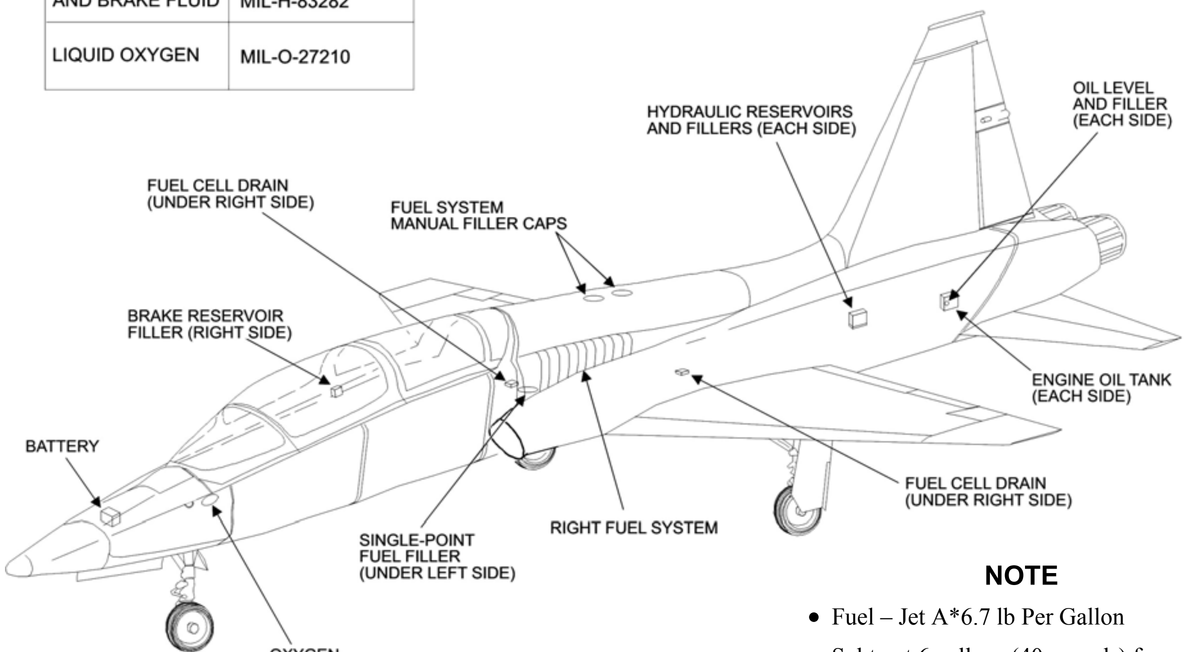
Parachute

The parachute container (headbox) contains a GQ Type 5000 parachute. During the ejection sequence, the head box deployment unit (HBDU) deploys the parachute container. Then the parachute rigging lines, followed by the canopy, are pulled from the bottom of the parachute container. The parachute canopy is connected to the parachute lift webs. The parachute lift webs have upper harness release fittings for attachment to the upper torso harness.

	NASA
FUEL	MIL-T-5624 GRADE JET A ALTERNATE: ‡ EMERGENCY: ‡
ENGINE OIL	MIL-L-7808 ALTERNATE: NONE
HYDRAULIC FLUID AND BRAKE FLUID	MIL-H-5606 MIL-H-83282
LIQUID OXYGEN	MIL-O-27210

NOTE

Refer to Strange Field Procedures in Section II for electrical units, air starting units, alternate, and emergency fuel operating information.



NOTE

- Fuel – Jet A*6.7 lb Per Gallon
- Subtract 6 gallons (40 pounds) from totals if manually refueled.
- Fuel – JP-4 6.5 lb per gallon.
- Subtract 6 gallons (39 pounds) from totals if manually refueled.
- Fuel – JP-8 6.83 lb per gallon.
- Subtract 6 gallons (48 pounds) from totals if manually refueled.

FUEL QUANTITY DATA
SINGLE-POINT REFUELING

	FULLY SERVICED				USABLE			
	GALLONS	POUNDS JET A*	POUNDS JP-4 (ALT)	POUNDS JP-8 (ALT)	GALLONS	POUNDS JET A*	POUNDS JP-4 (ALT)	POUNDS JP-8 (ALT)
LEFT SYSTEM	293	1963	1905	2001	286	1916	1859	1953
RIGHT SYSTEM	305	2044	1982	2083	297	1990	1931	2029
TOTAL	598	4007	3887	4084	583	3906	3790	3982

* JET A WITH ICING INHIBITOR

T38-529

Figure 1-22. Servicing Diagram

NORMAL PROCEDURES

SECTION II

TABLE OF CONTENTS

PREFLIGHT CHECK

On dual flights, all items marked with an asterisk (*) should also be checked in the rear cockpit.

BEFORE EXTERIOR INSPECTION

1. Check Form 1673 for aircraft status, proper service, and load configuration.
* 2. SAFE/ARM Handle – Safed.
* 3. Seat Safety Pin – Installed.
* 4. Canopy Jettison Pin – Installed.
5. Canopy Fracturing System Safety Pin – Removed.
* 6. Emergency Oxygen Gauge – Full.
* 7. Emergency Oxygen Handle – Seated.
* 8. Emergency Oxygen Hose – Attached.
* 9. Seat Survival Kit Straps/Lap Straps – Position.

CAUTION

Failure to route the lap belt straps over the SSK straps could result in entanglement during seat separation.

* 10. Leg Restraint Lines – Plugs Engaged.

* 11. Leg Garters – Attached and Condition.
* 12. Seat Back – Adjusted.
* 13. Upper Seat Latch – Locked.
14. Canopy Fracturing Lanyard – Attached.
15. Canopy Fracturing System Gas Lines Donor/Acceptor – Condition and Checked.
16. Mild Detonating Cord Manifold Gas Line – Checked.
* 17. Automatic Deployment Unit Linkage – Connected.
* 18. Automatic Deployment Unit – As Required.
19. Interseat Sequencing System Mode Selector – As Required.
* 20. Publications – Check for required navigational publications.
21. Battery Switch – ON.
22. Fuel and Oxygen Quantity – Check.
23. Voltmeter – Check.
24. Battery Switch – OFF.
* 25. Landing Gear Lever – LG DOWN.
26. Pitot Heat – OFF.

REAR COCKPIT (SOLO FLIGHTS)

1. Shoulder Harness – Lock.
2. Automatic Deployment Unit – MANUAL.
3. Left Upper Leg Garter – Snap Thru Right Shoulder Harness Strap.
4. Right Upper Leg Garter – Snap Thru Left Shoulder Harness Strap.
5. Lap Belt – Fasten.
6. Lower Leg Garters – Snap Onto Lap Belt.
7. Lap Belt – Tighten.
8. Lap Belt Excess – Tie Together.

EXTERIOR INSPECTION

Conduct the exterior inspection as shown in Figure 2-1.

INTERIOR INSPECTION

1. Crew Retractable Steps – Ensure Stowed (if required).

NOTE

If the crew retractable steps are used, the pilot will ensure they are stowed to prevent flight with the steps extended.

* 2. Safety Belt, Shoulder Harness, Crew/Survival Kit Retention Straps, Ankle/Thigh Garters, Oxygen Hoses, Helmet Chin Strap – Fasten and Adjust.

WARNING

- Do not disconnect the LH and RH SSK release fittings from the torso harness. This will disconnect the SSK, thus increasing the risk of serious injury or death during ejection.

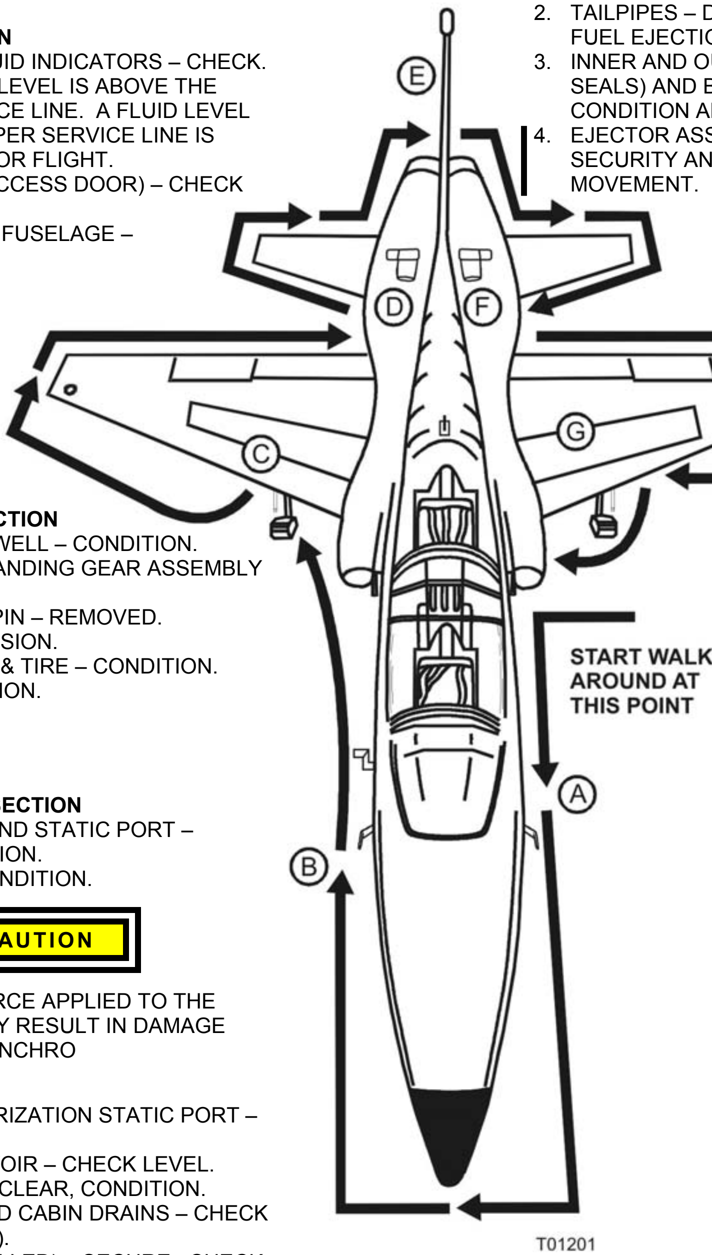
CAUTION

- Do not store objects or personal equipment under the ejection seat.
- Do not store objects or personal equipment on top of or behind the rear cockpit ejection seat or damage to canopy mechanism or inadvertent canopy opening may occur.

* 3. Battery Switch or External Electrical Power – ON (Battery ON required for pre-start Intercom System (ICS)/Very High Frequency (VHF) operations).
4. Voltmeter – Voltage check.
   - 22 volts or greater – Normal start.
   - 20 – 21.9 volts – Charge battery from external power for 15 min. prior to takeoff (engine power may be used if required).
   - Less than 20 volts – Change battery.

EXTERIOR INSPECTION

DURING THE EXTERIOR INSPECTION, THE AIRCRAFT SHOULD BE CHECKED FOR GENERAL CONDITION; CHOCKED WHEELS; ACCESS DOORS, PANELS, AND FILLER CAPS SECURED; GROUND WIRES REMOVED; AND FOR HYDRAULIC, OIL, AND FUEL LEAKS. CHECK ALL SCREWS/ FASTENERS FORWARD OF THE ENGINE INTAKES ARE PROPERLY INSTALLED OR THOSE MISSING ARE APPROPRIATELY ANNOTATED IN THE NASA FORM 1673. ADDITIONALLY, THE FOLLOWING SPECIFIC ITEMS WILL BE CHECKED:



RIGHT AFT SECTION
1. HYDRAULIC FLUID INDICATORS – CHECK. ENSURE FLUID LEVEL IS ABOVE THE BOTTOM SERVICE LINE. A FLUID LEVEL ABOVE THE UPPER SERVICE LINE IS ACCEPTABLE FOR FLIGHT.
2. OIL FILL CAP (ACCESS DOOR) – CHECK SECURED.
3. UNDERSIDE OF FUSELAGE – CONDITION.

RIGHT CENTER SECTION
1. SPEED BRAKE WELL – CONDITION.
2. WHEEL WELL/LANDING GEAR ASSEMBLY – CONDITION.
3. GEAR SAFETY PIN – REMOVED.
4. STRUT – EXTENSION.
5. WHEEL, BRAKE & TIRE – CONDITION.
6. WING – CONDITION.

RIGHT FORWARD SECTION
1. PITOT PROBE AND STATIC PORT – CLEAR, CONDITION.
2. AOA VANE – CONDITION.

CAUTION

EXCESSIVE FORCE APPLIED TO THE AOA STOPS MAY RESULT IN DAMAGE TO THE AOA SYNCHRO TRANSMITTER.

3. CABIN PRESSURIZATION STATIC PORT – CLEAR.
4. BRAKE RESERVOIR – CHECK LEVEL.
5. INLET DUCTS – CLEAR, CONDITION.
6. STICK WELL AND CABIN DRAINS – CHECK (IF APPLICABLE).
7. WSSP (IF INSTALLED) – SECURE. CHECK PYLON TO AIRCRAFT ATTACH BOLTS AND POD NOSE SECTION FOR SECURITY.

TAIL SECTION
1. EMPENNAGE – CONDITION.
2. TAILPIPES – DENTS, CRACKS, FUEL EJECTIONS
3. INNER AND OUTER LEAFS (FINGER SEALS) AND BLANK–OFF PLATES – CONDITION AND SECURITY.
4. EJECTOR ASSEMBLY DOORS – SECURITY AND FREEDOM OF MOVEMENT.

LEFT AFT SECTION
1. OIL FILL CAP (ACCESS DOOR) – CHECK SECURED.
2. HYDRAULIC FLUID INDICATORS – CHECK. ENSURE FLUID LEVEL IS ABOVE THE BOTTOM SERVICE LINE. A FLUID LEVEL ABOVE THE UPPER SERVICE LINE IS ACCEPTABLE FOR FLIGHT.
3. UNDERSIDE OF FUSELAGE – CONDITION.

LEFT CENTER SECTION
1. WING – CONDITION.
2. WHEEL, BRAKE & TIRE – CONDITION.
3. STRUT – EXTENSION.
4. GEAR SAFETY PIN – REMOVED.
5. WHEEL WELL/LANDING GEAR ASSEMBLY – CONDITION.
6. SPEED BRAKE WELL – CONDITION.

LEFT FORWARD SECTION
1. INLET DUCTS – CLEAR, CONDITION.
2. CABIN DRAINS – CHECK (IF APPLICABLE).
3. CABIN PRESSURIZATION STATIC PORT – CLEAR.
4. WHEEL WELL – CONDITION.
5. GEAR SAFETY PIN – REMOVED.
6. STRUT – EXTENSION.
7. TIRE – CONDITION.
8. PITOT PROBE, STATIC PORT, AND TEMP PROBE – CLEAR, CONDITION.
9. RADOME AND ANTI-STATIC STRIPS – SECURE.

Figure 2-1. Exterior Inspection

* 5. (Dual) Intercom Knob – ON (VOX as desired).
Verify operation, Adjust Volume and VOX (if available).

* 6. FMS Power – ON.
(Initiates Self-Test), Accept Present Position, and Enter Flight Plan/Fuel Load.

* 7. Circuit Breakers – Check.8.EFIS CRT Switch – OFF.

9. EFIS ADI (training) Switch – ON.
10.Rudder Trim Knob – Centered.
11. Gear Door Switch – NORMAL.
12. Aux Flaps Switch – NORM.
13. Exterior Lights – As Required.
14. Wing Flap Lever – Match Flap Position.

*15. Throttles – OFF.

16. Speed Brake Switch – Open (AFT).
17. Weather Radar Function Selector – OFF.

WARNING

The Weather Radar should not be operated within 6 feet of personnel or 15 feet from flammable or explosive materials.

18. Weather Radar Mode – Wx.
19. Fuel Shutoff Switches – NORMAL (guarded position).
20. Landing Gear Alternate Release Handle – In.
21. Cabin Altimeter – Check.
22. Landing Taxi Light Switch – OFF.
23. Accelerometer – Check.

*24. Landing Gear Lever – LG DOWN.

25. SAS Disconnect Switch – NORM.

*26. Airspeed-Mach Indicator – Check.
*27. Standby Attitude Indicator – Caged.
*28. Clock – Set.
*29. RMS/Audio – Setup.

- VHF/UHF/VOX Knobs – ON, Adjust Volume.
- Review RMS preflight test results – ACCEPT, if satisfactory.
- VHF/UHF Frequencies/Memory Channels – As Required.
- TACAN Channel – A/G, Channels – As Required.
- Transponder – Set Code; select ALT.

NOTE

Transponder remains in standby until weight off wheels.

- VOR/ILS Frequency – As Required.

30. Backup VHF/VOR Control Heads – Check.
31. Magnetic Compass – Check.

*32. Altimeter Barometric Pressure – Set As Required, Check for "A."
*33. Radar Altimeter – OFF.
*34. Vertical Velocity Indicator – Check.

35. Cabin Pressure Switch – CABIN PRESS.
36. Cabin Air Temperature Switch – AUTO.
37. Pitot Heat Switch – OFF.
38. Engine Anti-Ice Switch – OFF.
39. Fuel Boost Pump Switches – ON.
40. Crossfeed Switch – OFF.
41. Generator Switches – ON.

*42. Oxygen System – Check (PRICE). See Section IV for a description of the oxygen system PRICE Check.
*43. Warning Test Switch – TEST.

NOTE

- All four fire warning light bulbs in both cockpits must illuminate in TEST. Failure of any bulb to illuminate may indicate an inoperative fire detector.
- When the test switches in both cockpits are actuated simultaneously, all fire warning lights will illuminate. The landing gear audible warning signal will not come on in either cockpit.

44. Interior Lights – As Required.
*45. Forms/Publications/Loose Items – Stowed.

STARTING ENGINES

RIGHT ENGINE

Start the right engine first, using the following procedure:

1. Danger Areas – Clear. Fore, aft and under the aircraft. (See Figure 2-2.)
2. External Air – Apply.
3. Engine Start Button – Depress.
4. Throttle – Advance to IDLE at approximately 14% RPM (12% RPM minimum).

CAUTION

- Prior to moving either throttle to IDLE, ensure that the respective EGT OFF indication is out of view or the ON indication is in view as applicable (front cockpit only), otherwise an engine start cannot be properly monitored.
- If ignition does not occur before fuel flow reaches 360 LB/HR, retard throttle to OFF. Maintain airflow to permit fuel and vapors to be purged from engine. Wait at least 2 minutes to permit fuel to drain before attempting another start.
- If Exhaust Gas Temperature (EGT) does not begin to rise within 12 seconds after the first indication of fuel flow, abort the start. If engine light is normal but RPM does not reach generator cut-in speed before termination of the start cycle, push the engine start button to ensure aircraft electrical power is available to monitor the start.

5. Engine Instruments – Check.

NOTE

When the right engine is started and a good crossover occurs, power is applied to the air data computer. Both AOA meters will move full scale before indicating present AOA.

6. Hydraulic Pressure – Check.
7. Caution Light Panel – Check.

LEFT ENGINE

1. Left Engine – Start Same As Right Engine.

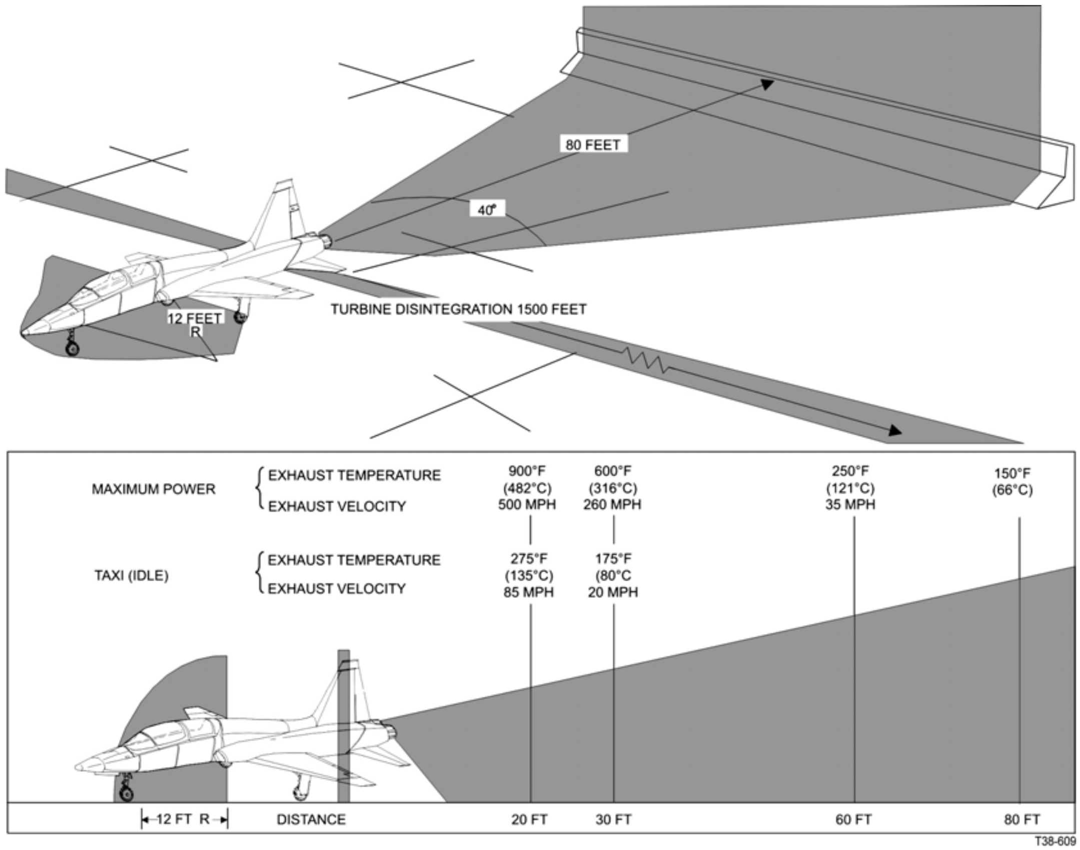


Figure 2-2. Danger Areas

CAUTION

Do not push left engine start button until a minimum of 30 seconds has elapsed after right engine start button has been pushed. The left engine start cycle will be shortened and may result in a hot start due to loss of external air to the engine.

2. Signal ground crew to disconnect external power and/or air supply.

* 3. Circuit Breakers – Check In.

BEFORE TAXIING

WARNING

Do not taxi until the IRS has completed alignment. The heading system will revert to reversionary mode if the aircraft is moved prior to alignment.

1. Canopy Defog and Cabin Temp – Check.

WARNING

For night or anticipated weather operation with conditions of high humidity and narrow temperature dew point spread, canopies should be closed and cabin temperature set to 100 degrees and AUTO to preheat all flight instruments and canopy surfaces. Return temperature control to comfortable setting after completion of line-up check.

* 2. EFIS CRT Switch – ON. Verify ADI/HSI Switch – ON.

NOTE

If ADI or HSI display appears abnormal, press SG1/SG2 button (must have FWD/AFT command) to switch between symbol generator 1 and 2 as required to reset displays.

3. Yaw Damper Switch – YAW.
4. Speed Brake – Closed.
5. Takeoff Trim Button – Press and Check Indicator Light Illuminates.
6. Wing Flap and Flap Slab Interconnect System – Check. Wing flaps down to 60%, full down, then retract to 60%. Check flap position indicator at 60% ±5% when flaps are lowered or retracted. Check operation of flap-slab interconnect system. Visually note trailing edge of slab moves down continuously as flaps are lowered, and moves up as flaps are raised.

WARNING

Do not attempt flight if proper operation of flap-slab interconnect system has not been verified. Leading edge of horizontal tail must be aligned with upper index mark on fuselage at 60% flap setting. The visual alignment portion of interconnect system check must be performed by ground personnel.

* 7. Flight Trim System – Check. Verify proper operation of fore and aft trim. Press takeoff trim button until indicator light illuminates.
8. Aileron Trim – Neutral (Check Visually).
9. Flight Controls – Check. With normal flight control movement, hydraulic pressure should not drop below 1,500 psi. Check visually for proper displacement and freedom of movement. Rudder deflection may be checked with mirrors when canopy is open.

WARNING

The artificial feel assembly makes abnormal flight control conditions difficult to detect by feel only; therefore, aircrews must visually confirm proper movement of the actual flight control surfaces.

10. Communication and Navigation Equipment – Check. Refer to Section IV for description of proper system operation.
    - FWD/AFT Button – FWD (solo); As Desired (dual).

NOTE

Operation of the ADI buttons is possible only in the cockpit designated by the FWD/AFT switch.

- Steering Mode Button – NORMAL.
- LOC/ILS Mode Button – Not Illuminated (unless localizer/ILS selected as primary Nav source).
- VBAR/NEEDLES Button – As Desired.
- NORM/INVERT Button – NORM.
- Symbol Generator Button – SG 1.
- Altitude Alerter – Input Desired Altitude in either cockpit.
- Cabin Altitude or Outside Air Temperature Mode – As desired (both cockpits).
- MDA Mode – Input Desired Altitude in one cockpit (front or rear).

* 11. Altimeter – Select NORM.

12. Fuel/Oxygen Check Switch – FUEL & OXY GAGE TEST.
13. Crossover Relay Check – Right Generator Switch OFF, then ON (when external electrical power used for start, also check Left Generator OFF, then ON).
14. Pitot Heat – Check.
* 15. Seat Height – Adjust to ensure ability to assume ejection position.
* 16. Seat and Canopy Safety Pins – Remove, Display to Ground Crew, and Stow.

CAUTION

Take care to prevent inadvertent pulling of canopy jettison T-handle when removing safety pin.

* 17. Brakes – Check Pedal Pressure.
18. Chocks – Removed.
19. Landing Taxi Light – As Required.
20. Weather Radar Function Selector – STBY.
* 21. Standby ADI – Uncage.

NOTE

Three-minute warm-up required for full alignment.

BEFORE TAKEOFF

WARNING

If exhaust fumes from other aircraft is encountered, use 100% oxygen.

CAUTION

- Low frequency vibration, buzzing, or chatter felt by the pilot through the rudder pedals may indicate present or pending stability augmentation system malfunction.
- If brake drag is encountered or suspected, the flight should be aborted.
- Simultaneous use of wheel brakes and nose wheel steering to effect turns results in excessive nose wheel tire wear. Nose wheel tires are severely damaged when maximum deflection turns are attempted at speeds exceeding 10 knots.
- A low nose gear strut indicates insufficient strut pressure and may result in a cocked nose wheel and/or damage to nose wheel well during retraction. Do not fly aircraft if nose gear strut is deflated or if strut “bottoms” during taxiing.
- To prevent possible damage to canopy downlock mechanism, taxi with either both canopies open or both closed and pressurized whenever practical.

* 1. Brakes – Check.
2. RMS – Verify Com/Nav/ Transponder selections.
   - Transponder – ALT
   - TACAN – A/G
* 3. Flight Instruments – Check (As Required).
4. Weather Radar – Run Test and Evaluate Radar Operation in ON.

CAUTION

The Weather Radar should not be operated within 6 feet of personnel or 15 feet from flammable or explosive materials.

5. Weather Radar Function Selector – As Required.
6. Radar Altimeter – Test and Set as desired.

* 7. Takeoff Trim Button – Press and Check Indicator Light Illuminates.
* 8. Flaps – Check Set at 60%.
* 9. Speed Brake – Check Closed.
10. Canopy Defog, Cabin Temp – As Required.
11. Engine Anti-Ice – As Required.
12. Battery Switch – Check ON.

CAUTION

If battery switch is in OFF position, the ICS, VHF radio, and transponder will not function.

* 13. Personal Connections – Check.
* 14. Oxygen System – Check (PRICE).
* 15. Cockpit Loose Items – Check Secured.
* 16. Takeoff Data – Review/Update.
* 17. (Dual) Takeoff Brief – Complete.

LINEUP CHECK

* 1. Canopy – Closed, Locked; Warning Light – Out.

CAUTION

- Before lowering the canopy, extend the instrument hood forward, as necessary, to ensure the hood is not bunched between the ejection seat parachute housing and the canopy, or damage may occur to the seat or canopy.
- Should the canopy be difficult to close and lock or if binding is encountered in transit, have the system checked by qualified maintenance personnel before flight.
- Should the canopy jam in the fully open position, the aircraft should not be taxied or towed until cleared by qualified maintenance personnel. Efforts to close the canopy, or vibrations set up by aircraft movement could result in canopy separation.

* 2. Helmet Visors – As Required.
3. Pitot Heat – ON.
4. IFF – ALT.
5. Landing/Taxi Light – As Required.
6. Strobe/Beacon – As Required.
7. Weather Radar Function Selector – As Required.
* 8. Flight Controls – Check for Free and Proper Movement.

WARNING

The artificial feel assembly makes abnormal flight control conditions difficult to detect by feel only; therefore, aircrews must visually confirm proper movement of the actual flight control surfaces.

* 9. Seat – Armed, Caution Light Out.
10. Nose Wheel Steering – Check Disengaged.
Once aligned with the runway centerline, allow the aircraft to roll forward slightly to ensure the nose wheel is not cocked.
11. Throttles – MIL.
If the brakes do not hold satisfactorily at military power, reduce the throttles and pump up the brakes again in an attempt to gain sufficient hydraulic pressure to hold the aircraft. If the second run-up attempt results in the brakes not holding, abort the aircraft.
12. Master Caution Light – OUT.
13. Engine Instruments – Check.
14. Hydraulic Pressures – Check.

TAKEOFF

The following takeoff procedure and that given in Figure 2-3 form the basis of the performance predictions in Appendix A, Part 2. Conditions such as weight, wind, and single-engine performance considerations, etc., may make it prudent to delay rotation and liftoff above the speed shown in the figure. However, tire limit speeds of 174 Knots Ground Speed (nose tire) and 195 Knots Ground Speed (main tires) should be observed.

WARNING

Avoid wake turbulence. Allow a minimum of 2 minutes before takeoff behind any heavier type aircraft or helicopter and a minimum of 4 minutes behind jumbo jet aircraft. With effective cross wind of over 5 knots, the interval may be reduced. Attempt to remain above and upwind of the preceding aircraft's flight path. See Section VI.

1. Brakes – Released.
2. Throttles – MAX.
3. Instruments – Check.

CAUTION

The takeoff should be aborted if either afterburner fails to light within 5 seconds or if the light-off is abnormal.

NOTE

The acceleration check speed is the only means by which actual aircraft (engine) performance can be referenced to the computed values. Less than predicted acceleration will invalidate all computed speeds and associated distances.

CROSSWIND TAKEOFF

Aileron into the wind will aid in directional control and help in preventing compression of the downwind strut. The aircraft should be allowed to crab into the wind as rotation occurs.

AFTER TAKEOFF

1. Landing Gear Lever – LG UP, when definitely airborne.

WARNING

Do not retract landing gear until positively climbing out of ground effect. At high-density altitude airports, this occurs at 175 KIAS. Tests have demonstrated that when operating at high density altitude airfields, delaying landing gear retraction until safely airborne and passing 175 KIAS provides greater single engine performance margin than retracting the gear immediately after becoming positively airborne, at SETOS, or at SETOS+10.

CAUTION

Check the red light in the gear handle out prior to 240 KIAS.

2. Wing Flap Lever – UP.

NOTE

Use of full aft stick to effect rotation should be avoided. The initiation of full aft stick will cause abrupt rotation and premature liftoff prior to computed take-off speed.

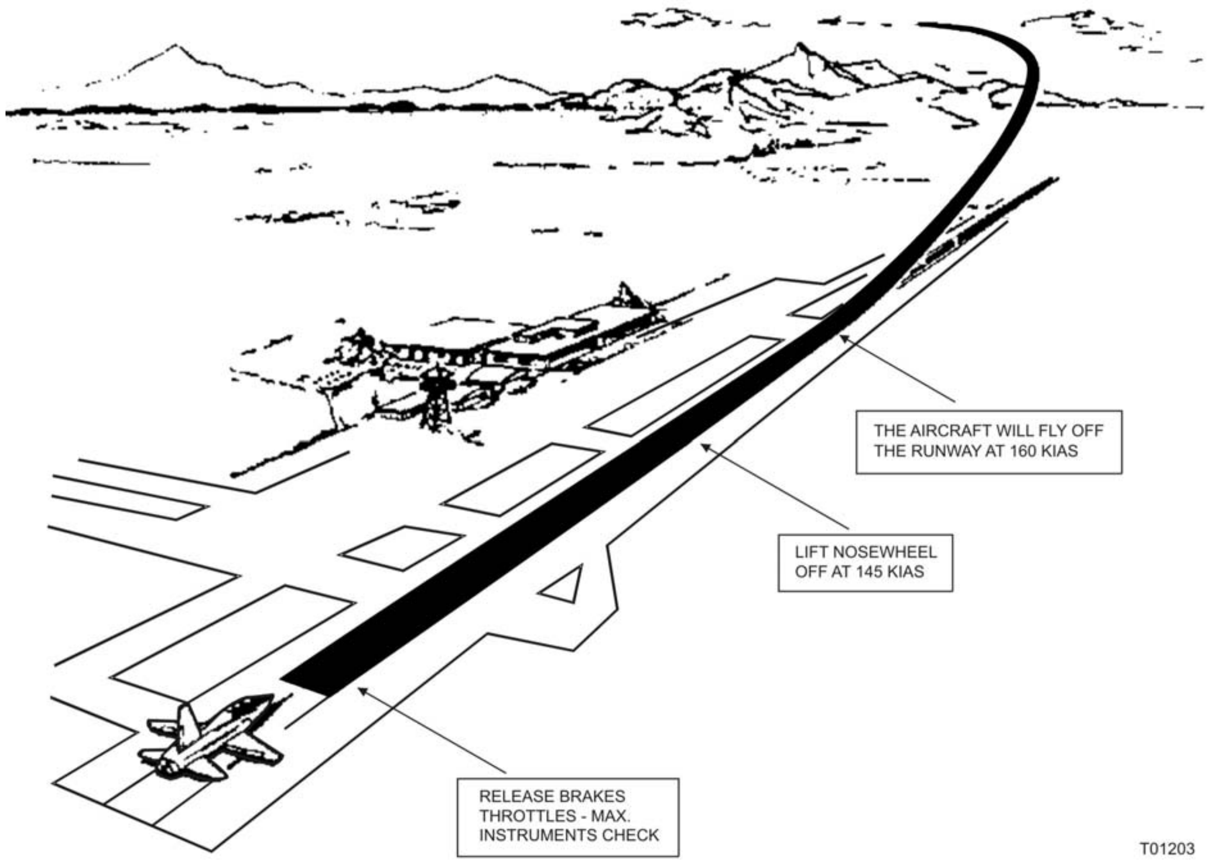


Figure 2-3. Normal Takeoff
Based on Gross Weight of 12,500 lb.

CLIMB

Accomplish Climb Check passing through 10,000 feet.

* 1. Oxygen System – Check (PRICE).
* 2. Fuel Quantity/Balance – Check.
  3. Cabin Pressure – Check.
  4. Canopy Defog and Cabin Temp – As Required.

Under high humidity conditions, excess moisture in the air conditioning system can be eliminated by turning the cabin temperature control knob to full hot (100°F) until the vent air is dry then returning the temperature control knob to the desired setting. Use canopy defog as required to prevent fogging of the canopy.

LEVEL-OFF AND CRUISE

* 1. Oxygen System – Check (PRICE).
* 2. Fuel Quantity/Balance – Check.
  3. Cabin Pressure – Check.
* 4. Altimeter – Set appropriate barometric setting.

NOTE

If altimeter reverts to standby operation at any time during flight, attempt to return to NORM position. If altimeter will not reset or reverts to standby after a few seconds, continue mission in that mode.

* 5. Altimeter Alerter – Set As Required.
  6. Canopy Defog and Cabin Temp – As Required.

DESCENT

* 1. (Dual) Intercom – ON.
* 2. Helmet Visors – As Required.
  3. Canopy Defog, Cabin Temp – As Required.

When descending into high humidity conditions, turn the defog knob to the full clockwise position at least 10 minutes prior to descent to preheat the canopy. This will help prevent canopy fogging at low altitude.

  4. Pitot Heat, Engine Anti-Ice – As Required.
* 5. Altimeter – Barometric Pressure Set As Required.
* 6. Fuel Quantity/Balance – Check.
  7. Crossfeed – OFF.
  8. Landing and Position Lights – As Required.
* 9. Weather Radar – As Required.
  10. (Dual) Approach Brief – Complete.
  11. Receiver Autonomous Integrity Monitoring (RAIM) – Check As Required.
* 12. Altitude Alerter – Set Alert and MDA Altitudes As Required.
* 13. ADI/HSI Navigation Display Modes/Range – As Required.
* 14. RMS – Verify Com/Nav Frequencies.

BEFORE LANDING

* 1. Pattern Airspeeds – Compute. See Figure 2-4.
* 2. Landing Gear – Down and Check Down. Physically press front cockpit lever full down.

CAUTION

Failure of landing gear lever interconnect cable while landing gear is lowered from rear cockpit may result in normal gear extension without full down travel of front landing gear lever, leading to possible uncommanded gear retraction on landing. To preclude this, front landing gear lever shall be physically checked full down any time gear is lowered from rear cockpit.

* 3. Hydraulic Pressures – Check.
* 4. Flaps – As Required.

LANDING

WARNING

Avoid wake turbulence. Allow a minimum of 2 minutes before landing behind any heavier type aircraft or helicopter and a minimum of 4 minutes behind jumbo jet aircraft. With effective crosswinds of over 5 knots, the interval may be reduced. Attempt to remain above and upwind of the preceding aircraft's flight path. See Section VI.

NORMAL LANDING

Normal landings are performed using flaps full down. See Figure 2-4 for recommended landing and go-around pattern. After touchdown, continue to increase backpressure on the stick to obtain the highest possible nose-high attitude without flying the aircraft off the runway. Just prior to loss of elevator authority, lower the nosewheel to the runway. After the nosewheel is lowered to the runway, a single, smooth brake application should be used to stop. This technique could increase landing distance as much as 50 percent from that computed from the landing distance chart in Part 7 of Appendix A. See NOTE.

NOTE

All stopping distances computed from Appendix A, Part 7, are based on optimum braking. Optimum braking is difficult to achieve. Variables such as brake and tire condition, pilot technique, etc., may increase computed distances.

CAUTION

- Extreme caution must be exercised when applying wheel brakes above 120 KIAS as locked wheels or tire skids are difficult to recognize. If tire skids are detected, immediately release both brakes and cautiously reapply.
- Extreme nose high aerobraking when crossing raised arresting cables may result in damage to the afterburner ejectors.
- Rubber deposits on the last 2,000 feet of wet runways make directional control a difficult problem even at very low speeds. Braking should be started in sufficient time so as not to require excessive braking on the last portion of the runway.

MINIMUM ROLL LANDING

Decrease airspeed 10 knots below normal landing final approach airspeed to ensure touchdowns at speeds noted in the landing distance chart in Part 7 of Appendix A. The landing distance chart shows data for landing at computed touchdown speed at approximately 12 degrees nose high attitude. Just prior to loss of elevator authority, lower the nosewheel to the runway and apply optimum wheel braking. For wet runways, a firm touchdown will tend to reduce the effects of hydroplaning.

CROSSWIND LANDING

Approach and Touchdown

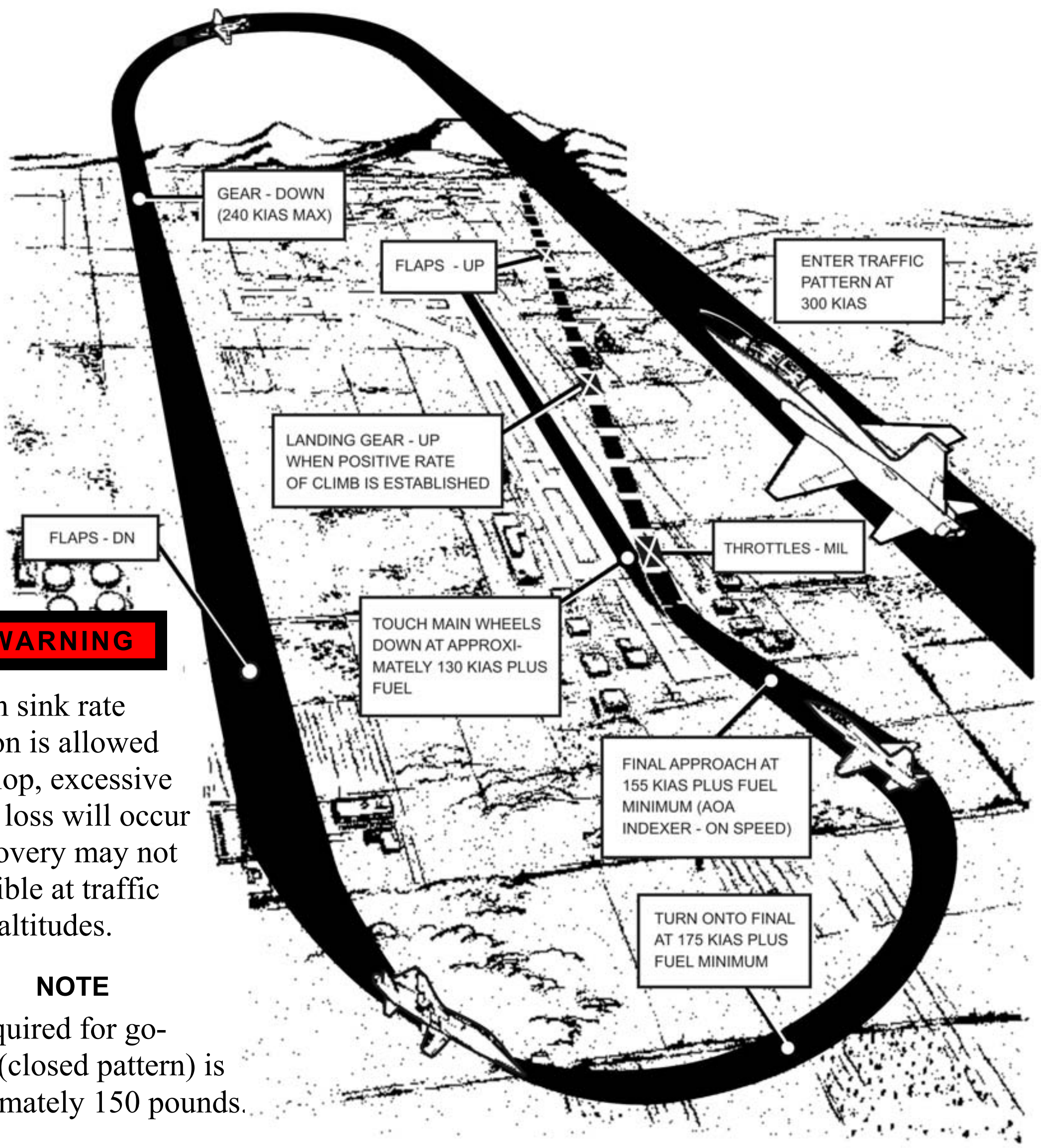
On final approach, counteract drift by crabbing into the wind, maintaining flight path alignment with the runway. The crab

NOTE

Increase final turn, final approach, and touchdown speeds 1 knot for each 100 pounds above 1,000 pounds of fuel and store remaining.

Increase final approach and touchdown speeds by half the gust factor.

FLAPS FULL DOWN



WARNING

If a high sink rate condition is allowed to develop, excessive altitude loss will occur and recovery may not be possible at traffic pattern altitudes.

NOTE

Fuel required for go-around (closed pattern) is approximately 150 pounds.

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Figure 2-4. Landing and Go-Around Pattern Flaps Full Down

should be held through touchdown. When the crosswind component exceeds 15 knots, touchdown should be planned for the upwind side of the runway. Maintain precise airspeed control throughout the final approach; in gusty conditions, increase the indicated airspeed by one-half of the gust increment above the wind velocity. Refer to Section V for landing rate of descent.

After Touchdown

Do not commence a normal aerobrake; however, the landing attitude should be maintained by increasing back pressure on the stick. The ground run distance may increase as much as 50 percent due to the decreased aerodynamic braking and less than optimum wheel braking. Aileron into the wind will aid in directional control, will help in preventing compression of the downwind strut and will prevent the upwind wing from becoming airborne. Maintain directional control of the aircraft with the rudder. A too rapid increase in the back stick pressure may cause the aircraft to become airborne and drift across the runway. Drift will create a high probability of tire damage. Just prior to loss of elevator authority, lower the nosewheel to the runway.

Lowering the nose prematurely in a crosswind will produce a compression of the downwind strut. This hampers directional control and may be minimized by use of aileron. Early downwind strut compression combined with weathervaning usually results in damage to the downwind tire.

USE OF WHEEL BRAKES

Wheel Brake Operation

To minimize brake wear, the brakes should be used as little and as lightly as possible. If the first application of brakes does not provide adequate pressure or if the brakes feel spongy, normal pressure might be regained by pumping the brake pedals. The pedals should be allowed to return to the full up position between strokes. Failure of certain brake components within a cockpit may result in complete failure of one or both brakes. Should this occur, braking might be gained by operating the brakes in the other cockpit. Full advantage of the length of runway should be taken during landing or aborted takeoff. Minimize use of brakes during turns and avoid dragging the brakes during taxiing. When there is considerable lift on the wings, such as immediately after touchdown, heavy brake pressure will lock the wheel more easily than when the same pressure is applied after the full weight of the aircraft is on the tires. Once a wheel is locked, it may be necessary to completely release brake pressure to allow wheel rotation.

Optimum Braking Action

The physical limitations of the tire and brake system make it extremely difficult to consistently achieve optimum braking action, particularly at high speeds (above 120 KIAS), where the weight component is reduced due to lift. A single, smooth application, increasing as airspeed decreases, offers the best braking opportunity. Great caution should be used when braking at speeds above 100 KIAS. Locked brakes are difficult to diagnose until well after the fact. Braking should be discontinued at the first indication of directional problems and then cautiously reapplied. At speeds below 100 KIAS, the chances of approaching optimum braking action are greatly increased.

WARNING

- Braking required for high speed, heavy gross weight abort may result in extremely hot brakes or brake failure and the possibility of tire fire should be anticipated.
- If hot brakes are suspected, the aircraft should not be taxied into a congested area. Ensure all personnel remain clear of the main wheels until they have cooled.

GO-AROUND

Make the decision to go-around as early as possible. Military power is normally sufficient for go-around, but do not hesitate to use maximum power if necessary.

WARNING

If conditions do not permit aerial go-around, do not try to hold aircraft off runway. Continue to fly aircraft to touchdown and follow go-around procedure.

1. Throttles – MIL (MAX if necessary).
2. Landing Gear Lever – LG UP, when definitely airborne.
3. Wing Flap Lever – UP.

NOTE

If touchdown is made, lower the nose slightly to accelerate. Establish takeoff attitude to allow the aircraft to fly off the runway at takeoff speed.

TOUCH-AND-GO LANDINGS

To make a touch-and-go landing, perform the desired approach and landing. After touchdown, follow the normal go-around procedure.

WARNING

Touch-and-go landings encompass all aspects of the landing and take-off procedures in a relatively short time span. Be constantly alert for possible aircraft malfunctions and/or unsafe operator technique during these two critical phases of flight.

AFTER LANDING

* 1. SAFE/ARM Handle – Safed.

NOTE

The safety pin cannot be installed into the hole in the seat firing handle if the SAFE/ARM handle is in the 'ARMED' position.

* 2. Seat Safety Pin – Installed.
* 3. Canopy Jettison – Pinned.
4. Weather Radar – STBY.

WARNING

The Weather Radar should not be operated within 6 feet of personnel or 15 feet from flammable or explosive materials.

NOTE

Taxi in STBY to minimize bouncing of radar dish

5. EFIS CRT Switch – OFF.
6. Gear Door Switch – OPEN.
7. Strobe/Beacon Switch – Beacon.
8. Takeoff Trim Button – Press and check Indicator Light illuminates.
* 9. Wing Flaps – UP.
10. Speed Brake – Open.
11. Cabin Altimeter – Check.
If reading is below field elevation, write up the failure on NASA Form 1673.
12. Cabin Pressure Switch – RAM DUMP.

CAUTION

After setting cabin pressure switch to RAM DUMP, ensure cabin altimeter displays field elevation before opening canopy. Pressure equalization may take several seconds.

13. Pitot Heat – OFF.
* 14. Loose Items – Secure (before opening canopy).
* 15. Canopy – Unlocked.

WARNING

Loss of canopy and severe injury may occur if either canopy is unlocked prior to depressuring to field elevation. The canopy could blow off its hinges and fall into the cockpit area. Any time the aircraft has been pressurized, RAM DUMP must be selected and the cabin pressure checked prior to opening the canopy.

16. Cabin Pressure Switch – CABIN PRESS.
* 17. Radar Altimeter – OFF.
* 18. FMS – OFF.
* 19. Seat – UP.
If the rear seat is raised to the Full Up position, there is insufficient room between the top of the seat back and the bottom of the secondary cartridges to allow seat back adjustment. The rear seat should be raised to the Full Up position and then lowered slightly (1-2 seconds) to facilitate seat back adjustment.
20. Landing-Taxi Lights – As Required.

ENGINE SHUTDOWN

1. Operate engines at 70% RPM or less for minimum of 1 minute.
2. Weather Radar – OFF.
3. Position/Formation Lights – OFF.

NOTE

Allow 10 seconds for landing-taxi light retraction and closure of ram dump door before engine shutdown.

4. Landing/Taxi Light – OFF.
* 5. Oxygen – 100%.
6. Throttles – OFF.
* 7. Standby Attitude Indicator – Cage and Lock.
* 8. All Unguarded Switches – OFF.
9. Wheels – Chocked.
10. Battery – OFF.

WARNING

Ensure the ejection seat is safed, the seat pin installed, and all equipment properly stowed to prevent inadvertent movement of the seat firing handle during egress.

* 11. Seat & Canopy Pins – Verify Installed.
12. ISS Handle – SOLO

STRANGE FIELD PROCEDURES

The following information provides guidance for operation at fields that do not normally support the aircraft.

1. Oil: Use MIL-L7808
Alternate: None
Check oil level immediately after flight.
2. Fuel: Use JET A+, JET A-1+, or JP8.

Alternate Fuels

All other jet fuels are considered alternate. Fuels not containing icing inhibitor (JET A and JET A-1) may only be used under the following conditions:

- If the initial fuel temperature is 50ºF, flight is unrestricted;

- If the initial fuel temperature is 40ºF to 50º F, the minimum cruise altitude static air temperature is -40ºF;
- If the initial fuel temperature is below 40ºF, flight is not recommended.

Single-Point Refueling

Improper procedures can cause single-point refueling adapter failures. The primary cause of this failure appears to be from a sudden jolt being applied to the single-point refueling adapter. The jolt can occur from higher than normal pressure or a sudden whiplash caused by a kink in the line. Decals emphasizing correct refueling procedures are located inside the refueling receptacle access door. Observing the following procedures will minimize refueling problems:

- Check to see that there are no sharp curves in the refueling line leading to the aircraft.
- With the refueling hose nozzle fuel shutoff lever closed, ensure a no-flow pressure of 45 psi (preferred) is being applied (55 psi maximum). A high pressure can rupture or damage the fuel cells and crack the single-point refueling adapter. Low pressure may not allow the fuel shutoff valves to function.
- Ensure that the refueling shutoff lever on the refueling hose is opened slowly.
- After fuel-flow starts, there will be a drop in pressure; however, do not increase fuel-flow pressure.
- Ensure both shutoff valves are operational prior to single-point refueling.

Start fuel flow and then move the precheck valve handle, located adjacent to the single-point fueling adapter, to the PRIM (primary) position. Flow should stop within 10 seconds. Stoppage is indicated by fuel flow not greater than 10 gallons per minute at fuel truck meter. Return precheck valve handle to OFF. Allow flow to continue for short duration and then place precheck valve handle in SEC (secondary) position. Fuel flow should stop within 10 seconds. Return precheck valve handle to OFF position and continue refueling. If fuel flow fails to stop in either check position, do not use single-point refueling.

Manual Refueling – Service left system first or aircraft may settle on tail.

1. Oxygen: Use MIL-0-27210.
2. Hydraulic Fluid and Brake Fluid: Use MIL-H-5606.
3. Tire Pressure: Main – 225 ±5 psi. Nose – 75 +5/-0 psi.
4. Landing Lights – Check as Required.
   If the landing lights were used on the previous flight, they should be inspected to ensure no damage has occurred. To extend the lights, use the following procedure:
   a. Battery Switch – ON
   b. Position Lights Switch – BRIGHT or DIM.
   c. After 5 seconds, Battery Switch – OFF.
   d. Position Lights Switch – OFF.
   e. Landing Lights – Inspect.
5. Loose Fasteners: Use Torq-Set Bit.
6. Air Starting Units:
   Air Force – MA-1, MA-1A, MA-1MP, MA-2, MA-2MP, M32A-60, MA-3MP, A/M 32A-95, and 502-70.
   Navy – GTC-85, MA-1E, WELLS AIR START SYSTEM, and RCPP/RCPT/NCPP-105.
7. Electrical Units: 115/200 volts, 3-phase 400-cycle required.

FUEL SPECIFICATIONS	
GRADE DESIGNATION	FREEZE POINT °C
PRIMARY FUEL	
JET A+	- 50
JET A-1 +	- 50
JP-8	- 50
ALTERNATE FUEL	
JP-4	- 60
JP-5	- 50

EFIS OPERATION

NOTE

When the EFIS CRT switch is turned on, various flags may appear on the displays until all of the associated systems become operational. Following the application of power, approximately 90 seconds should be allowed before testing or operating the EFIS.

SYSTEM TESTS

1. TST/REF Button – Press and hold for 3 seconds.
   a. If SELF TEST PASS messages appear on the ADI and HSI, the system is functioning properly and operation may continue. Press the TST/REF button momentarily to resume normal operation.
   b. If a SELF TEST FAIL message appears, a malfunction exists and the system should be serviced.
2. Verify that the ADI horizon line, the HSI compass scale, and the ADI turn rate scale are white. This confirms that all display colors are operational.
3. Verify operation of each button on HSI control panel.

FMS NAVIGATION

1. NAV Button – Select FMS.
2. Steering Mode Button – Select NORMAL.
3. HSI or ARC Button – Select the desired display format.
4. Range Buttons – Select desired range (N/A for Compass Rose).
5. Bearing Pointers – Set as desired.

VOR OR TAC NAVIGATION

1. NAV Button – Select VOR or TAC.
2. Course Knob – Select desired course.

NOTE

HSI CDI sensitivity for enroute VOR, and TACAN navigation is plus or minus 10.0 degrees for fullscale deflection.

3. Steering Mode Button – Select NORMAL.
4. HSI or ARC Button – Select desired display format.
5. Range buttons – Select desired range (N/A in Compass Rose).
6. Bearing Pointers – Set as desired.

LOC/ILS NAVIGATION

1. RMS – Tune VOR/ILS receiver to appropriate ILS frequency.
2. NAV Button – Toggle to LOC.
3. LOC PBI – Confirm illumination.
4. Course Knob – Select localizer front course.

NOTE

For back course operation, set the course arrowhead to the runway front course designation. Then follow the back course steering commands and lateral deviation indications. ADI bank steering is corrected for back course operation wherever BC is displayed near the ADI lateral deviation scale center mark. Glide slope indication and steering are not available during back course approaches.

5. Steering Mode Button – Select NORMAL.
6. VBAR/NEEDLES PBI – Select NEEDLES.

7. HSI or ARC Button – Select desired display format.
8. Range Buttons – Select desired range (N/A in Compass Rose).
9. Bearing Pointers – Set as desired.
10. When established on final, LOC/ILS PBI – ILS. If desired, VBAR may be selected.

FMS OPERATIONS

PREFLIGHT OPERATIONS

System Turn-On/Initialization

1. Self-test is followed by INITIALIZATION page.
2. Data Entry
   - Wait for <GNSS>.
   - For corrections, use LSKs and ENTER.

   Else
   - Use ICAO identifier.
3. ACCEPT or ENTER – Accept all data.
   This step is required for IRS alignment.

Display Brightness/Parallax Adjust

1. ON-OFF DIM – Press once.
2. BRIGHT or DIM, UP or DOWN – As desired.
3. CANCEL – Return to previous page; cancel sub-menu.

Create a Pilot Route

1. DATA – Select page 1 of 4.
2. PILOT DATA [2L] – Select.
3. ROUTE [4R] – Select.
4. CREATE ROUTE [3R] – Select.
5. Enter Data – See Pilot Defined Routes, Section IV, Auxiliary Equipment.

Copy Route onto Flight Plan

1. FPL – Select.
2. COPY PLT/CO RTE [3R/4R] – Select.
3. Enter number of desired route – See Copy Company Route, Section IV.

Invert Flight Plan

1. FPL-MENU-MENU – Display FPL Menu 2 of 2.
2. INVERT FPL [1R] – Press twice to invert.

Delete Entire Flight Plan

1. FPL – Select any FPL numbered page.
2. Use LSK to put cursor on any waypoint.
3. Enter ‘99’ – Press ENTER.

Or

1. FPL-MENU – Display FPL Menu 1 of 2.
2. DEL FPL [5L] – Press twice.

To delete the bottom part of a flight plan, put the cursor on the line below the last point you want to keep, enter ‘98’, and press ENTER.

Enter Airway onto Flight Plan

1. FPL – Select.
2. Place cursor on waypoint just after airway origination point (e.g., after LEV for Q100).
3. LIST – Select.
4. AIRWAY [2R] – Select.
5. Select appropriate Airway (use PREV/NEXT if required) and ENTER.
6. Select endpoint of airway selected; ENTER; check route.

Copy Departure onto Flight Plan

1. FPL-MENU-DEPART [4L] – Select.
2. RUNWAY [2R] – Enter if desired.
3. SID [3R] – Select.
4. SID reference number – Select and ENTER.
5. Transition reference number – Select and ENTER.
6. FPL [5R], FPL menu button, check route – See ‘Inserting a SID’ in Section IV.

Fuel Mode Entries

1. FUEL – Select page 1 of 5.
2. Confirm physical loading. Fuel onboard preset to 3,750 pounds. Press ENTER to accept or modify as required.

NOTE

Fuel quantity must be updated after inflight afterburner use. The fuel flow transmitters do not measure afterburner fuel flow.

3. If fuel is already initialized, FUEL Page 2 will be presented initially—use PREV to select FUEL Page 1 for fuel weight corrections.

Manual Fuel Flow Input

1. FUEL – Select page 5 of 5.
2. Use left LSKs to enter.

Leg Changes

1. NAV – Select page 1 of 3.
2. FR/TO [1L/2L] – Select FROM or TO waypoint, and ENTER.

Direct To

1. DTO – Select
2. Use numeric selection (from flight plan, LIST, or direct entry process). Use LSK [1-4R] if desired for direction of turn, etc.
3. If prompted, enter NX waypoint from current flight plan. If an NX waypoint is not supplied, the flight plan becomes UNLINKED.

Add Waypoint to Flight Plan

1. FPL – Select.
2. Use LSK to place cursor over waypoint to follow the new waypoint. Use PREV/NEXT as necessary.
3. Data Entry as appropriate, LIST, etc.

Insert GAP in Flight Plan

1. FPL – Select.
2. Use LSK to place cursor over waypoint to follow the new waypoint; use PREV/NEXT as necessary.
3. LIST – Select.
4. GAP – Select [3R].

NOTE

A GAP prevents auto leg change.

Delete Waypoint or GAP from Flight Plan

1. FPL page – Use PREV/NEXT as necessary.
2. Use LSKs to place cursor on waypoint or GAP to be deleted.
3. DEL – Press twice.

Designate/Delete Fly-Over Waypoint

1. FPL – Use PREV/NEXT as necessary.
2. Use LSK to place cursor on fly-over waypoint.
3. OVFLY [4R] – To toggle fly-over asterisk.

INFLIGHT OPERATIONS

Pseudo-VPRTAC (PVOR)

1. NAV – Page 1 of 3.
2. MNVR [2R] – Select.
3. PVOR [2R] – Select.
4. Data Entry.

Or

1. DTO – Select DTO page.
2. PVOR [5L] – Select.
3. Data Entry.

NOTE

- If the PVOR is a flight plan waypoint, to track outbound a GAP must follow it (to avoid auto leg change).
- Can input the DESIRED TRACK directly, or enter the inbound or outbound radial.

Cancel PVOR Mode

1. DTO – To any point.

To Fly Parallel Course (SXTK)

1. NAV – Select NAV page 1 of 3.
2. [4L] – Adjacent to SXTK – Select.
3. Data Entry – Enter 0 to cancel.

Setup Vertical Navigation

1. VNAV – Select PATH VNAV page 1.
2. TO/NX [2L/3L] – Depress.
3. Enter waypoint for VNAV constraint.
4. Enter offset distance as appropriate.
5. Enter target altitude.
6. Enter TGT V/S or VTO.

NOTE

± changes offset sign.

Cancel Vertical Navigation

1. VNAV-VNAV – Select VNAV 2 of 2.
2. CNCL VNV [5L] – Cancel TGT V/S.

Delete VNAV Profile

1. VNAV – Select VNAV 1 of 2.
2. TO/NX [3L/4L] – Select either.
3. ‘99’ – Enter, and press ENTER.

Copy STAR and/or Approach onto Flight Plan

1. FPL-MENU-ARRIVE [4R] – Select.
2. ARRIVE [1R] – Ensure correct airport.
3. RWY [2R] – Select as desired (opt.).
4. STAR [3R] – Select as desired.
5. APPR [4R] – Select as desired.
6. FPL [5R] – Review flight plan; remove ‘NO LINK’ messages if desired.

NOTE

Transitions may be required for STAR, APPR, or both. When in doubt, select a transition and delete unnecessary waypoints if outside the approach label (e.g., *GPS 17R*).

Review Selected Approach Data

1. FPL-MENU-MENU – Select Menu 2 of 2.
2. APPR PLAN [5L] – Then use PREV/NEXT to view other pages.

RAIM Predict

1. FPL-MENU – Select Menu 1 of 2.
2. RAIM PRED [3R] – Select.

Deselect/Reselect Sensor

1. DATA-DATA – Select DATA page 2 of 4.
2. Select desired sensor status page using LSK.
3. Select DESELECT or SELECT as appropriate.

Manual DME Tuning

1. DATA-DATA – Select Data page 2 of 4.
2. DME [3R] – Select DME status page.
3. MAN DME [4L] – Select.
4. Use LIST to enter DME ID.

NOTE

BACK, then ENTER deletes manual input.

Manual FMS Position Update/Cold Turn-on in Flight

1. NAV – Select last NAV page.
2. HOLD POS [5L] – Select.
3. FMS 1 POS [1L] – Select.
4. Enter data via LAT/LONG or REF TO NAVAID.
5. ACCEPT – Press twice.

Check Distance/Radial From a Known Position

1. NAV – Select last NAV page.
2. HOLD POS [5L] – Select.
3. FMS 1 POS [1L] – Select.
4. REF WPT – Select.
5. If necessary, enter ID of known position.
6. Read data.
7. RETURN [5R] – Exits page without accepting changes.

Interrogate Stored NAV DATABASE

1. DATA – Select DATA page 1 of 4.
2. NAV DATA [1L] – Select.
3. Type ID into WPT IDENT field; or
4. Use left LSKs to select data desired.

NOTE

The NAV DATABASE cannot be altered.

Reinstate Roll Steering After STEERING FAIL Message

1. DATA-PREV – Select Data page 4 of 4.
2. HDG [3R] – Select.
3. Select BACK and ENTER.

Clearing an FPL UNLINKED Message

1. FPL Message means the flight plan you see on the NAV page is not matched with the flight plan in the FPL.
2. FPL – Select.
3. LSK – Place where you want the fix to be, and enter fix name.
4. DTO – Desired fix; or
5. DTO – Any point on your flight plan.

SHUTDOWN/AFTER FLIGHT

Power Failure up to 7 Minutes

1. ON/OFF DIM – If power loss was less than 7 seconds, LCD displays last page.
2. DATA – If over 7 seconds, POWER FAIL page is displayed. Select DATA page 3 of 4.
3. FMS 1 POS [1L] – Select.
4. LAT/LONG [2R] – Input, or
5. AUTO GPS POS UPDATE [3R] – Select.
6. ENTER – Press twice.
7. ACCEPT – Select.
8. NAV – Select NAV page 1; observe ANP.
9. MSG – Check for messages.

Power Failure Over 7 Minutes

1. ON/OFF DIM – System runs through self test.
2. ACCEPT [5L] – Initialize system before updating position.
3. Manual FMS Position Update Procedure – Complete.

Incidental Action for Engine Failure/ Shutdown/Relight

1. FUEL-PREV – Select FUEL page 5 of 5.
2. LSK for FAILed Fuel Flow – Select.
3. ‘0’ – Manually enter for the failed engine to reinstate valid fuel computations; or
4. BACK-ENTER – Resets the readout.

System Standby

1. ON/OFF DIM – Select.
2. OFF/STBY [5R] – Select.
3. CONFIRM STANDBY [5R] – Select.

System Shutdown

1. ON/OFF DIM – Select.
2. OFF/STBY [5R] – Select.
3. CONFIRM OFF [1R] – Select.

WEATHER RADAR OPERATION

WARNING

Do not attempt to operate the radar until completely familiar with all safety information (see Weather Radar Description in Section IV).

CAUTION

The weather radar should not be turned off during taxi or maneuvering flight. Stresses caused by aircraft movement and antenna scan startup/shutdown may damage the radar.

RADAR DISPLAY PREFLIGHT TEST

1. Select EHSI radar display mode (360-deg or ARC).
2. Select 80 NM range (half range of 40 displayed).
3. Turn function selector knob to TST position.
4. Observe radar display and confirm four distinct color bands displayed.
5. Turn function selector knob to STBY.

RADAR PREFLIGHT TEST

1. Taxi aircraft to a clear area no closer than 100 feet from personnel, combustible materials, or metallic buildings.
2. Select Wx mode button.
3. Select a weather display mode on the EHSI.
4. Turn function selector to ON.
5. Observe EHSI display to confirm operation.
6. Select WxA mode and observe magenta weather areas (if any) flash.
7. Operate the radar tilt operation (must be in command via the FWD/AFT PBI):
   a. Vary +15 degrees up to -15 degrees down.
   b. Observe tilt display in lower-left corner of EHSI.
   c. Verify ground clutter shows at low tilt angles, precipitation (if any) shows in higher tilt settings.
8. Select STBY to complete test.

RADAR FLIGHT OPERATION

1. Select a weather display mode on the EHSI.
2. Select desired EHSI range (must be less than 1,000 NM).
3. Select desired weather mode (Wx or WxA).
4. Turn function selector to ON.
5. Adjust radar tilt to optimize weather display (must be in command via the FWD/AFT PBI.)

INERTIAL REFERENCE SYSTEM OPERATION

PREFLIGHT CHECKLIST

1. IRS turns on when Battery is in NORM or EMER.
2. Alignment time approx. 3+30. Do not taxi before alignment is complete.
3. When GNSS1 coordinates are ACCEPTed, preflight actions are complete.
4. Note valid heading (when HDG, FHDG cautions disappear) when alignment is complete.
5. IRS Status and information available on DATA Page 2, LSK [1L].
6. IRS position vs. FMS position available on DATA Page 3.

EMERGENCY PROCEDURES

SECTION III

TABLE OF CONTENTS

GENERAL

A Critical Procedure is an emergency procedure that must be performed immediately without referencing a printed checklist and must be committed to memory. These critical procedures appear in **BOLDFACE** capital letters. Non-critical Procedures are all other steps wherein there is time available to consult the checklist.

In the event of multiple emergencies, the pilot is required to exercise sound judgment as to the appropriate action. A thorough knowledge of the correct procedures and aircraft systems is essential to analyze the situation correctly and determine the best course of action.

To assist the pilot when an emergency occurs, three basic rules are established, which apply to most emergencies occurring while airborne. They should be remembered by each aircrew member.

1. Maintain aircraft control.
2. Analyze the situation and take proper action.
3. Land as soon as practical.

Land as Soon as Possible – An emergency will be declared. A landing should be accomplished at the nearest suitable airfield considering the severity of the emergency, weather conditions, field facilities, ambient lighting, aircraft gross weight, and NASA policy.

Land as Soon as Practical – Emergency conditions are less urgent, and although the mission is to be terminated, the degree of the emergency is such that an immediate landing at the nearest adequate airfield may not be necessary.

FORMAT

The format of Emergency Procedures differs slightly between the Checklist and the Flight Manual. Procedures in the Checklist have been grouped by malfunction category (engine, electrical, etc.) to provide maximum in-flight utility.

GROUND OPERATION EMERGENCIES

ENGINE FIRE DURING START

If a fire warning light(s) illuminates, or if there are other indication of a fire, proceed as follows:

1. Throttles – OFF.
2. Battery/APU – OFF.

NOTE

Advise the other crewmember of egress intentions prior to shutting off battery/APU.

EXCESSIVE HYDRAULIC PRESSURE (CAUTION LIGHT NOT ILLUMINATED) ON GROUND

1. Shut down the affected engine.

NOSE WHEEL STEERING FAILURE

Inoperative nose wheel steering may indicate the LANDING GEAR CONTROL & NOSE WHEEL STEERING circuit breaker (located in the right nose avionics bay) is open. If open, the following systems will be affected:

- The landing gear handle solenoid will remain engaged in the handle, preventing the gear handle from being raised. In the front cockpit only, the solenoid can be overridden using the landing gear lever override button; however, the gear will not retract since the landing gear hydraulic selector valves freeze in their last position.
- The gear door switch will be inoperative. The gear doors will remain in the last position prior to failure.

- Gear down indications will be normal except the nose gear indication in the rear cockpit will not illuminate.
- The gear warning horn will be inoperative.
- The landing lights will not extend.
- The canopy warning horn will be inoperative.
- Without the Air Data Computer (ADC) gear down indication, the angle of attack high-speed indexer light will remain off. Angle of attack indications should be correct.

The aircraft should be aborted with inoperative nose wheel steering.

DEPARTING PREPARED SURFACE

Any time the aircraft departs a hard surface (taxiway or runway), immediately shut down both engines. REFER TO EMERGENCY EXIT ON THE GROUND TO ABANDON THE AIRCRAFT.

EMERGENCY EXIT ON THE GROUND

Because the ejection seat provides the capability to eject from ground level with zero airspeed, two options are available to abandon the aircraft during an emergency while stationary on the ground: emergency ground egress or ejection. The decision about how to leave the aircraft will be dependent on the nature of the emergency and the time available for escape. Since the potential exists for either cockpit to eject both seats (depending on how the inter-seat sequencing handle is configured), it is CRITICAL that the decision to either emergency ground egress or eject on the ground be coordinated between the aircrew prior to abandoning the aircraft.

WARNING

Serious injury or death will occur to an aircrew in the process of emergency ground egress if the other aircrew initiates a command ejection.

EMERGENCY GROUND EGRESS

When a situation develops which requires the aircrew to abandon the aircraft and the crew makes the decision to emergency ground egress, place the throttles at OFF, battery switch at OFF, insert the ejection seat safety pin, disconnect personal leads, and release safety belt. Open the canopy. If either canopy cannot be opened by the normal procedure, pull the canopy jettison T-handle. If either canopy fails to open or jettison, break through the canopy using the canopy breaker tool (Figure 3-1).

NOTE

Use canopy breaker tool only if all other canopy release methods fail.

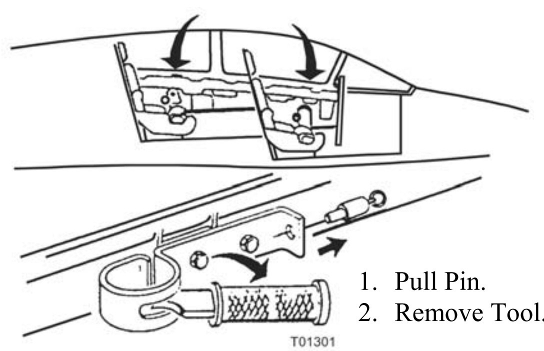


Figure 3-1. Canopy Breaker Tool

WARNING

Do not start to evacuate the aircraft until certain it is not necessary to eject. Evacuate the aircraft if there is sufficient time to safely complete the emergency egress. Ejection after emergency ground egress procedures are initiated will result in serious injury or death.

CAUTION

The canopy seals will remain inflated if engines are shut down with both canopies locked, making the canopies more difficult to open.

If the decision is made to emergency ground egress, perform the following steps:

1. **INFORM OTHER AIRCREW.**
2. **SAFE/ARMED HANDLE – SAFE.**
3. Throttles – OFF.
4. Battery – OFF.
5. Ejection Seat Safety Pin – Install (time permitting).
6. Shoulder Harness, Lap Belt, Seat Survival Kit and Upper/Lower Leg Garters – Release.
7. Canopy – Open.
8. Egress the Aircraft.

WARNING

Keep feet away from the seat firing handle during egress. Inadvertent firing of the ejection seat during emergency ground egress can cause serious injury or death.

EJECTION ON THE GROUND

Refer to EJECTION PROCEDURES in the IN-FLIGHT EMERGENCIES section.

USE OF CANOPY BREAKER TOOL

To break the canopy, grasp the canopy breaker tool with both hands and use your body weight behind an arm swinging thrust. Aim the point of the tool to strike perpendicular to the canopy surface. The blade alignment will determine the direction of the cracks. No set pattern of blows is necessary on the front canopy. Several minutes of chopping may be required to open an adequate hole in the rear canopy.

WARNING

To preclude personal injury, the curved edge of the blade must be towards you. This will allow glancing blows against the canopy to deflect away from you.

SMOKE, FUMES, OR ODORS IN COCKPIT

Do not take off if smoke, fumes, or unidentified odors are detected. Refer to Smoke, Fumes, or Odors in Cockpit procedure under Inflight Emergencies in this section.

TAKEOFF EMERGENCIES

ABORT/BARRIER ENGAGEMENT

If the decision is made to abort during a takeoff or touch-and-go-landing, such variables as gross weight, pressure altitude, runway condition (i.e., dry, wet, icy) and runway length must be evaluated. The braking energy required during a high speed, heavy gross weight abort may result in brake failure, a significant decrease in braking effectiveness, hot brakes, or tire failure/fire. Below 130 KIAS, maximum deceleration can be obtained by optimum braking in a three point attitude, but tests have demonstrated that optimum braking is difficult to achieve and should not be attempted at air speeds above 100 KIAS. Aerodynamic braking is more effective than cautious wheel braking above 100 KIAS and it avoids the potential for skidding, blown tires, brake failure, etc. Therefore, use aerodynamic braking to the maximum extent possible during any abort above 100 KIAS. Once the nose wheel returns to the runway, initiate a smooth brake application with the stick full aft, increasing brake pressure as the airspeed decreases. Unless brake failure occurs, avoid pumping the brakes. During heavy gross weight aborts, the nose will lower at approximately 120 Knots Indicated Airspeed (KIAS). When the nose wheel is lowered to the runway, immediately commence moderate braking while maintaining full aft stick. Optimum braking should not be attempted in excess of 100 KIAS. Aerodynamic braking performed with less than full flaps or a 12 degree pitch attitude becomes progressively less effective. Aerobraking is recommended even if it is not possible to obtain this optimum configuration and pitch attitude. If runway length is insufficient to completely stop the aircraft, decelerate as much as possible and prepare to engage the barrier or depart the hard surface. Approach the barrier perpendicularly, in a three-point attitude and if possible, in the center. After barrier engagement, actuation of the controls or changing aircraft configuration may cause damage to the aircraft.

1. **THROTTLES – IDLE.**
2. **WHEEL BRAKES – AS REQUIRED.**

WARNING

- Braking required for high speed, heavy gross weight abort may result in extremely hot brakes or brake failure. The possibility of tire fire should be anticipated.
- If hot brakes are suspected, the aircraft should not be taxied into a congested area. Ensure all personnel remain clear of the main wheels until they have cooled.

CAUTION

- During high-speed abort situations, it is essential that maximum aerodynamic braking be attained. Once established in an aerobrake, lowering flaps can further reduce the stopping distance. Flaps should not be repositioned until the full aft stick pitch attitude is attained. The aircraft may become airborne if flaps are lowered above the computed full flap touchdown speed. Caution should be used when changing the configuration during a high speed abort as it can distract the crew from the primary task of braking.
- Steer so as to engage perpendicular to barrier (not necessarily in the center) and discontinue braking before engagement. Continue braking again after barrier is engaged.
- Heavy braking above 100 KIAS may cause skidding, tire failure, and loss of directional control.
- Extreme caution must be exercised when applying wheel brakes above 120 KIAS, as locked wheels or tire skids are difficult to recognize. If tire skid is detected, immediately release both brakes and cautiously reapply.
- MA1A barrier engagement is unlikely with the WSSP installed or the speed brake open.

NOTE

- An aborted takeoff with tire failure will present a greater problem than landing with a failed tire. The effects of a tire failure are most pronounced at heavy gross weights and speeds below 100 KIAS. Directional control is more difficult and braking effectiveness is greatly reduced at higher gross weight.
- If the abort was made as a result of an engine fire, place the throttle of the affected engine to OFF once the aircraft is under control. If the fire is confirmed, accomplish the Emergency Exit On The Ground procedures once the aircraft is stopped.

Refer to Takeoff/Abort charts in Part 2 of Appendix A.

ENGINE FAILURE/FIRE WARNING DURING TAKEOFF, TAKEOFF CONTINUED

If an engine fails on takeoff prior to reaching decision speed, use the procedure in this section titled ABORT/BARRIER ENGAGEMENT. If an engine fails on takeoff above the computed decision speed, it is possible to continue the takeoff. Limited excess thrust is available for takeoff, acceleration, and climb-out when operating on a single engine. The available runway should be used to accelerate the aircraft above single-engine take-off speed (SETOS). The computed single engine takeoff speed is the minimum speed at which the aircraft will takeoff and be able to fly out of ground effect. Thrust predictions of the takeoff factor can be verified only by an accurate acceleration speed check. A significant relationship exists between airspeed and initial climb performance: between SETOS and SETOS +10 KIAS, single-engine climb performance increases at the rate of 100 feet per minute for each knot of airspeed above SETOS. Best acceleration occurs with the aircraft in a three point attitude, with the stick at or slightly aft of the takeoff trim setting. The nose wheel should not be allowed to “dig-in,” nor should it be permitted to lift off. This attitude must be maintained until the airspeed reaches a minimum of SETOS; however, SETOS +10 KIAS is the optimum rotation speed. Initial pitch attitude is shallower than normal. Climb should be restricted to only that required to avoid obstacles until the airspeed reaches 190 KIAS and flaps are retracted. The gear should be retracted as soon as the aircraft is airborne above SETOS +10 KIAS. Gear door drag is not a factor during retraction above SETOS +10 KIAS. The flaps should be raised after gear retraction and above 190 KIAS. Due to the critical nature of airspeed and altitude and the ejection envelope, the decision made by the pilot may vary.

WARNING

With a take off factor (TOF) above 4.2 (gross weight 12,500 lb) single-engine takeoff is not considered possible.

1. **THROTTLES – MAX.**

WARNING

Continuing a single-engine takeoff should only be attempted at maximum thrust.

NOTE

Depending on airspeed and altitude, it may be necessary for the pilot to leave the throttle of the affected engine at a high power setting until reaching a safe airspeed and/or altitude for ejection.

2. **FLAPS – 60%.**

WARNING

With other than 60% flaps, single-engine capability is impaired to such an extent that high takeoff factors coupled with heavy gross weights may make takeoff impossible.

NOTE

After flaps are set at 60%, the flap indicator should be checked to ensure flaps are 60±5%.

3. **ATTAIN AIRSPEED ABOVE SETOS, +10 KNOTS DESIRED.**

WARNING

If engine failure occurs after rotation, it will probably be necessary to lower the nose to attain speed above SETOS. If engine failure occurs after takeoff, it may be necessary to allow the aircraft to settle back to the runway.

4. Gear – UP (when airborne above SETOS +10 KIAS).

NOTE

If the left engine is inoperative but wind-milling, generally gear retraction may be accomplished but will require an extended time period; however, gear doors may not completely close. Gear retraction, when initiated between SETOS plus 10 knots and 190 KIAS, may require up to 1 minute.

5. Flaps – UP (as required above 190 KIAS).

NOTE

If unable to retract the landing gear, best level flight/climb capability is obtained at 190 KIAS with 60% flaps or at 220 KIAS with the flaps up. At high gross weight, with the landing gear extended, flap retraction should not be initiated prior to 220 KIAS.

TIRE FAILURE DURING TAKEOFF, TAKEOFF CONTINUED

A takeoff abort with tire failure will present a greater problem than landing with a failed tire. The effects of a tire failure are most pronounced at heavy gross weights and speeds below 100 KIAS. Directional control is more difficult and braking effectiveness is greatly reduced at higher gross weights.

1. **GEAR – DO NOT RETRACT.**

The following techniques should be considered when landing with a blown tire:

- If possible, do not change the flap configuration.
- If possible, reduce fuel weight before landing.
- Land on the side of the runway away from the blown tire and make maximum use of rudder and wheel braking to maintain directional control.
- Nosewheel steering should be engaged as a final attempt to maintain or regain directional control. Ensure the rudder pedals are neutralized prior to engaging nose wheel steering.
- Once the aircraft is stopped, do not clear the runway, change the configuration, or activate the flight controls. Shut down engines when maintenance/fire trucks are in position.

LANDING GEAR RETRACTION FAILURE

If the warning light in the landing gear lever remains illuminated after the lever has been moved to the LG UP position, proceed as follows:

NOTE

If both throttles are below 96%, altitude below 9,500 feet, and airspeed below 181 KEAS, the landing gear light and landing gear warning horn may remain on. Pushing one throttle above 96% will turn off the horn if speed below 181 KEAS is required.

1. Airspeed – Maintain below 240 KIAS.
2. Landing Gear Lever – LG DOWN.

NOTE

After placing the landing gear lever down and a safe gear-down indication is obtained, do not retract or recycle the gear unless a greater emergency exists.

3. Land as soon as practical.

It may be necessary to reduce fuel weight to obtain a safe landing distance. As a guide, landing distance with full flaps will be approximately (fuel weight +2,500) feet past the touchdown point.

NOTE

If unable to raise the landing gear, the aircraft will consume approximately 10-15 lb. of fuel per nautical mile. When configured with gear down and full flaps, the aircraft will burn approximately 60 lb/min at low altitudes and airspeeds below 220 knots.

IN-FLIGHT EMERGENCIES

SINGLE-ENGINE FLIGHT CHARACTERISTICS

Single-engine directional control can normally be maintained at all speeds above the stall. Very little rudder is required because of the close proximity of the thrust lines to the centerline of the aircraft. In high-drag, high-thrust, low-airspeed conditions, rudder must be used to coordinate flight to obtain optimum aircraft performance. There are conditions under which the aircraft will not maintain altitude in takeoff configuration or landing configuration with one engine operating at either MIL or MAX thrust. For fully fueled takeoffs, single engine takeoff speed should be attained to ensure excess thrust is available. At other fuel weights, final approach speed will ensure excess thrust is available for go-around. Single-engine performance in a landing configuration with 60% flaps is shown in the Thrust Required and Available chart and the Effect of Bank Angle on Vertical Velocity charts in Part 7 of Appendix A. Minimum single-engine flying speed for any condition occurs where the thrust available and thrust required lines cross. If the airspeed is less than the minimum speed, altitude must be sacrificed to attain this minimum and/or the configuration must be changed to reduce the drag. Every effort should be made to immediately attain a speed that will give excess thrust. It is imperative that the speed brake be closed during all single-engine flight to obtain the performance stated in the single-engine charts. The single-engine service ceiling can be attained by following the climb schedule shown in the Single-Engine Service Ceiling chart in Part 3 of Appendix A.

THROTTLE BINDING

If a binding or stuck throttle is experienced inflight, do not attempt further movement of the affected throttle. Attempt to minimize use of the unaffected throttle and recover using single engine procedures.

If both throttles are stuck, and altitude and airspeed permit, attempt to break one throttle free. Consider using zero or negative Gs to dislodge any foreign objects. If able, attain a power setting suitable for landing approach. If neither throttle can be freed, consider using the fuel shutoff switch to shutdown one engine. Aircraft weight, available runway length, and barrier capabilities should be taken into consideration if landing will be attempted with one or both throttles stuck at high power settings.

CAUTION

Due to the close proximity of the throttle linkages and potential for foreign object interference, attempts to dislodge a stuck throttle may cause inadvertent shutdown of either engine.

ENGINE FAILURE/SHUTDOWN DURING FLIGHT

If an engine operates abnormally or fails during flight, reduce drag to a minimum and maintain airspeed and directional control while investigating to determine the cause. Failure of the left engine may deactivate speed brake, normal landing gear extension and retraction, nose wheel steering, and the stability augmenter system. However, left engine windmilling rpm under this condition may supply sufficient hydraulic pressure to operate these systems. Use the following procedure for shutting down an engine in flight:

CAUTION

Certain failures of the main fuel control may result in an engine remaining at the power setting selected at the time of failure despite additional throttle movements. With an engine stuck at a high power setting, consideration should be given to shutting down the engine to preclude excessively fast landing speeds which may result in extremely hot brakes and possible barrier engagement/ runway departure. If the engine cannot be shut down with the throttle, close the affected fuel shutoff switch.

1. Safe single-engine airspeed – Maintain.
2. Throttle (inoperative engine) – OFF for 10 seconds before attempting a start if conditions permit.
3. Crossfeed – As Necessary.

WARNING

With the crossfeed ON and either both boost pumps ON—or both boost pumps OFF—a rapid fuel imbalance can occur.

With fuel less than 250 pounds in either system:

4. Fuel Boost Pump Switches – LEFT and RIGHT ON.
5. Crossfeed Switch – ON.

NOTE

Under single engine low fuel conditions with two operating boost pumps, placing the crossfeed ON and both boost pumps ON will provide the maximum usable fuel.

Refer to Single-Engine Diversion Range Summary Table in Part 4 of Appendix A.

DUAL ENGINE FAILURE AT LOW ALTITUDE

If both engines fail during flight at low altitude and with sufficient airspeed, the aircraft should be zoomed (approximately 20 degrees nose up attitude) to exchange airspeed for altitude and to allow additional time to accomplish subsequent emergency procedures. ALTERNATE AIRSTART should be attempted immediately upon detection of dual engine flameout. If the decision is made to eject, ejection should be accomplished during the zoom while the aircraft is in a nose high positive rate of climb. It is imperative that the ejection sequence be initiated prior to reaching a stall or rate of sink.

WARNING

Do not delay ejection by attempting airstarts at low altitude if below the optimum airstart airspeed and below 2,000 feet AGL.

RESTART DURING FLIGHT

Airstarts can be expected over the range of operating conditions shown in Figure 3-2. The engine airstart requirements are based on engine windmill speed and pressure altitude and are independent of ambient temperature. Lines of constant indicated airspeed have been superimposed on the basic engine requirements. These are the indicated airspeeds required to achieve corresponding windmill speeds. A minimum of 12-14% is required to achieve any engine fuel flow and 18-20% engine RPM is the heart of the airstart envelope at all altitudes. Airstart attempts in the area above the upper left hand corner of the envelope will normally result in a hung start. If airspeed is increased and/or altitude decreased with an engine in a hung start, it may accelerate up to operating speed. Airstart attempts at engine windmill speeds higher than the upper limit will normally fail because of a lean mixture (low fuel ratio). Combustion may be established by decreasing airspeed and/ or decreasing altitude. Since the ignition circuitry is engaged for about 30 seconds after pushing the start button, it may be necessary to press the start button again. Do not attempt a restart if the engine was shut down due to FOD, fire, or if the engine is seized. Use the following procedures:

1. Throttle (inoperative engine) – OFF (10 seconds, if conditions permit).
2. Altitude – Below 25,000 feet.
3. Engine RPM – Within airstart envelope, 12% minimum (18 - 20% optimum).
4. Battery Switch – ON.

WARNING

With dual engine failure, battery switch must be ON to provide ignition. Battery switch in EMER does not energize the ignition circuitry.

5. Boost Pump Switches – Check ON.
6. Engine Start and Ignition Circuit Breaker – IN.
7. Start Button – Push.
8. Throttle – Advance to IDLE.

NOTE

- Leave throttle at IDLE for 30 seconds before abandoning a start.
- If dual engine flameout occurs, right engine should be attempted first as right engine instruments will operate normally as soon as engine start button is pushed.

If restart attempt fails:

9. Throttle – OFF for as long as practical.

NOTE

Throttles should be left off as long as practical, up to 5 minutes. Flight test results indicated that a failed engine restart can result in wet igniter plugs which can preclude successful starts. Windmilling the engine for as long as practical will help dry the igniter plugs and increase the chances for a successful restart.

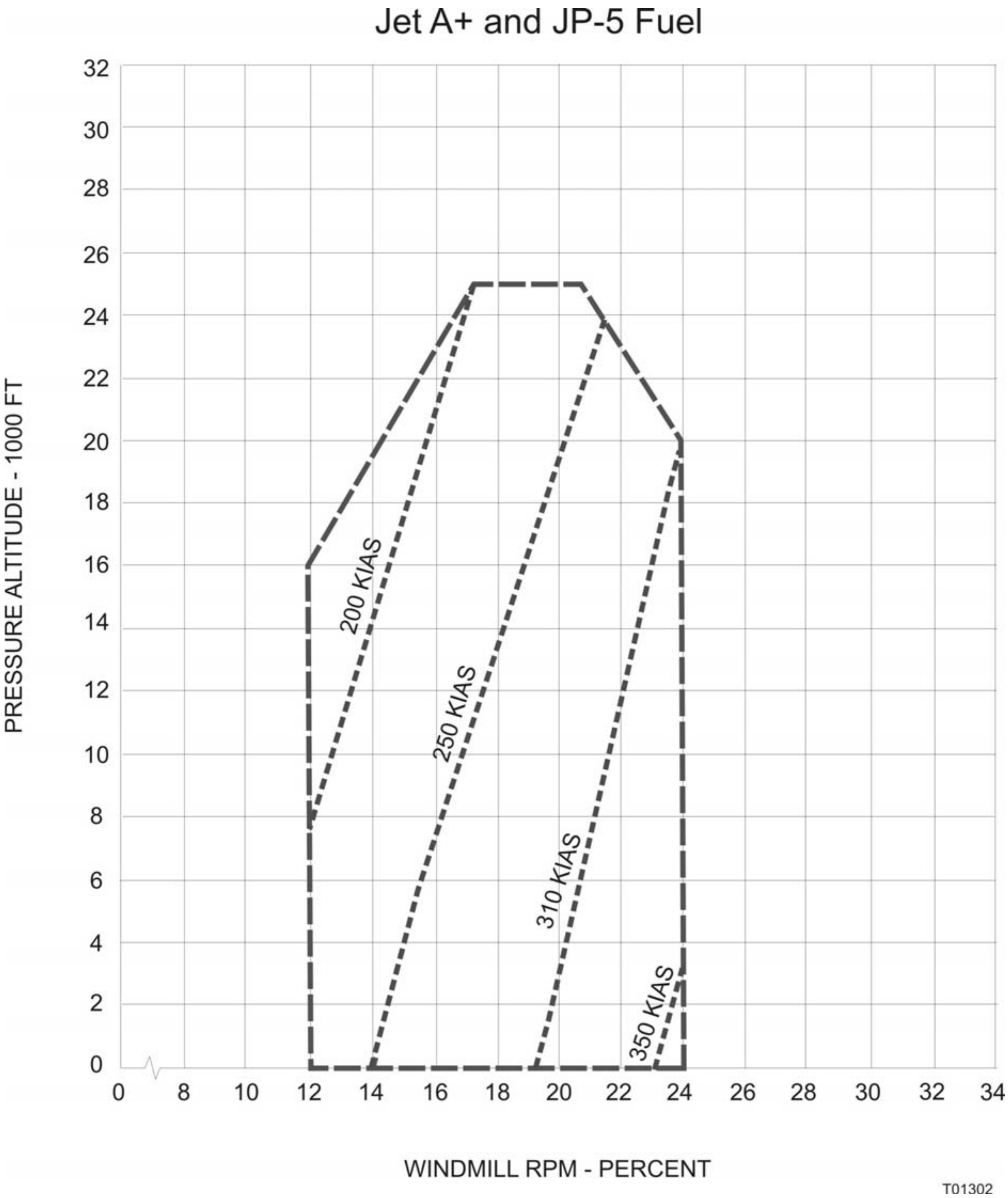


Figure 3-2. Airstart Envelope

NOTE

- Increase glide speed 1 knot for each 100 lb. of fuel remaining.
- Multiply altitude in thousands of feet by 1.6 to obtain approximate maximum glide distance in nautical miles.

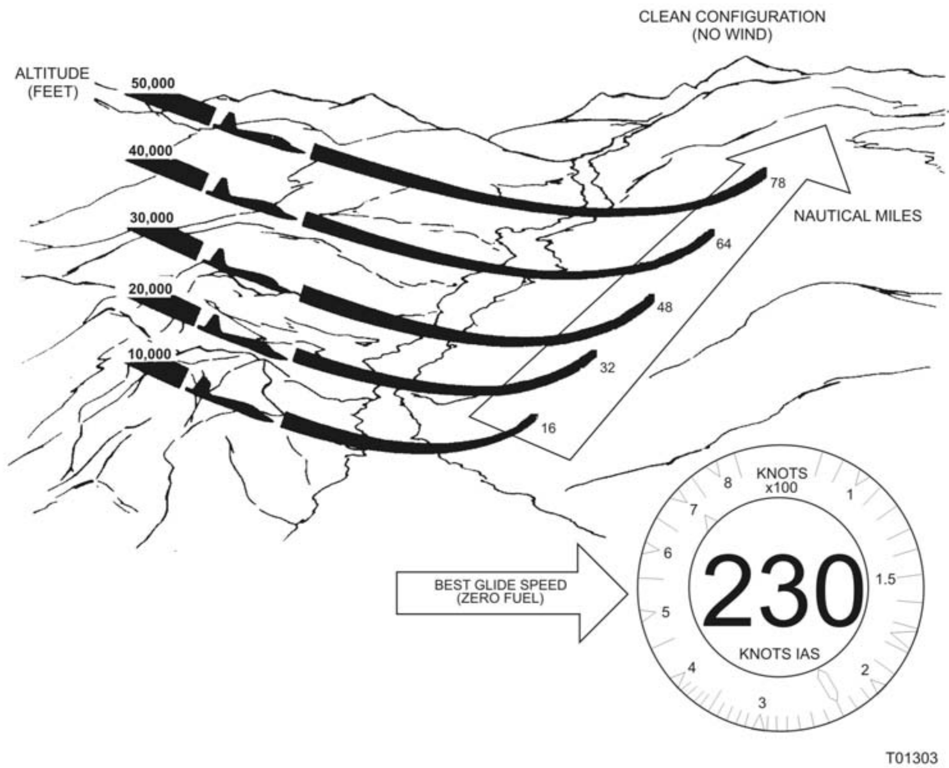


Figure 3-3. Maximum Glide (Both Engines Windmilling)

10. Crossfeed Switch – ON.
11. Attempt another start.

NOTE

- The RPM may hang up during restart after combustion occurs at low airspeeds. RPM hangup during an airstart may be eliminated by increasing airspeed.
- If it appears a boost pump has failed, remain below 25,000 feet and turn crossfeed OFF to avoid having to use abnormal fuel balancing procedures.
- If it appears a boost pump has failed and flight below 25,000 feet is impractical, engine operation above 25,000 feet with gravity fuel flow is possible at reduced power settings. If a reduced power setting is also impractical, use crossfeed operation to ensure boost pump pressure and to minimize the possibility of fuel flow interruption. Monitor the fuel balance and descend as soon as practical. Flight at lowest practical altitude and reduced power settings will minimize the probability of fuel flow interruption.

ALTERNATE AIRSTART

The alternate airstart is primarily designed for use at low altitude when thrust requirements are critical. An airstart may be accomplished by advancing the throttle to MAX range. This energizes normal and afterburner ignition for approximately 30 seconds (if throttle remains in MAX range). If the engine does not start after 30 seconds, additional starts may be attempted by retarding the throttle out of MAX range to reset the circuit and again advancing the throttle into MAX range to reactivate the ignition cycle. After engine start, the throttle may be left in MAX range if afterburner operation is desired.

If alternate airstart is required, proceed as follows:

1. **THROTTLE(S) – MAX.**

WARNING

- If throttle is already in MAX, recycle throttle to MIL then MAX.
- With dual engine failure, battery switch must be at ON to provide ignition. Battery switch in EMER does not energize the ignition circuitry.

NOTE

If the throttle is in the MAX range, pushing the start button will also provide ignition, but only for the period of time the button is held.

COMPRESSOR STALL

Engine compressor stalls occur due to an interruption of airflow into the engine. A compressor stall is indicated by the following:

- Low Altitude and High Airspeed – Pop, bang, or buzz with a rapid RPM drop and high Exhaust Gas Temperature (EGT).
- High Altitude and Low Airspeed – Audible chug or pop with decreasing RPM and decreasing EGT.

If an engine compressor stalls, proceed as follows:

1. Throttle – IDLE.
2. Start Button – Press.

NOTE

Rapidly retarding the throttle to IDLE and immediately pushing the engine start button may permit the engine to recover and prevent complete flameout.

3. Increase/Decrease airspeed as necessary.

NOTE

- After a compressor stall, the engine may not recover to the full range of operation. If normal instrument indications can be achieved for a given power setting, the engine should not be shut down unless other circumstances dictate.
- If engine damage is suspected, advance throttle above idle only if required.

4. EGT/RPM – Monitor.

If engine will not recover:

5. Throttle – OFF.

NOTE

If the engine is shut down, an airstart may be attempted as applicable.

FIRE WARNING DURING FLIGHT (AFFECTED ENGINE)

If a fire light illuminates, use the following procedure:

NOTE

An illuminated fire warning light should be considered a valid fire indication even though the test circuit may be inoperative.

1. **THROTTLE – IDLE.**

WARNING

When a fire light is preceded or accompanied by a pop, bang or thump, it usually indicates a serious engine malfunction and/or fire. Consideration should be given to shutting down the engine.

CAUTION

If the fire light goes out, test the fire circuit using the warning test switch. If one or both bulbs of the affected fire light does not illuminate, it indicates a possible burn through of one or both fire sensors. In this case, shut the engine down.

2. **THROTTLE – OFF, IF FIRE LIGHT REMAINS ON.**

WARNING

- Do not delay placing the throttle to OFF due to possible rapid loss of flight control system from fire damage.
- If engine cannot be shut down with the throttle, the fuel shutoff switch (affected engine) should be used.

CAUTION

Do not attempt to restart the affected engine if the fire is extinguished. Make a single-engine landing.

3. **IF FIRE IS CONFIRMED – EJECT.**

Any time the fire warning lights illuminate, verify the condition by other indications before abandoning the aircraft. It is possible that the warning system may have malfunctioned and given an erroneous indication. Fire is usually accompanied by one or more of the following indications: excessive EGT, erratic or vibrating engine operation, fluctuating fuel flow, smoke trailing the aircraft and/or smoke in the cockpit.

4. Land as soon as possible.

ELECTRICAL FIRE

1. Oxygen – 100%.
2. Cabin Pressure Switch – RAM DUMP, Below 25,000 feet, if possible.
3. Battery – EMER.
4. Generators – OFF.

NOTE

With boost pumps inoperative, engine flameout may occur if above 25,000 feet.

5. All non-essential electrical equipment – OFF.

If fire continues:

6. Generators – Reset, then ON.
7. Battery – OFF.

SMOKE, FUMES, OR ODORS IN COCKPIT

If smoke, fumes, or odors are encountered in the cockpit, proceed as follows:

WARNING

All odors not identifiable shall be considered toxic.

1. Oxygen – 100%.

NOTE

If odors persist, use of emergency oxygen bottle should be considered. If the emergency oxygen supply is activated, disconnect from the normal aircraft oxygen system.

2. Check for Fire.

CAUTION

Vibrations accompanied by fumes and/or odors from the air conditioning system may indicate air conditioner turbine failure. If this condition is suspected, select oxygen – 100%, descend below FL250, and select RAM DUMP to deactivate the air conditioning system. This should stop the vibrations.

3. Cabin Pressure Switch – RAM DUMP, below 25,000 feet, if possible.
4. If Smoke Becomes Severe – Jettison Canopy, below 300 KIAS, if possible.

LOSS OF CANOPY

If either or both canopies are lost, proceed as follows:

1. Immediately slow the aircraft to 300 KIAS or less.
2. Reestablish intercockpit communications.
3. Land as soon as practical.

CABIN PRESSURE LOSS

1. Oxygen system – 100% and Emergency. Below 25,000 feet oxygen system operation may be returned to normal.
2. Descend immediately – Maintain aircraft at or below 25,000 feet.
3. Land as soon as practical.

OXYGEN SYSTEM EMERGENCY OPERATION

Should either crewmember detect symptoms of hypoxia or hyperventilation, proceed as follows:

1. Supply Lever – Check ON.
2. Diluter Lever – 100% OXYGEN.
3. Emergency Lever – EMERGENCY.
4. Connections – Check security.

WARNING

If positive pressure is not felt after completing Step 4 or oxygen system contamination is suspected, use of the emergency oxygen cylinder should be considered. If oxygen system contamination is suspected, further consideration should be given to disconnecting the aircraft oxygen hose after activating the emergency oxygen cylinder.

5. Breathe at a rate and depth slightly less than normal until symptoms disappear.
6. Descend below 10,000 feet MSL (cabin pressure) and land as soon as practical.

OIL SYSTEM MALFUNCTION

The engine oil pressure indicator displays engine oil pressure on the ground and in the air. Abnormal engine oil pressure indications frequently are an early indication of engine trouble. During cold weather starts, oil pressure usually exceeds 55 psi. To expedite oil warm-up, engine may be operated at MIL power or below. If oil pressure does not return to operating limits within 6 minutes after engine start (5-20 psi at idle), shut down the engine.

In flight, if engine oil pressure is not within the operating limits or a sudden change in pressure of 10 psi or more occurs at any stabilized rpm, proceed as follows:

1. Throttle – Retard (to maintain within limits).

2. Throttle – OFF (if 5 to 55 psi pressure cannot be maintained or if engine seizure appears imminent).

NOTE

- Simultaneous failure of the engine RPM indications and oil pump (oil pressure indicates zero) may be an indication of a sheared oil pump shaft. In this case, T-5 system will be lost.
- If the operating engine requires shutdown, the engine previously shut down for oil system malfunction may be restarted.

If the right engine is to be shut down, check crossover. If crossover is bad, consider lowering 60% flaps to reduce landing distance and trim the aircraft to final approach airspeed (fuel permitting). If crossover is good, leave generator OFF.

ENGINE OVERTEMPERATURE

If excessive exhaust gas temperature occurs, immediately retard throttle to the setting at which the exhaust gas temperature of the affected engine decreases and remains within limits.

NOZZLE FAILURES

Several failures of the engine nozzles are possible: nozzle stuck closed, nozzle stuck open, and fluctuating nozzle.

Nozzle Stuck Closed (At or Near Zero):

If nozzle failure occurs in closed range, excessive EGT is possible. If this condition occurs, follow the engine overtemperature procedure. The engine may be used if EGT is kept within limits. MAX power probably will not be available. Pilots should fly a straight-in approach and landing using Single-Engine procedures. EGT may increase above acceptable limits during landing rollout or taxi. If this occurs, the engine should be shut down.

If a nozzle stuck closed is encountered, use the following procedure:

1. Throttle – Retard to maintain EGT within limits.
2. Land as soon as practical.

Nozzle Stuck Open (in the Open Range 20-85%):

If a nozzle fails in the open position, low EGT will result. The affected engine will operate from idle to MIL, but with a much lower thrust output. Afterburner may not be available. Pilots should fly a straight-in approach and landing using Single-Engine procedures.

If a nozzle stuck open is encountered, use the following procedure:

1. Abort mission.
2. Land as soon as practical.

Fluctuating Nozzle:

A nozzle which is fluctuating above the normal thrust range (above 98.5% rpm or 630°C EGT) with corresponding fluctuation in EGT indicates a possible T5 sensor failure. Crosscheck fuel flow to prevent interpreting a fluctuating nozzle as a fuel control problem. Pilots should fly a straight-in approach and landing using Single Engine procedures.

If a fluctuating nozzle is encountered, use the following procedure:

1. Throttle – Retard until nozzle stabilizes.
2. Land as soon as practical.

EJECTION VS FORCED LANDING

Ejection is preferable to landing on an unprepared surface. Do not land the aircraft with both engines flamed out.

DITCHING

Ejection is to be accomplished in preference to ditching the aircraft.

EJECTION PROCEDURE

The ejection seat can be used to safely escape for most values of the aircraft height, velocity, attitude and flight path, at or between these limits:

- Zero height at zero velocity, in near level attitude and zero sink rate.
- 600 KIAS between zero and maximum height.

Forces on the body increase with velocity. If possible, put the aircraft into the best conditions for safe ejection. The best conditions for safe ejection are between 200 and 300 KIAS. If the canopy jettison system or canopy fracturing system does not operate, the ejection seat will eject through the canopy. After ejection, the aircrew will stay with the seat until a safe altitude and airspeed is reached. Man-seat separation is automatic but can be manually commanded using the manual override (MOR) handle. Refer to Figures 3-4 and 3-5 for the ejection sequence of events for a low/medium and high altitude ejection, respectively.

WARNING

- Do not delay ejection below 2,000 feet in futile attempts to start the engines or for other reasons that may commit you to an unsafe ejection or a dangerous flame-out landing. Accident statistics emphatically show a progressive decrease in successful ejections as altitude decreases below 2,000 feet above the terrain.
- Under uncontrollable conditions, eject at least 15,000 feet above the terrain whenever possible.

During any low-altitude ejection, the chances for successful ejection can be greatly increased by pulling up to exchange airspeed for altitude if airspeed permits. Ejection should be accomplished while in positive rate of climb with the aircraft approximately 20 degrees nose-up and before the start of any sink rate.

Ejection while the nose of the aircraft is above the horizon and in a positive rate of climb will result in a more nearly vertical trajectory for the seat, thus providing more altitude and time for seat separation and parachute deployment. See Figures 3-6 and 3-7 for safe minimum ejection altitude versus sink rate and Figures 3-8, 3-9, and 3-10 for ejection altitude versus bank/dive angle. If rate of climb cannot be accomplished, level flight ejection should be accomplished immediately to avoid ejection with a sink rate. The automatic safety belt must not be opened before ejection, regardless of altitude. If the safety belt is opened manually, safe ejection is unlikely.

WARNING

If the aircraft is not controllable, ejection must be accomplished at whatever speed exists, as this offers the only opportunity for survival. At sea level, wind blasts and deceleration will exert medium forces on the body up to approximately 450 KIAS (0.7 mach). Severe forces causing flailing and skin injuries occur between 450 (0.7 mach) and 600 KIAS (0.9 mach). Excessive forces above 600 KIAS (0.9 mach) can produce serious injuries and death. As altitude increases, the speed ranges of the injury-producing forces will be a function of the mach number.

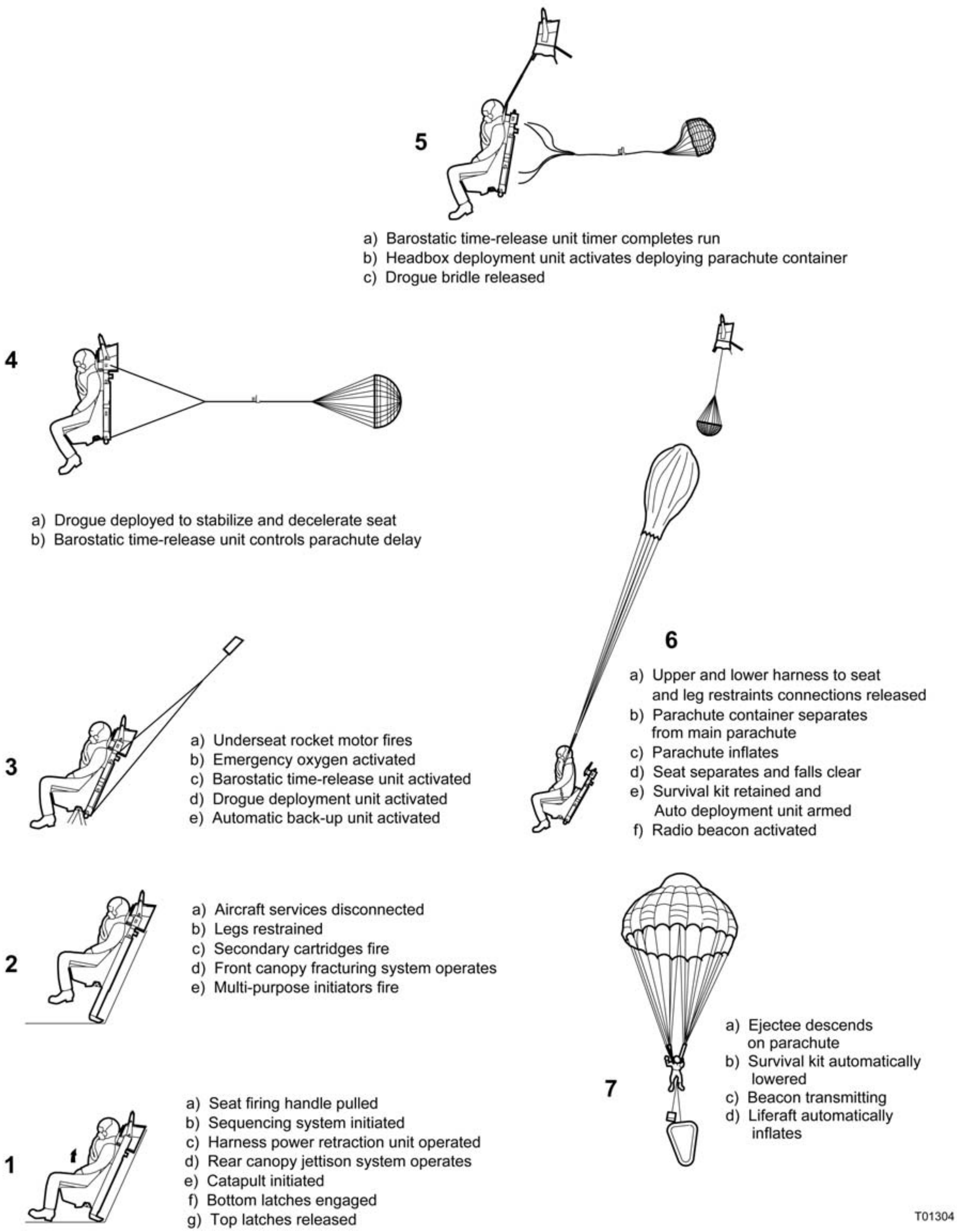


Figure 3-4. Ejection Sequence – Low/Medium Altitude

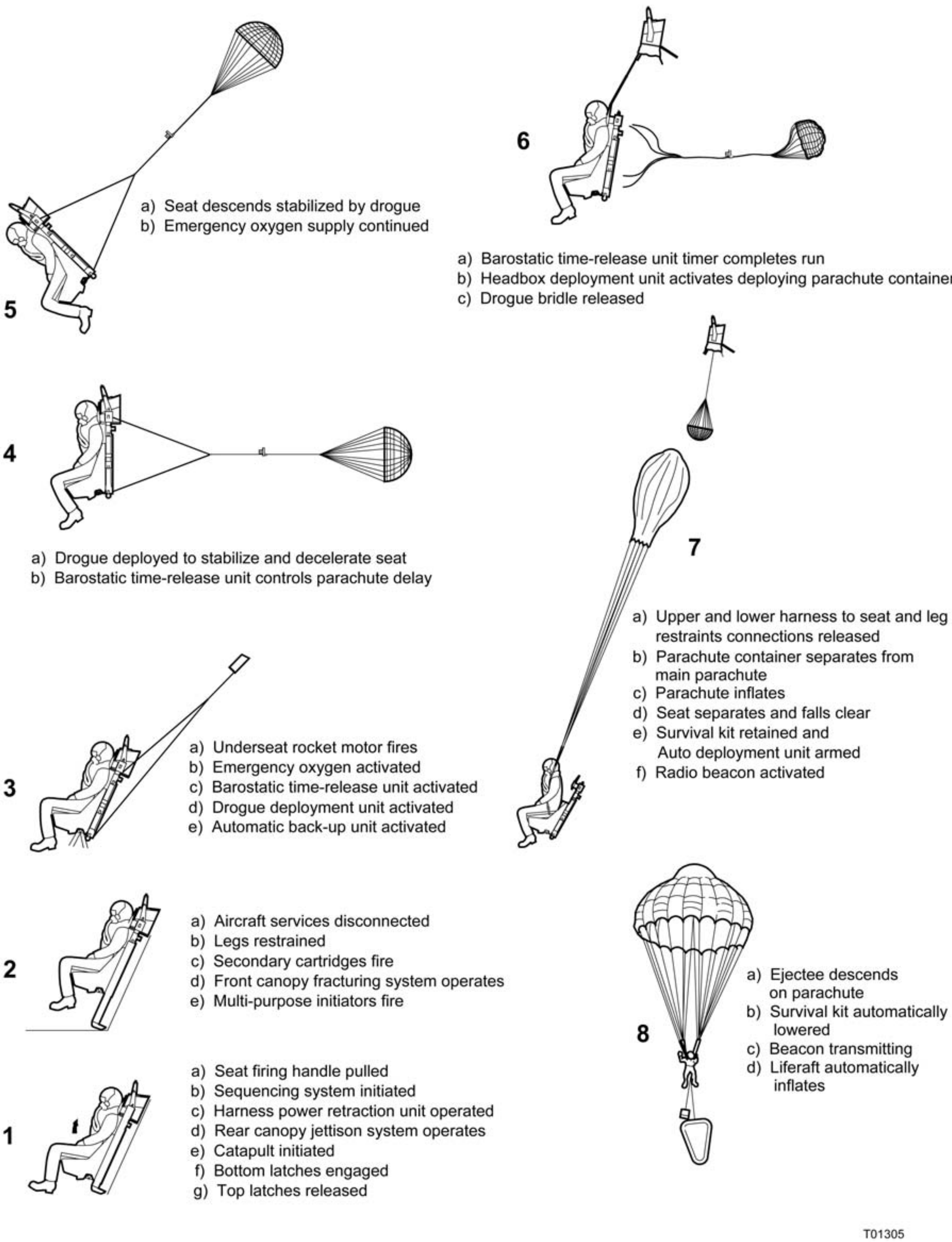


Figure 3-5. Ejection Sequence – High Altitude

EJECTION ALTITUDE VS SINK RATE
0.25 SECOND DELAY OPENING PARACHUTE

NOTE

The performance shown is for near sea-level atmospheric conditions with an airspeed of 150 KIAS, the wings level, and a slight nose up attitude. Refer to Figure 3-6 and Figure 3-7.

NOTE

For escape over high altitude terrain, increase the required heights by 1 percent per 1,000 ft of aircraft altitude above mean sea level.

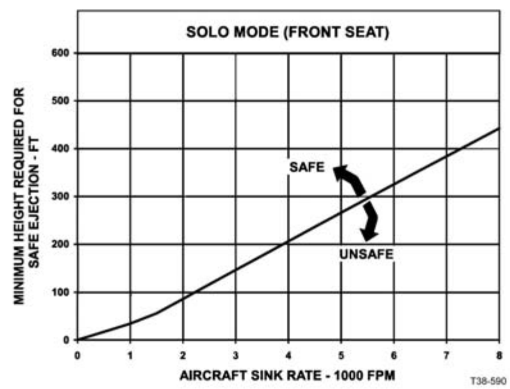


Figure 3-6. Minimum Ejection Height vs. Sink Rate – Front Seat in SOLO

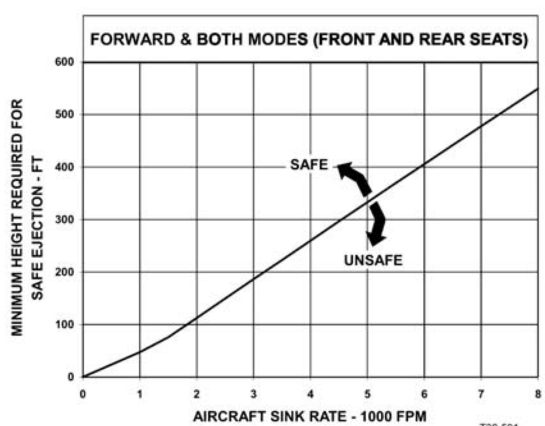


Figure 3-7. Minimum Ejection Height vs. Sink Rate – Front and Rear Seats in FWD and BOTH

EJECTION ALTITUDE VS BANK/DIVE ANGLE
0.25 SECOND DELAY OPENING PARACHUTE

NOTE

- The performance shown is for near sea-level atmospheric conditions with the aircraft in a constant attitude. Refer to Figure 3-8.
- For escape over high altitude terrain, increase the required heights by 1 percent per 1,000 ft of aircraft altitude above mean sea level.

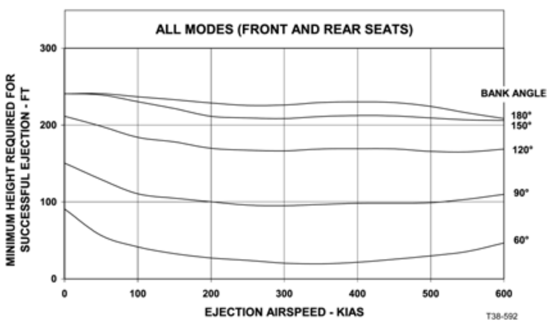


Figure 3-8. Minimum Ejection Height vs. Bank Angle

NOTE

- The performance shown is for near sea-level atmospheric conditions with the wings level. Refer to Figure 3-9 and Figure 3-10.
- For escape over high altitude terrain, increase the required heights by 1 percent per 1,000 ft of aircraft altitude above mean sea level.

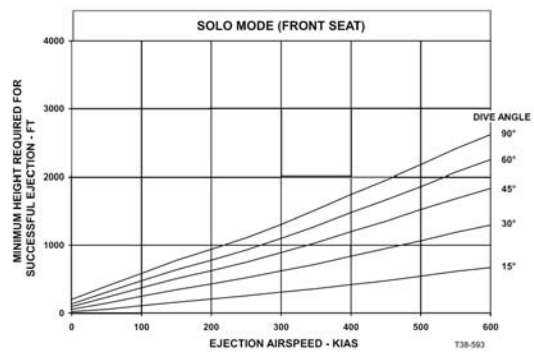


Figure 3-9. Minimum Ejection Height vs. Dive Angle – Front Seat in SOLO Mode

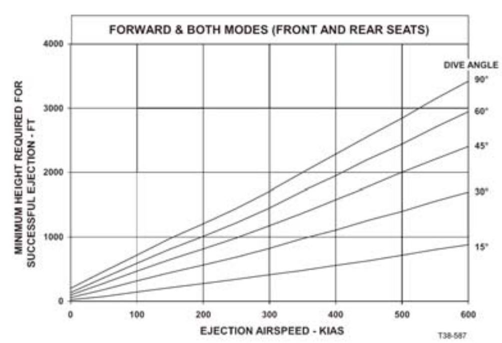


Figure 3-10. Minimum ejection height vs. dive angle – Front and rear seats in FWD and BOTH mode

BEFORE EJECTION

If time and conditions permit:

1. Notify crewmember of decision to eject.
2. Select 7700 code in transponder field of RMS and if not in radio contact with appropriate agencies, select guard frequencies on VHF (121.5) and UHF (243.0) and transmit MAYDAY.
3. Turn aircraft toward uninhabited area.
4. Stow all loose equipment.
5. Tighten oxygen mask and chin strap (well beyond comfortable range), and lower and lock visor(s).
6. Attain proper airspeed, altitude, and attitude.

NOTE

For controlled ejection, the recommended flight conditions are:

- Straight and level
- Speed: 200 – 300 KIAS
- Altitude: 2,000 – 4,000 ft AGL

7. Assume proper position.

WARNING

- Keep spine straight, head firmly against the headpad, legs stretched out forward of seat with weight of thighs resting on seat cushion.
- Maintaining aircraft control may require use of only one hand to initiate the ejection sequence.

EJECTION

WARNING

Make sure that your body posture is correct prior to initiating ejection. Incorrect body posture can cause serious injury or death.

1. **SEAT FIRING HANDLE – PULL AND HOLD UNTIL SEAT SEPARATION OCCURS.**

If the ejection sequence does not start:

2. Pull the seat firing handle up again.

If the seat firing handle will not move:

3. SAFE/ARMED – Check ARMED.
4. Seat Firing Handle Safety Pin – Check removed.

TRIM MALFUNCTION

If an aircraft trim malfunction results in either full nose up or full nose down trim, stick force needed to position the horizontal stabilizer may be several times greater than expected. Runaway trim effects may be minimized by immediately attempting to trim opposite the undesired stick forces in order to stop or reverse the horizontal tail trim movement. If the trim malfunction results in excessive nose down trim loads, increasing airspeed may reduce required stick forces to maintain level flight. If the trim malfunction results in excessive nose up trim loads, decreasing airspeed may reduce required stick forces to maintain level flight.

NOTE

The takeoff trim system is independent and, depending on trim position, may help relieve some stick pressure near approach airspeeds.

STABILITY AUGMENTER MALFUNCTION

The stability augmenter yaw system can fail with a resulting rudder deflection of 4 degrees. This deflection will cause a yaw and resulting moderate rudder roll. At high speed/high Angle-of-Attack (AOA), the roll rate is greater and the yaw is less noticeable. Opposite rudder will immediately neutralize the yaw and roll. If yaw oscillations are induced by the stability augmenter, the yaw switch should be placed OFF.

NOTE

If the yaw damper switch is found in the OFF position during flight, the mission may be continued. Do not re-engage the damper switch.

1. AOA – Reduce (if able).
2. Apply opposite rudder and aileron (as required to control yaw and roll).
3. SAS Disconnect Switch – DISC.

If disengaging the SAS disconnect switch and/or yaw damper switch corrects the malfunction, the mission may be continued.

4. Yaw Damper Switch – Check OFF.

If yaw damper switch remains engaged or if malfunction continues:

5. Yaw Damper Switch – OFF.
6. Stability Augmenter Circuit Breakers – Pull (FCP pedestal).

RUDDER SYSTEM FAILURE

If rudder system failure is experienced, the failure mode may be a full 30 degrees hardover rudder. The pilot's indications of this type failure will be a smooth, increasing, uncontrollable yaw and a resulting roll. Opposite rudder inputs will have no effect on the yaw. As the yaw angle increases, the engines will probably stall, stagnate, or flameout. Immediate aileron inputs may control the roll at first; but, as the rudder approaches full deflection, the rudder roll authority will overcome the ailerons and the aircraft will depart controlled flight. Aircraft control cannot be regained. Eject as soon as practical after confirming that full opposite rudder input cannot control the yaw and roll.

FUEL QUANTITY INDICATOR AND LOW LEVEL CAUTION LIGHT SYSTEM MALFUNCTION

When fuel quantity indicator failure is experienced, the fuel low-level caution light is unreliable. Failure of the fuel low-level caution system is indicated when either fuel quantity indicator reads less than 250±25 pounds and the low-level light does not illuminate. With fuel quantity indicator failure or low-level caution system failure, closely monitor the fuel quantity and land as soon as practical.

WARNING

Do not attempt crossfeed operation with a fuel quantity indicator inoperative as it will be impossible to monitor the fuel balance.

CAUTION

A fuel quantity indicator may fail but still check good using the fuel quantity test switch.

LOW FUEL PRESSURE

The fuel pressure lights may blink momentarily due to a fuel requirement surge (e.g., afterburner light). This is not a malfunction. If the fuel pressure caution light illuminates continuously, it probably indicates the loss of the corresponding boost pump. However, it is also a possible indication of a fuel leak, a generator phase failure, or a surging engine-driven fuel pump. Turning the crossfeed ON should cause the fuel low pressure light to go out. If not, a fuel leak may be indicated. A generator phase failure will have other indications (see PARTIAL GENERATOR FAILURE).

WARNING

If a fuel leak can be verified, strong consideration should be given to shutting down the affected engine using normal throttle cutoff. An internal leak could cause a fire or an explosion and requires an immediate recovery.

If a fuel pressure caution light comes on continuously, proceed as follows:

1. Boost Pump Circuit Breakers – Check.

Circuit breakers for the left/right boost pumps are located on the rear cockpit left/right console circuit breaker panels, respectively.

NOTE

- If circuit breakers are found popped, turn off appropriate boost pump before resetting circuit breakers.
- Only reset a boost pump circuit breaker once. If generator phase failure is suspected, there will be other indications.

2. Power – Reduce.

NOTE

- If it appears that a boost pump has failed, remain below 25,000 feet. Turn crossfeed OFF to avoid having to use an abnormal fuel balancing procedure.
- If a reduced power setting at high altitude is impractical, turn the crossfeed switch on to minimize the possibility of fuel flow interruption. Monitor fuel balance and descend as soon as practical.

3. Descend – 25,000 feet or below.
4. Land as soon as practical.

TRANSFORMER-RECTIFIER FAILURE

Continuous illumination of XMFR RECT OUT caution light indicates the possible failure of both transformer-rectifiers. If both fail, all systems requiring DC power can be supplied by the battery. Battery life depends on many factors and cannot be accurately predicted. When powering all DC equipment (battery switch ON), battery life should be approximately 10-20 minutes. Use of the emergency bus (battery switch EMER) can extend battery life to approximately 2 hours. Refer to Figure 1-14 to determine what components are powered by DC and which are available with battery switch in EMER.

NOTE

- The XMFR RECT OUT and MASTER CAUTION lights may blink due to surge current developed by high battery voltage overriding the DC bus voltage.
- Total AC failure will also result in a XMFR RECT OUT light.

If the XMFR RECT OUT caution light illuminates continuously, proceed as follows:

1. Voltmeter – Check.
   Normal DC Bus Voltage is 28±2 volts.
2. Transformer-Rectifier Circuit Breakers (6) – In.

The transformer-rectifier circuit breakers are located on the front cockpit center pedestal and the rear cockpit left console circuit breaker panels.

3. Remain VFR if possible.
4. Battery – EMER.
5. Cockpit Instruments Rheostat – Out of OFF position.
6. Caution, Warning, and Indicator Lights Bright/Dim Switch – DIM.

This allows 14 volt AC to illuminate the caution and warning lights.

7. Monitor use of VHF transmitter and battery voltage.
8. Land as soon as possible.

Prior to lowering the landing gear:

9. Battery – ON.

After landing:

10. Stop on runway and have gear pinned.

CAUTION

If complete DC failure occurs with the landing gear extended, down-side hydraulic pressure will be lost. The gear should be pinned prior to taxiing clear of the runway.

DUAL GENERATOR FAILURE/ COMPLETE ELECTRICAL FAILURE

With a complete electrical failure (AC and DC), all aircraft electrical components (except engine tachometers) are inoperative, and each engine anti-ice valve opens. Use the following procedures:

1. Battery Switch – Check ON.
2. Generator Switches – RESET then ON.

Hold generator switches at RESET momentarily, then return switches to ON in an attempt to regain electrical power.

If generators fail to reset, proceed as follows:

3. Generator Switches – OFF.

NOTE

With boost pumps inoperative, engine flameout may occur if above 25,000 feet.

4. Battery Switch – EMER.
5. Descend – To lowest practical altitude below 25,000 feet.
6. Land as soon as practical.

If electrical power cannot be restored, attempt to get to and maintain Visual Meteorological Conditions (VMC). Plan to fly an electrical failure pattern. A no-flap landing will be necessary and the landing gear must be extended using the alternate system (see LANDING GEAR ALTERNATE EXTENSION).

7. Battery – ON.

CAUTION

If complete DC failure occurs with the landing gear extended, down-side hydraulic pressure will be lost. The gear should be pinned prior to taxiing clear of the runway.

After landing:

8. Stop on runway and have gear pinned.

GENERATOR FAILURE

Loss of electrical systems following the illumination of a generator caution light may indicate a failure of crossover circuitry. Refer to Figure 1-15 to determine the system loss associated with a left or right generator failure with no crossover. If generator caution light illuminates, proceed as follows:

1. Adjust RPM of engine with failed generator to opposite side of shift range (65-70%).
2. Generator Switch – RESET, then ON.

WARNING

The pilot should refrain from attempting to reset the generator more than once due to the danger of generator fire.

NOTE

- If the right generator failed with no crossover and subsequently resets, consider setting the flaps at 60% and trimming the aircraft to level flight (fuel permitting) in the event the right generator fails again.
- If a generator fails, resets successfully, then fails later, another reset may be attempted after returning gearbox to the shift range where generator operation can be maintained or to facilitate flap extension and retrimming for approach speeds. Repeated resetting of a faulty generator should not be attempted.
- If generator failure was due to gearbox failure to shift, leave engine in range of successful generator operation until on final approach, then use as required.

If generator caution light continues to illuminate, proceed as follows:

3. Generator Switch – OFF.
4. Land as soon as practical.
5. After landing, engine with failed generator will be shut down after clearing runway.

If generator caution light continues to illuminate and the crossover circuitry fails, proceed as follows:

3. Generator Switch – OFF.
4. Descend below 25,000 feet if practical.
5. Check fuel with FUEL & OXY QTY CHECK switch.
6. Land as soon as practical.

If the right generator fails with no crossover and cannot be reset, a no-flap pattern will be required. Consider burning down fuel if no-flap landing distance is critical.

7. After landing, engine with failed generator will be shut down after clearing runway.

PARTIAL GENERATOR FAILURE

The loss of certain electrical components without illumination of the generator caution light may indicate the loss of one or two phases of an AC generator. Three-phase items on the AC bus and the effect of phase failure include:

1. Boost Pumps: Fuel pressure lights may illuminate.
2. Transformer Rectifiers: XMFR RECT OUT light may illuminate.
3. Flaps: Actuation of flaps may be slow.

If conditions permit, use the following procedures:

1. Identify the affected generator by reference to the circuit breaker diagram.
2. Affected Generator – OFF (attempt to force crossover).

If malfunction not corrected:

3. Affected Generator Switch – ON.
4. Land as soon as practical.

GEARBOX FAILURE – AIRFRAME-MOUNTED

A complete gearbox failure is indicated by simultaneous illumination of the generator and hydraulic lights for the same engine. Confirm complete gearbox failure by checking the appropriate hydraulic indicator.

WARNING

If one system reads zero, hydraulic fluid transfer may occur from the pressurized to the unpressurized system. In this case, total hydraulic failure and therefore loss of aircraft control may occur in as little as 35 minutes.

If gearbox fails completely and excessive vibration exists:

1. Throttle (affected engine) – OFF.
2. Land as soon as possible.

ELECTRONIC ALTIMETER THOUSANDS DIGIT FAILS

The electronic altimeter has two LCD windows. The right window displays tens and hundreds digits and the left window displays the thousands and ten thousands digits. If the window with the thousand and ten thousands digits fails, these digits can be recovered by moving them to the right window. Tens and hundreds can then be read using the pointer.

To transfer thousands digit to right side of display:

1. ALTIMETER NORM/STBY switch – Hold in STBY for 3 seconds.

NOTE

With the thousands digits transferred to the right side of the altimeter display, the altimeter displays corrected altitude only in NORM. In STBY, the altimeter displays full pneumatic (uncorrected) altitude.

2. NORM/STBY Switch – Select NORM.

INFLIGHT IRS FAILURE

1. Monitor attitude using STBY ADI and heading using Magnetic Compass.
2. Maintain straight-and-level flight until attitude is restored.

NOTE

After power is restored, the IRS will immediately perform a built-in test and begin a reversionary alignment. A reversionary alignment requires 20-40 seconds (cumulative) of straight-and-level flight. The alignment is complete when the attitude is restored. Heading will initially realign to 360 degrees.

3. Set reference heading:
   a. Select DATA Page 2.
   b. Depress LSK[1L] for IRS status page.
   c. Depress LSK[1R] and enter magnetic heading – hold aircraft heading steady until heading transfers to HDG (approximately 10 seconds).
4. Update heading approximately every 15 minutes.
   The heading will drift 15 degrees per hour without updates.

GPS INTEG CAUTION LIGHT ILLUMINATES

NOTE

The GPS INTEG caution light indicates Actual Navigation Performance (ANP) exceeds Required Navigation Performance (RNP) for phase of flight (enroute, terminal, or approach), or GPS Horizontal Integrity Limit (HIL) is exceeded. GPS approach capability is not available with the GPS Integ Light illuminated.

If the GPS INTEG caution light illuminates in flight, perform the following:

1. Verify accuracy of FMS navigation using VOR or TCN.
2. Check GPS satellite status.
   a. Data Page 2
   b. Select GNSS LSK [2L]

PITOT HEAT FAILURE

If the PITOT HEAT OFF light illuminates in flight, perform the following procedure:

1. Pitot Heat switch – Check ON.

If Pitot Heat switch ON or if light remains illuminated:

2. Remain clear of icing.
3. Land as soon as practical.

AIR DATA COMPUTER FAILURE

The ADC provides altitude and airspeed corrected for mach and configuration to the airspeed indicator and altimeter when each instrument is in NORM. Illumination of the MADC FAIL light indicates a problem with the ADC computed output. This may force the airspeed indicator and/or altimeter into STBY mode. If either or both instruments remain in NORM, displayed data should be considered suspect.

In STBY, the airspeed indicator and altimeter will display corrected data provided a communications link between the instruments is intact. An intact communications link is indicated by an “A” next to the thousands digits on the altimeter. A broken communications link is indicated by a series of dashes in the mach window on the airspeed indicator. With ADC failure and a lack of the communications link between the airspeed indicator and the altimeter, significant airspeed and altitude errors can occur (see Figure A1-1).

If the MADC FAIL caution light illuminates inflight, perform the following procedures:

1. Airspeed Indicator and Altimeter – Select STBY mode.
2. Verify presence of “A” next to altimeter thousands digits.

If “A” not present or if dashes are present in airspeed mach window:

1. Hold airspeed paddle switch in NORM for 3 seconds.

Holding the paddle switch in NORM for 3 seconds forces establishment of the communications link between the airspeed indicator and the altimeter.

If the dashes remain in the airspeed indicator mach window or if the “A” does not appear in the airspeed indicator:

1. Above 0.80 Mach – Inform ATC and request 4,000 foot block altitude.
2. Descend as required below FL350 and slow below 0.80 Mach.

Below 0.80 Mach, altitude errors are significantly reduced.

3. Land as soon as practical.

NOTE

Due to pitot-static errors with uncorrected airspeed and altitude, add 5 knots to final approach and landing speed and 60 feet to all altitude minimums.

HYDRAULIC SYSTEMS MALFUNCTIONS

Three different types of hydraulic system malfunctions may be encountered: hydraulic fluid overtemperature, low pressure, and high pressure. The hydraulic caution light will illuminate for either a fluid overtemperature or a low pressure condition. To determine the cause of a hydraulic caution light, check the indicators. Readings below 1,500 psi indicate a low pressure situation. Momentary drops in pressure sufficient to cause illumination of the hydraulic caution light may be an indication of an unpressurized system. Normal or excessive pressure readings with a hydraulic caution light indicate a fluid overtemperature condition. The hydraulic indicators provide the only warning of high hydraulic pressure: a situation that can cause a hydraulic overtemperature condition. Although fluid overtemperature and high pressure usually occur together, it is possible to have one without the other. The corresponding engine should be shut down immediately whenever an overtemperature condition exists. If the pressure is high, but not accompanied by a caution light or sluggish controls, the aircraft should be landed as soon as possible; be alert for conditions of overtemperature.

WARNING

- An ejection should be accomplished with dual hydraulic system failures, since flight control is impossible.
- Hydraulic pressure provided solely by a windmilling engine is insufficient to control the aircraft for landing.

HYDRAULIC MALFUNCTIONS (CAUTION LIGHT ILLUMINATED)

With a utility hydraulic system failure, the speed brake, nose wheel steering, normal landing gear system, and stability augmenter will be inoperative. If the UTILITY or FLIGHT HYDRAULIC caution light illuminates, use the following procedure:

1. Hydraulic Pressure Indicators – Check.

If hydraulic pressure is low:

1. Monitor both systems and avoid zero and negative G flight.

If the flight (right) hydraulic system fails, the utility (left) hydraulic system will operate the flight controls. If the utility system fails, the stability augmentation, nose wheel steering, normal gear extension, and speed brake will be inoperative.

WARNING

If one system reads zero, hydraulic fluid transfer may occur from the pressurized to the unpressurized system. In this case, total hydraulic failure and therefore loss of aircraft control may occur in as little as 35 minutes.

2. Land as soon as practical.

CAUTION

If utility hydraulic pressure is depleted, stop straight ahead and have gear pins installed prior to clearing runway.

If a leak is suspected, consider an emergency ground egress due to the possibility of a fire. If hydraulic pressure is normal or high (fluid overtemperature):

1. Shut down affected engine.

If the right engine is to be shut down, check crossover. If crossover is bad, consider lowering 60% flaps to reduce landing distance and trim the aircraft to final approach speed (fuel permitting). If crossover is good, leave generator OFF.

NOTE

If the Hydraulic Caution light goes out, the engine may be restarted if necessary. However, the engine should be left shut down as long as possible to permit maximum cooling of hydraulic fluid.

2. Land as soon as possible.

EXCESSIVE HYDRAULIC PRESSURE (CAUTION LIGHT NOT ILLUMINATED)

A steady-state hydraulic pressure higher than 3,200 psi in either system must be considered a system malfunction. Proceed as follows:

1. Land as soon as practical.
2. If accompanied by sluggish flight controls, shut down the affected engine.

If the right engine is to be shut down, check crossover. If crossover is bad, consider lowering 60% flaps to reduce landing distance and trim the aircraft to final approach airspeed (fuel permitting). If crossover is good, leave generator OFF.

WARNING

- An ejection should be accomplished with dual hydraulic failure since flight control is impossible. Hydraulic pressure provided solely by a windmilling engine is insufficient to control the aircraft to landing.
- Sluggish flight controls are indicated by slow or erratic response to normal control inputs. If the actuator seals continue to expand to the point of binding, the flight controls will not respond at all to stick inputs. In case of binding flight controls, consideration should be given to ejecting.

3. After landing and clear of runway, shut down the affected engine.

NOTE

If left engine is shut down, pin gear prior to continued taxi operations.

CONTROLLABILITY CHECK (STRUCTURAL DAMAGE)

If structural damage or a flight control malfunction occurs or is suspected in flight, a decision must be made whether to abandon the aircraft or attempt a landing. The purpose of this check is to determine if the aircraft is landable and if so, to determine what configuration is best for landing. Normally, the aircraft would be configured with gear and full flaps and slowed to a minimum controllable air speed or normal touchdown speed, whichever is higher. If unable to achieve a normal configuration and airspeed, then configuration and airspeed should be adjusted in order to accomplish a landing. Proceed as follows:

1. Notify appropriate ground agency of intentions.
2. Climb to at least 15,000 feet AGL (if practical) at a controlled airspeed.
3. Simulate a landing approach.

CAUTION

Consider using the auxiliary flap control switch to reposition the flaps. If damage to the flaps or flap actuating mechanism (other than flap-slab interconnect) is known or suspected, do not reposition flaps.

4. Determine airspeed at which aircraft becomes difficult to control.

WARNING

Touchdowns as high as 200 knots are possible. High speed touchdown initially limits the effectiveness of aerodynamic and/or wheel braking.

NOTE

Slow to minimum controllable airspeed or touchdown speed, whichever occurs first. As a guide, if you have to deflect the stick more than 3/4-stick travel to maintain level unaccelerated flight, you have reached your minimum controllable airspeed. Touchdown speed is generally ±5 knots of level flight stall speed. Do not allow airspeed to decrease below touchdown speed.

Once a touchdown speed is computed, do not change the speed due to fuel weight lost en route to the airfield. If a touchdown speed greater than 200 knots is computed, another controllability check at a lower fuel weight should be considered. Touchdowns greater than 200 knots should not be attempted as the nosegear will touch down first increasing the possibility of a high speed Pilot-Indicated Oscillation (PIO).

5. Do not change aircraft configuration.
6. Maintain at least 20 KIAS above minimum controllable airspeed during descent and landing approach.
7. Fly a power-on straight-in approach requiring minimum flare. Plan to touchdown at 10 knots above either normal touchdown speed or minimum control speed whichever is higher.

With any structural damage, do not aerobrake. Hold the landing attitude until loss of slab authority and then cautiously apply the wheel brakes. Not aerobraking could increase normal landing distance by as much as 50 percent.

WING FLAP ASYMMETRY

If lateral rolling and yawing is experienced during operation of the wing flaps or while the flaps are extended, an asymmetric wing flap condition probably exists. Asymmetry may occur from physical binding or only one flap tracking when the flaps are actuated resulting in a gradually increasing uncommanded roll and yaw as the flap extends or retracts. This is readily detected and can be corrected by reversing the direction of flap movement. A more serious control situation arises when the asymmetry occurs following an instantaneous failure within the flap system. The severity is dependent on airspeed and flap position (in transit or fully extended) at the moment of failure. The situation is characterized by an immediate uncommanded yaw and rapid roll. Sufficient control authority is available to counteract the yaw and roll at pattern airspeeds. If either condition occurs, use the following procedure:

1. Throttles – MAX.
2. Wing Flap lever – Actuate to eliminate or minimize the wing flap asymmetric condition.
3. Attain airspeed above 180 KIAS.
4. Aux Flap Switch – Emergency.

NOTE

In the emergency position, flap settings can be set to any intermediate position to eliminate the asymmetrical condition.

If a flap setting less than 60% is used, fly AOA on speed indications on final. With 60% or greater, use normal pattern airspeeds.

If asymmetry persists:

5. AIRSPEED – Maintain airspeed 20 KIAS above final approach and touchdown speeds. Do not touch down below 160 KIAS.

NOTE

If the asymmetric condition cannot be corrected and conditions permit, land from a straight-in approach.

WING FLAP HORIZONTAL TAIL LINKAGE MALFUNCTION

If the interconnect system fails with the flaps retracted, the aircraft will have the following characteristics: As flaps are lowered, a smooth but definite pitch-up will occur. This pitch-up can be controlled. As flaps approach 60%, the control stick must be positioned very close to the forward stop to maintain controlled flight. Heavy forward stick forces will be required which cannot be completely trimmed out, as the stick will be forward of the trim cut out limit. Although the aircraft may be flown in level flight in this configuration, very little nose down control authority is available to maneuver the aircraft. If such a condition is encountered, retract the flaps and make a no-flap landing whenever possible. A no-flap landing is preferred. However, if landing conditions require the use of some flap extension to reduce touchdown speed and improve aerodynamic braking, a flap setting of between 30% and 45% will provide limited but adequate nose down control authority and manageable forward stick forces. Fly a straight-in approach and be careful to avoid over-rotation as forward stick pressure is relaxed to initiate the landing flare. Final approach and touchdown airspeed will be between the normal and no-flap computed speeds; maintain an AOA on-speed indication on final approach.

NOTE

It is easy to confuse trim failure with flap-slab interconnect failure. Careful analysis of configuration and control movements at the time of occurrence are essential.

If the interconnect system fails with flaps lowered any amount, the horizontal tail will instantly reposition to the zero flap setting and all flight control compensation is removed. This will always result in an abrupt and uncommanded aircraft pitch-up. The severity of the pitch-up is directly dependent on the airspeed and flap setting at the moment of failure. The stick must be positioned forward (to within 1 inch of the forward stop) to obtain controlled level flight. Furthermore, the available nose down slab deflection is greatly reduced and the stick must be positioned full forward to arrest the initial pitch-up rate caused by the interconnect failure. These forward stick forces cannot be trimmed out. When a safe airspeed and altitude are obtained, positioning the flaps up will return flight control and handling characteristics to normal. Flight tests have verified that at speeds as low as touchdown airspeeds, this type of failure is recoverable and that a controlled go-around is possible. However, the recovery procedure requires immediate pilot response and must be precisely applied within 3 seconds to ensure recovery without a loss of altitude. Recovery from an interconnect failure during the final approach or touchdown phase requires the use of full afterburners and the immediate retraction of flaps to 60% to eliminate the excess drag caused by full flaps.

ABRUPT AND UNCOMMANDED AIRCRAFT PITCH-UP, WING FLAPS EXTENDED

If an abrupt aircraft pitch-up occurs while the wing flaps are extended, flap-slab interconnect failure should be suspected. If the failure occurs at conventional traffic pattern airspeeds and configurations, the aircraft, in addition to pitching up, will exhibit heavy buffeting, wingrock, and stall immediately. If this occurs in the traffic pattern, proceed as follows:

NOTE

Interconnect failure can occur even after flaps have stabilized in a given position.

1. Control Stick – Full forward to arrest pitch rate.

WARNING

- If takeoff is made with interconnect failure, a lighter than normal stick force and reduced amount of stick travel will be required for rotation. Until the flaps are retracted, significant forward stick pressure will be required to keep the pitch attitude from increasing.
- If interconnect cable failure occurs after flaps are down 60% or more, a sudden pitch-up will occur and the aircraft will stall instantaneously. Full forward stick will be necessary to arrest the rate of pitch-up and the pilot must take corrective action within three seconds to ensure recovery without a loss of altitude.

NOTE

The amount of horizontal tail authority will be that available with zero flaps regardless of the actual flap setting.

2. Throttles – MAX.
3. Flaps – 60%.

WARNING

If failure occurs while flying at final approach airspeed, initially repositioning the flaps to 60% will reduce stick forces and will provide the best chance of recovery. Do not retract the flaps to the no-flap position until the aircraft accelerates above no-flap flying airspeed.

NOTE

With the flaps set at 60% or more, the required stick position will be beyond the forward trim cutout limit.

4. Landing gear – LG UP when continued flight is assured.
5. Flaps – UP when the aircraft accelerates above no-flap flying airspeed. (Be prepared to relax forward stick force as flaps are retracted.)

NOTE

Moderate to heavy stick forces will be present until the flaps are retracted.

6. Land with wing flaps retracted.

WARNING

- If interconnect cable failure occurs after flaps are down 60% or more, a sudden pitch-up will occur and the aircraft will stall instantaneously. Full forward stick will be necessary to arrest the rate of pitch-up and the pilot must take corrective action within 3 seconds to ensure recovery without a loss of altitude.
- If failure occurs while flying at final approach airspeed, initially repositioning the flaps to 60% will reduce stick forces and will provide the best chance of recovery. Do not retract the flaps to the no-flap position until the aircraft accelerates above no-flap flying airspeed.

BRAKE SYSTEM MALFUNCTION (FLUID VENTING)

Failure of certain components of the wheel brake master cylinders or brake lines located within the pressurized area of the cockpit may cause brake fluid vent overboard through the brake fluid reservoir. If allowed to continue, all the brake fluid could be forced overboard. If brake fluid venting overboard is suspected or detected (i.e., red brake fluid visible on the right side of the aircraft by the rear cockpit), proceed as follows:

1. Descend – 25,000 feet or below, if practical.
2. Cabin Pressure Switch – RAM DUMP, below 25,000 feet.
3. Land at lowest practical gross weight.

With no other known malfunction, plan to land in the center of the runway.

WARNING

If brake failure is encountered on landing roll, braking action may be regained by repeatedly pumping the brakes. The pedals should be released to the full UP position between strokes.

CAUTION

Do not pump the brakes in flight as this action could introduce air into the brake system which could result in complete brake failure.

LANDING EMERGENCIES

SINGLE-ENGINE LANDING

A straight-in approach should be flown. See Figure 3-11 or Section IX for single-engine approaches. Operating with one engine may cause yaw – especially in MAX. This can usually be controlled with the use of rudder. The following procedure should be accomplished before landing:

WARNING

Use maximum power, if necessary, to maintain landing pattern air-speeds. Refer to Section VI and Part 7 of Appendix A for the effect of bank angle on vertical velocity.

1. Gear – Down and Check Down.

Under certain conditions, level, configured, single-engine flight may be impossible. Consider delaying configuration until just prior to the glideslope.

NOTE

- Power required under single-engine conditions may be in excess of that required to activate the landing gear warning system.
- If left engine is inoperative, normal windmilling RPM will provide adequate utility hydraulic pressure for a landing gear normal extension in a slightly longer extension time. If utility hydraulic system pressure is depleted, use the landing gear alternate extension system to extend the gear and allow additional time for gear extension.

2. Wing Flaps – 60% (Set on Final Prior to Descent).
3. Wing Flaps – DOWN when landing is assured (optional).

CAUTION

- At high density altitudes and/or high gross weights, limited excess thrust is available to offset full flap drag. If full flaps are selected in the flare, an immediate touchdown and premature landing may occur.
- Aerodynamic braking with less than 100% flaps is less effective and longer landing distances should be anticipated (as much as 500 feet). If landing distance is computed to be over 2/3 of runway length, consider tracking flaps to full once below full flap landing airspeed.

If the left engine has failed, have the landing gear pinned prior to taxiing clear of the runway (conditions permitting).

SINGLE-ENGINE GO-AROUND

The available altitude and/or runway should be used to accelerate. The aircraft should be rotated at single engine takeoff speed plus 10 knots or in time to become airborne prior to the end of the runway, whichever comes first. Allow the aircraft to accelerate straight ahead, climbing only as necessary, until reaching 190 KIAS.

If, during the go-around, a touchdown occurs and take-off appears questionable, an abort may be warranted.

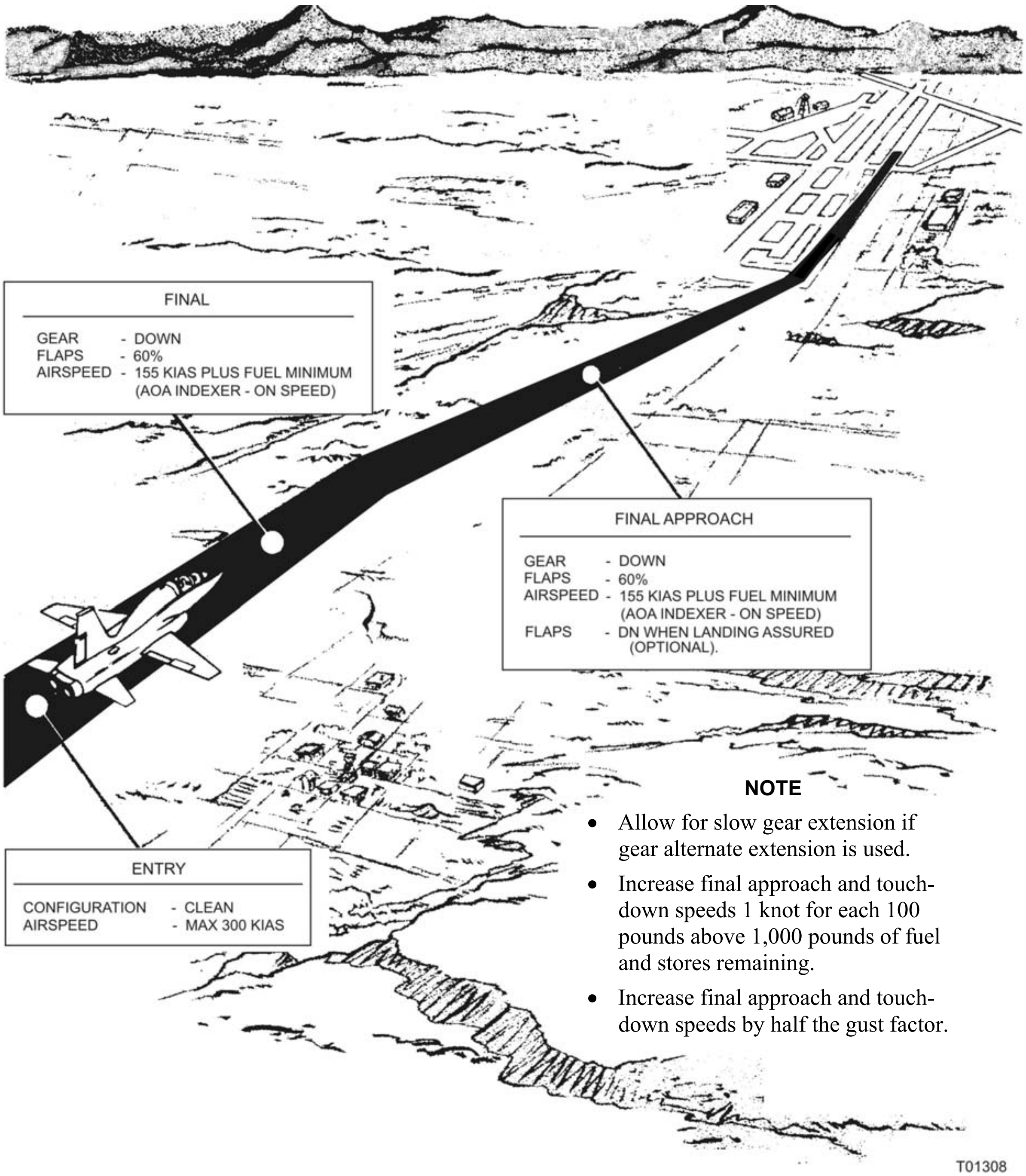


Figure 3-11. Single-Engine Landing Pattern

If go-around is continued:

1. **THROTTLE(S) – MAX.**

WARNING

- A single-engine go-around should be attempted only at maximum power.
- With TOF above 4.2 (gross weight 12,500 lb) single engine takeoff is not considered possible.

2. **FLAPS – 60%.**

WARNING

With other than 60% flaps, single-engine capability is impaired to such an extent that high TOF coupled with heavy gross weights may make go-around impossible.

NOTE

After flaps are set at 60%, the flap indicator should be checked to ensure flaps are 60±5%.

3. **AIRSPEED – ATTAIN FINAL APPROACH SPEED MINIMUM.**

Under most conditions, final approach airspeed will ensure excess thrust for single-engine flight.

WARNING

- Under high gross weight, high density altitude conditions with a Weapons system stowage pod (WSSP) installed, final approach airspeed may not be sufficient to permit safe gear retraction. Computed single-engine takeoff speed +10 KIAS should be used instead.
- It may be necessary to lower the nose to sacrifice altitude and perhaps allow the aircraft to settle to the runway to attain single engine takeoff speed. If the aircraft settles to the runway, lower the nose to facilitate acceleration.

4. Gear – UP (As required above final approach speed).

NOTE

If the left engine is inoperative but windmilling, gear retraction may be accomplished, but will require an extended time period; however, gear doors may not completely close. Gear retraction, when initiated between final approach speed and 190 KIAS, may require up to 1 minute.

5. Flaps – UP (As required above 190 KIAS).

NOTE

If unable to retract the landing gear, best level flight/climb capability is obtained at 190 KIAS with 60% flaps or at 220 KIAS with the flaps up. At high gross weight, with the landing gear extended, flap retraction should not be initiated prior to 220 KIAS.

NO-FLAP LANDING

If a landing is to be made with the wing flaps retracted, use the normal landing procedure modified as follows:

1. Downwind Leg – Extend.
2. Airspeed – Increase the final turn, final approach, and touchdown airspeeds by 15 KIAS.

As a guide, the no-flap landing distance is approximately 2 x (2,500 + fuel weight) past the touchdown point. Consider burning down fuel to reduce landing roll.

CAUTION

Extreme caution must be exercised when applying wheel brakes above 120 KIAS as locked wheels or tire skids are difficult to recognize. If a tire skid is detected, immediately release brakes and cautiously reapply.

NOTE

- No-flap final approach airspeeds required for fuel loads over 2,000 lb. will be in excess of that required to activate the landing gear warning system.
- A no-flap full stop landing using aerobraking to just prior to loss of elevator authority and optimum braking thereafter may double the normal landing distance.

LANDING GEAR EXTENSION FAILURE

Unsafe cockpit gear indications should not be the only factor in the determination of an unsafe gear condition. Gear position should be determined by chase aircraft, if available, or other visual means. In the absence of visual confirmation of gear position, any gear that indicates down in one or both cockpits is down and locked based upon the independent warning systems for each cockpit green light indicator. If all gear are fully down (verified by chase or other visual means) but one or more are indicating unsafe, stop straight ahead on the runway and have the gear safety pins installed.

Before attempting a landing with gear up, carefully consider whether to attempt a landing or to eject. Use the following table as a guide in determining whether a landing is feasible. Disregard gear door position.

GEAR CONDITION*		RECOMMENDED ACTION
NOSE	MAIN	
UP	BOTH DOWN	LAND
UP	BOTH UP	LAND
UP	ONE DOWN	EJECT
DOWN	BOTH UP	
DOWN	ONE DOWN	
*Actual landing gear position (not indication)		

WARNING

- Landing in lieu of ejection for gear conditions where ejection is recommended is considered more hazardous.
- Recommendation to land presupposes that a favorable runway environment exists.

NOTE

Landing with all gear up may be accomplished with a baggage pod installed.

The landing surface should be smooth and hard, i.e., no lips or joints between asphalt and concrete that could snag the pylon. Approach end arrestment cables should be removed. The aircraft should be configured with speed brakes down and full flaps.

Use normal approach speeds for all configurations. Use normal touchdown speeds for all configurations except when landing with all gear up. Minimize sink-rate at touchdown but maintain a normal landing attitude to avoid excessive “slap-down.” The procedures to be used for landing with gear extension failure are contained in the following paragraphs.

If the landing gear normal extension procedure fails to extend the gear to a down and locked position, leave the landing gear lever at LG DOWN and use the landing gear alternate extension system to extend the gear by using the following procedure:

See T-38(N)-1NS1.

NOTE

- Any combination of three green landing gear lights between the front and rear cockpit is a safe gear indication. Press to test any unlit bulbs. Burned out bulbs can be replaced with the trim light or boost pump lights (rear cockpit).
- ~~The gear handle light/gear warning tone provides an independent means to confirm gear down configuration. If the aircraft is below 181 KEAS, below 9,500 feet MSL, both throttles below 96%, and with the gear handle down, the gear should be considered down and locked if the gear handle light and warning tone are off.~~

1. Airspeed – 240 KIAS or less.
2. Flaps – As Required.
3. Gear Door Switch – OPEN.
4. Landing Gear Lever – LG DOWN.
5. Landing Gear Alternate Release Handle PULL approximately 10 inches and hold until gear unlocks; then stow handle.
6. Gear Position – Check.

Landing gear alternate extension will take approximately 15-35 seconds.

CAUTION

Stop straight ahead on the runway and have the landing gear safety pins installed prior to clearing runway.

NOTE

- Once the three landing gear position indicators indicate that all three gears are down and locked, do not further activate landing gear controls.
- After lowering the landing gear with the alternate release handle, do not attempt to reset the switches by cycling the landing gear lever. Cycling the landing gear lever may lead to further complications, particularly if the alternate release handle is not fully stowed.
- If the main gear fails to extend fully, yawing the aircraft and applying negative or positive G forces may aid in extension.
- If the landing gear has been extended by use of the landing gear alternate release handle, nose wheel steering will not be available for taxiing.

If the gear alternate extension system does not provide a safe gear indication and utility hydraulic pressure is available, use the following procedure to return utility hydraulic pressure to the landing gear system and possibly provide a safe gear indication.

7. Landing Gear Lever – LG UP (momentarily), LG DOWN.

If the landing gear still fails to extend, steps 8 and 9 below may extend the landing gear. The decision to land with the nose gear up or unsafe, all gear up, eject or continue with attempts to extend the landing gear should be carefully considered based on fuel remaining and the risk involved with these options. If a gear-up configuration is obtained and fuel is not critical, continued attempts to obtain a more favorable gear-down configuration may be warranted.

WARNING

If a main landing gear fails to extend to the locked position due to the main landing gear side brace pin backing out (verified by chase aircraft), repeated gear extension attempts may cause the pin to fall out of the side brace bellcrank.

This can cause the gear to fail to retract or extend fully, resulting in an unlandable configuration.

If an unsafe gear indication remains:

8. Landing Gear Alternate Extension – Repeat.
9. Landing Gear – Recycle.

NOTE

Repeated attempts of steps 8 and 9 have resulted in successful gear extensions. Alternate extending while yawing the aircraft and applying negative or positive G forces may aid in extension.

If unsafe gear indication remains:

10. Generators – OFF.
11. Battery – EMER.

Battery switch in EMER removes all DC power from the landing gear system.

12. Landing Gear Alternate Release Handle – pull 10 inches and hold until gear unlocks; then stow handle.
13. Battery – ON.
14. Generators – ON.
15. Gear position – Check.

If all gear remain up and locked after using both normal and emergency lowering procedures, accomplish steps 16-22, below. This procedure is only effective if all the landing gear have remained up and locked after using both normal and emergency lowering procedures. If fuel is critical, refer to Landing With All Gear Up checklist.

16. Gear Door Switch – Check OPEN.
17. Throttle (Left Engine) – OFF.
18. Control Stick – Rapid lateral stick movements to deplete utility hydraulic pressure.
19. Landing Gear Lever – LG Down.
20. Landing Gear Alternate Release Handle – pull approximately 10 inches while pressure is deleted and hold until gear unlocks; then stow handle.
21. Gear Position – Check; if indications are still unsafe, landing gear lever LG UP, then LG DOWN.
22. Left Engine – Restart.

LANDING WITH NOSE GEAR UP OR UNSAFE

1. Cabin Pressure Switch – RAM DUMP.
2. Shoulder Harness – LOCK
3. Wing Flaps – FULL DOWN.
4. Landing Pattern – Normal.
5. Throttles – IDLE at touchdown.
6. Nose – Gently lower to runway.
7. If nose gear is up, throttles – OFF, when nose touches runway.
8. Wheel Brakes – As Required.

NOTE

Do not use brakes if a safe stop can be made without them when the nose gear is down but indicating unsafe.

If the nose gear is down with an unsafe indication, leave the left engine running until gear is pinned. Utility hydraulic pressure may keep the gear from collapsing.

9. Battery Switch – OFF.

LANDING WITH ALL GEAR UP

This procedure should be used only under favorable conditions of the runway environment. Burn down excess fuel prior to landing.

1. Gear – UP.
2. Cabin Pressure Switch – RAM DUMP.
3. Shoulder Harness – LOCK.
4. Speed Brake – Open.

NOTE

After landing, the speed brake may grind down beyond the actuator attach point. When this occurs, expect the nose to drop suddenly accompanied by increased noise, vibration, and deceleration.

5. Wing Flaps – Full Down. Fly a power on approach requiring minimum flare.
6. Landing Pattern – Normal. Plan to touchdown at 10 knots above normal touchdown speed.
7. Throttles – OFF at touchdown.
8. Battery Switch – OFF.

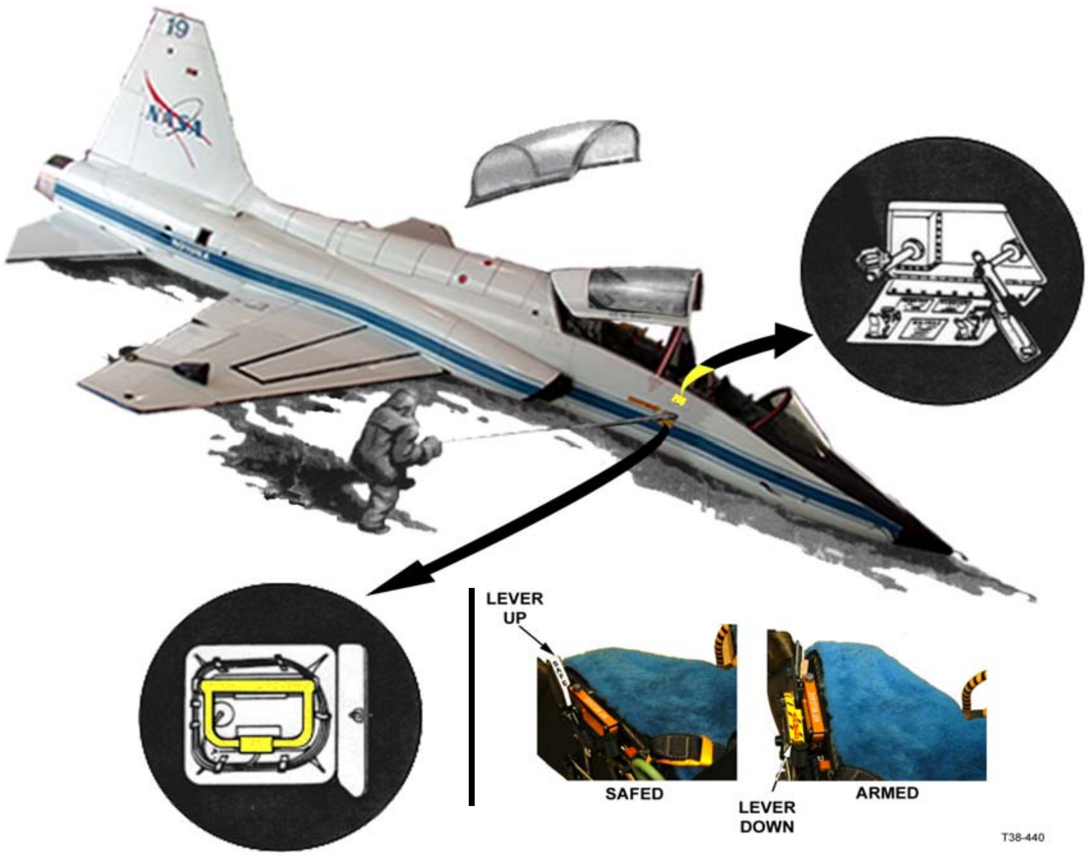
LANDING WITH BLOWN TIRE, LOCKED BRAKE, OR DIRECTIONAL CONTROL DIFFICULTY

The aircraft may be safely landed with a blown tire, locked brake, or similar directional control difficulty. Plan to land at minimum gross weight unless landing sooner is necessitated. Go-around after touchdown on a blown tire or locked brake should be avoided as rubber or other debris may be ingested by the engines. When it has been determined that a main gear tire has blown or a brake is locked, land on the side of the runway away from the malfunction. Make maximum use of rudder and wheel braking to maintain directional control. Nosewheel steering should be engaged only as a final attempt to maintain or regain directional control.

WARNING

If one brake system fails or failure is suspected, with no other directional control problems such as a blown tire or locked brake, plan to land in the center of the runway. Stop the aircraft by using aerodynamic braking followed by a combination of wheel brake and nose wheel steering. Rudder pedals should be neutralized prior to engaging the nose wheel steering to prevent violent swerving and possible loss of directional control.

EMERGENCY ENTRANCE



NORMAL ENTRANCE
(LEFT SIDE OF FUSELAGE)

1. PUSH TWO LATCHES TO OPEN DOOR.
2. PULL HANDLE (OR HANDLES) OUT UNTIL ENGAGED.

NOTE

A moderate force is required to rotate handles.

3. ROTATE HANDLE (OR HANDLES) FULLY CLOCKWISE TO UNLOCK AND RAISE CANOPY TO FULL OPEN.

CANOPY JETTISON ENTRANCE
(EITHER SIDE OF FUSELAGE)

WARNING

Do not use this method when residual fuel is around cockpit area.

1. PUSH LATCH TO OPEN DOOR.
2. PULL D-HANDLE OUT TO FULL LENGTH (APPROXIMATELY 6 FEET).

NOTE

Both canopies are jettisoned when emergency D-handle is pulled.

IF UNABLE TO OPEN CANOPY

BREAK CANOPY BEHIND PILOT/ AIRCREW WITH AX OR SIMILAR IMPLEMENT.

NOTE

Spraying canopy with CO_2 will cause the glass to become brittle and easy to break.

AFTER ACCESS TO COCKPIT IS GAINED

WARNING

Inadvertent seat jettison is possible if seat firing handle is raised.

1. SAFE/ARM HANDLE – SAFE.
2. TIME PERMITTING, SEAT/CANOPY SAFING PINS – INSTALL.

Figure 3-12. Emergency Entrance

AUXILIARY EQUIPMENT

SECTION IV

TABLE OF CONTENTS

CABIN AIR CONDITIONING AND PRESSURIZATION SYSTEM

A diagram of the cabin air conditioning and pressurization system is shown in Figure 4-2. The system provides pressurized air to support cabin pressure, canopy seal, canopy defog, and cabin air conditioning operations. The system uses eighth stage compressor bleed air from the engine. A ram air heat exchanger cools a portion of the bleed air. Some of the cooled air is mixed with the hot bleed air to provide air to the canopy defog; the temperature of the defog air is automatically controlled between 200°F and 280°F. Some of the cooled air is used for the canopy seals. The remainder of the cooled air is routed through a cooling turbine to provide refrigerated air to the cabin air conditioning system. A water separator removes excess moisture from the refrigerated air. Pilot selection of the air conditioning system controls mixes the hot engine compressor bleed air with the refrigerated air to provide the desired cockpit temperature. All controls in the air conditioning and pressurization system, except the canopy defog, are electrically [alternating current (AC)] controlled. The canopy defog is pneumatically controlled and does not require AC power.

CABIN PRESSURE REGULATOR

A cabin pressure regulator maintains cabin pressure below 25,000 feet through the entire operational flight envelope. A cabin altimeter on the instrument panel of the front cockpit (Figure 1-7) indicates the pressure altitude within the cabin. This is also displayed on the Altitude Alerter in both cockpits. Refer to Figure 4-1 for cabin pressurization schedule.

CABIN PRESSURE SWITCH

A guarded cabin pressure switch (Figure 4-2) is located on the right subpanel of the front cockpit. The switch controls cabin air conditioning and pressurization. When the switch is placed in the CABIN PRESS position, both the cabin air conditioning and pressurization systems are activated. When the cabin pressure switch is placed in the RAM DUMP position, canopy defog, cabin pressurization and air conditioning systems, and canopy seal are deactivated, and ram air enters the cabin for ventilating purposes. Placing the cabin pressure switch in the RAM DUMP position does not deflate the canopy seal, but prevents airflow into the seal. The seal will remain inflated for an indefinite amount of time. Normal seal deflation is provided by an AC switch activated by opening the canopy-locking lever, provided AC power is available.

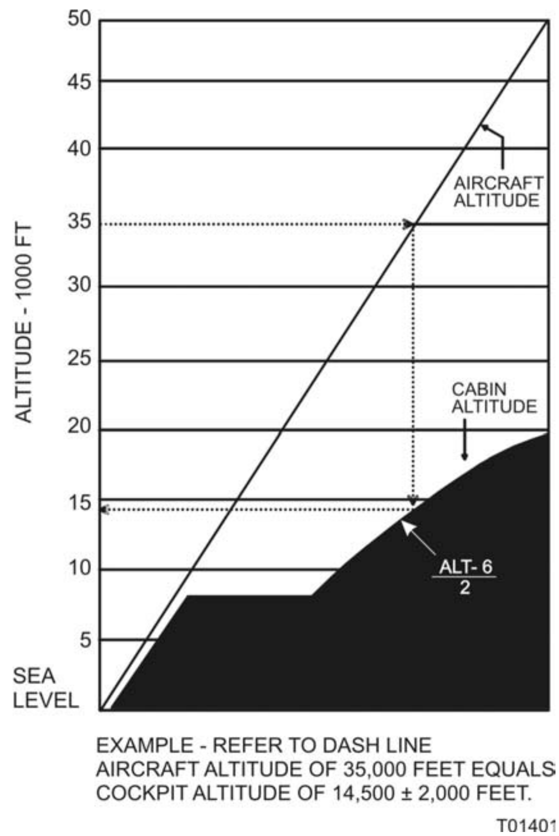


Figure 4-1. Cabin Pressurization Schedule

CAUTION

Vibrations accompanied by fumes and/or odors from the air conditioning system may indicate air conditioner turbine failure. If this condition is suspected, select oxygen – 100%, descend below FL250, and select RAM DUMP to deactivate the air conditioning system. This should stop the vibrations.

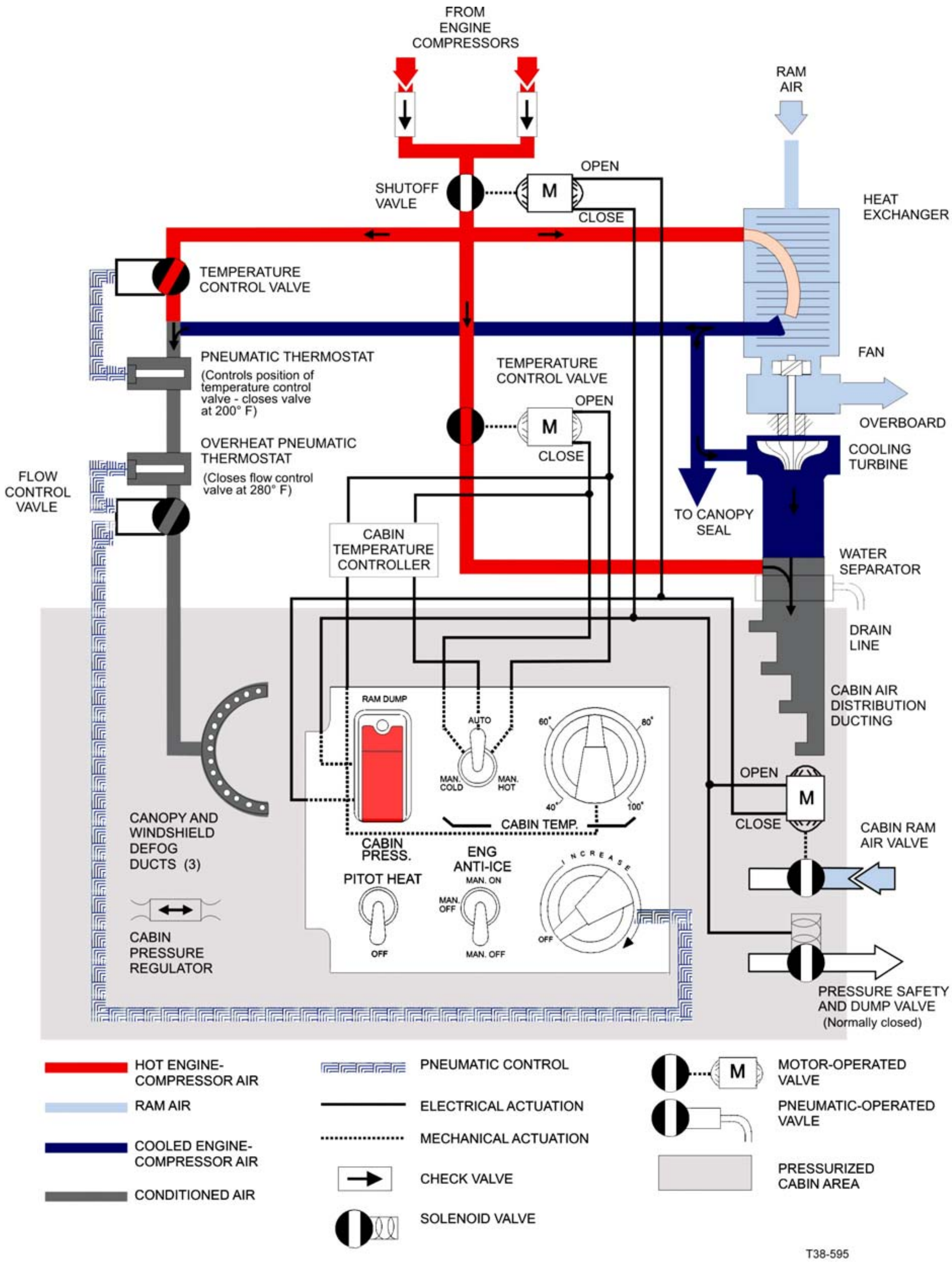


Figure 4-2. Cabin Air Conditioning and Pressurization System

CABIN AIR TEMPERATURE SWITCH AND CABIN TEMPERATURE CONTROL KNOB

A cabin air temperature switch (Figure 4-2) is located on the right subpanel of the front cockpit. In AUTO, the cabin temperature controller automatically positions the temperature control valve to adjust the cabin temperature to the setting selected by the pilot on the cabin temperature control knob. The MAN HOT and MAN COLD positions provide for manual temperature control when the automatic temperature control system fails. Holding the switch in the desired position manually moves the temperature control valve to adjust cabin temperature.

NOTE

- When controlling temperature manually, momentarily stop the switch at the center position before going to the desired position.
- To eliminate cabin air conditioning duct “howl” with the rear cockpit cabin air inlet valve closed, adjust either the front cockpit cabin air inlet valve toward the closed position or the rear cockpit cabin air inlet valve toward the open position.

When operating under high humidity conditions, the water separator in the air conditioning system may not remove all the moisture from the refrigerated air. This will result in water or ice pellets coming out of the air conditioning vents. This excess moisture can be eliminated by turning the cabin temperature control knob to full hot (100°F) until the vent output is dry then returning the temperature control knob to the desired temperature setting. This technique may have to be repeated if flight in high humidity conditions is continued.

CANOPY DEFOG KNOB

The flow of defog air to the windshield and both canopies is controlled by the canopy defog knob in the front cockpit (Figure 4-2).

ENGINE ANTI-ICE SYSTEM

Engine anti-icing is accomplished by directing compressor eighth-stage air to the inlet guide vanes and bullet nose of the engine. A normally closed shutoff valve is controlled electrically by a three-position engine anti-ice switch (Figure 4-2) on the right subpanel of the front cockpit. The switch positions are placarded MAN ON in the up position and MAN OFF in the center and down positions. Placing the switch at MAN ON allows hot air to flow to the inlet guide vanes and bullet nose of the engine and causes the ENG ANTI-ICE ON light on the caution light panel and the MASTER CAUTION light in each cockpit to illuminate.

The caution light alerts the crewmember that the switch is in the MAN ON position but does not indicate that the system is operating. At engine speeds of 94% to 98% rotations per minute (RPM), an increase in Exhaust Gas Temperature (EGT) of approximately 15 degrees Celsius (C) is normal with the switch at MAN ON. The engine anti-ice system fails to the ON position with a complete loss of AC electrical power. Below 65% RPM, the anti-ice valve is always open, allowing hot air to flow to the inlet guide vanes and bullet nose of the engine, regardless of the position of the engine anti-ice switch. The switch should normally be at MAN OFF. A 9 percent loss in MIL thrust and a 6.5 percent loss in MAX thrust can be expected with the engine anti-ice switch on.

PITOT-STATIC PROBE ANTI-ICING

The pitot probes are protected against icing or can be de-iced (for light accumulations) by an electrical heating system powered by the right AC bus. The heaters are controlled by the pitot heat switch (Figure 4-2) on the right subpanel in the front cockpit. Placing this switch to the up position (placarded PITOT HEAT) turns on the pitot probe's heaters. This switch also activates the Angle-of-Attack (AOA) vane heater and the static air temperature probe heater.

AOA VANE ANTI-ICING

The vane of the AOA transmitter is protected against icing or can be de-iced (for light accumulations) by an electric heating element powered by the left AC bus and activated when the pitot heat switch is turned on.

AIR TEMPERATURE PROBE ANTI-ICING

The air temperature probe is protected against icing or can be de-iced (for light accumulations) by an electric heating element powered by the left AC bus and activated when the pitot heat switch is turned on.

NOTE

> The air temperature readout on the altitude alerter is accurate only while airborne with the pitot heat on.

PITOT HEAT OFF Caution Light

Operation of the heating elements that perform anti-icing functions for the air temperature probe, pitot static probes, and AOA vane is monitored by circuitry that senses an inoperative condition. If the pitot heat switch is off or inoperative, or if any one of the heating elements fails to conduct, the PITOT HEAT OFF annunciator on the caution panel in the right console of each cockpit will illuminate.

COMMUNICATION AND NAVIGATION EQUIPMENT

Communication and navigation equipment installed in the aircraft is listed in Table 4-1. Refer to Figure 1-14 for electrical power requirements to operate the communication and navigation equipment.

RADIO MANAGEMENT SYSTEM

Operation of the Communications, Navigation, and Identification (CNI) transceivers in the T-38N is accomplished through the Radio Management System (RMS). The RMS consists of a control box (generally referred to as the RMS) in the center pedestal of each cockpit with a 1-1/2 X 3-5/8 inch green monochrome cathode ray tube (CRT) digital display, two digital data adapters, and a configuration module. The RMS and the CNI transceivers are powered by the 28 volts direct current (VDC) bus. The RMS is hot (on) any time 28 VDC external or 24-volt battery power is applied to the aircraft. The front and rear cockpit control boxes have identical capabilities and display identical data. Inputs to either RMS are simultaneously displayed on the other CRT with the exception of transponder codes. There is a 4-second delay before a new code appears on the other CRT. The RMS incorporates control of the following CNI components:

- Very High Frequency (VHF) Communication
- Ultra High Frequency (UHF) Communications

Table 4-1. Communication and Navigation Equipment

TYPE	DESTINATION	USE	OPERATOR	RANGE	CONTROL LOCATION
INTERCOM	AN/AIC-18	Crew intercommunication; flight crew and ground personnel intercommunication when aircraft is parked.	Both crew-members. (ground crew)	Either cockpit and exterior when ground receptacle is used.	Audio Panel
UHF RADIO	AN/ARC 164 (with mod)	Air-to-air and air-to-ground communication.	Both crewmembers.	Line of sight.	RMS, audio panel, and right throttle.
VHF RADIO	VCS-40	Air-to-air and air-to-ground communication.	Both crewmembers.	Line of sight.	RMS, audio panel, and control stick.
TACAN/DME	ARN 154 (with mod)	Bearing and range information from ground station; FMS present position source.	Both crewmembers.	Line of sight; DME – up to 389 NM.	RMS and audio panel.
VOR/ILS	VNS-41	Bearing, vertical and/or horizontal guidance during approach, and marker beacon signals.	Both crewmembers.	VOR-line of sight. Localizer – 85 NM. Glide slope – 35 NM. Marker beacon – overhead.	RMS and audio panel.
DME	KDM 706	Range from VOR/DME Station only.	Both crewmembers via VOR.	Line of sight up to 389 NM.	RMS
IFF	MST 67A	Automatic and manual replies to ground interrogation for aircraft identification and air traffic control.	Both crewmembers.	Line of sight.	RMS

- Transponder with altitude reporting
- Tactical Air Command and Navigation (TACAN)
- VHF Omnidirectional Radio Range (VOR) Navigation/Instrument Landing System (ILS)
- Distance Measuring Equipment (DME)

The RMS provides the capability for either crewmember to select a maximum of 20 preset VHF or 20 UHF communications frequencies, up to 10 preset TACAN channels, and up to 10 VOR/ILS frequencies. The presets can be changed or reordered by the crew whenever power is on. Crewmembers can also manually tune primary and standby VHF and UHF communications frequencies, transponder codes (with or without altitude reporting), TACAN channels (X or Y), and VOR/ILS frequencies. A DME Hold capability makes it possible to maintain VOR DME during an ILS approach. In the event of some RMS system or certain Direct Current (DC) bus failures, separate backup VHF com and VOR nav control heads located in the front cockpit beside the RMS. The backup VHF com head is operational on the DC emergency bus.

AUDIO CONTROL PANEL

The audio control panel (Figure 4-3), located under the RMS in each cockpit, contains the volume control knobs for the following components:

- UHF Communications
- VOR/ILS
- Marker Beacon
- TACAN
- Intercom System (ICS)
- VOX

Figure 4-3. Audio Control Panel

Each volume control knob incorporates an on/off capability for that system's volume. Both ICS volume control knobs are functional if either one (or both) ICS knobs are pulled out. Volume controls for the other transceivers are functional only after the applicable volume control knob in that cockpit is pulled out. Rotation of the knobs clockwise increases the volume and counter clockwise rotation decreases it. Voice operated transmitter (VOX) circuitry permits "hot mic" type ICS communications without constant ambient noise. The VOX sensitivity may be set in each cockpit to permit intercommunications whenever a crewmember speaks. VOX is selected by pulling the VOX knob out and adjusting it clockwise to increase VOX threshold (crew must talk louder to activate mic). Full counter clockwise rotation overrides VOX (hot mic).

RMS PRE-FLIGHT TEST

When external or battery power is turned on, the RMS begins a brief warmup period in conjunction with the initiation of a pre-flight test (PFT). The PFT display will appear a few seconds after power is applied at near maximum CRT brightness. The test should last about 20 seconds, up to 60 seconds if numerous failures are detected. If no failures are detected, the PFT page will be replaced after 5 seconds by the normal operating page. Either crewmember can also press the Transfer switch adjacent to the RETURN callout to immediately switch to the normal operating page. If failures are identified during the PFT, a crewmember must press the Field switch (rectangle symbol) adjacent to the ACCEPT cue to advance to the normal operating page. Even though failures are detected by the PFT, the RMS and its associated com/nav equipment may be partially or even fully operational.

WARNING

Annunciation of a fault message may indicate a subtle error with a com/nav system that makes it unreliable for Instrument Flight Rules (IFR) operations.

NORMAL OPERATING PAGE, TUNING KNOBS

The normal operating page is the default display for the RMS (Figure 4-4). It displays all five of the CNI capabilities of the RMS with a rectangular cursor outlining the standby VHF frequency. The RMS will default to this configuration 20 seconds after the last input to any CNI system on the normal page display. The rectangular cursor indicates the data that can be changed with the tuning and data entry knobs. The cursor is moved to another field (CNI system) by pressing the square symbol field switch to the left of the desired field. When the cursor is outlining the desired standby frequency, the concentric tuning and data entry knobs are rotated to change the data. Turning the knobs clockwise increases the applicable data to its upper limit and then rolls over to the lower limit. The reverse is true when turning the knobs counter clockwise. The large (outer) knob makes coarse adjustments and the small inner knob makes fine changes. The small inner knob

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Figure 4-4. RMS Normal Operating Page

may also be pulled out to change the UHF frequency numbers to the right of the decimal point and to toggle between TACAN X and Y channels. Table 4-2 shows the specific numbers changed (shaded) by each knob for the sample frequencies/data.

Table 4-2. Tuning Knob Fields

	Large Knob	Small Knob	Small Knob Pulled Out
VHF Com/Nav	122.50	122.50	N/A
UHF Nav	255.50	255.50	255.50
Transponder	4767	4767	N/A
TACAN	110X	110X	110X
Memory Preset	4	Same as Large Knob	N/A

The tuning knobs are also used in conjunction with the DIM button to adjust the brightness of the RMS display. When DC power is supplied to the aircraft, the RMS display comes on at near maximum brightness. The intensity may then be changed by first pressing the DIM button. The word “DIM” appears in the middle of the RMS display with a rectangular cursor around it. Turning the large tuning knob clockwise increases the display brightness and counter clockwise rotation decreases it. The large knob requires 16 clicks to take the display from minimum to maximum brightness. The small knob operates in the same fashion, except 100 clicks of clockwise rotation are required to go from minimum to maximum brightness. When either extreme is achieved, the intensity remains unchanged with further knob rotation until the direction is reversed. The intensity may also be increased gradually by holding the DIM button “in” until the desired brightness is achieved.

FIELD AND TRANSFER SWITCHES, MANUAL DATA ENTRY

Data is changed by first moving the cursor to the standby frequency in the desired field with the applicable field switch. The desired frequency/channel can then be selected by rotation of the tuning knobs. After data is entered into the standby com/nav display, pressing the diamond symbol transfer switch to the right of that field toggles the standby and primary frequency/channel. Data can also be entered directly into the active com/nav field by moving the cursor to the desired field and pressing and holding the transfer switch “in” for 3 seconds. The cursor will highlight the active frequency/channel and the standby data will disappear. (The direct mode can be selected for a field without first moving the cursor to that field, but no data can be altered until the cursor is positioned over the display.) In the direct mode, rotation of the tuning knobs will change the active frequency/channel. The RMS will remain in the direct tune mode (standby field will remain blank) until the transfer switch for that field is pressed. Pressing and holding the transponder field switch "in" for 3 seconds will cause the special Visual Flight Rules (VFR) code selected on the transponder special function page (nominally 1200) to replace the existing code. Twenty seconds after the last tuning knob or switch operation, the cursor will return to the VHF standby frequency if it is present (non direct tuning mode). A dashed line in a com/nav frequency field indicates a problem with that radio or frequency. (This will occur with the VHF radio when the aircraft is on ground power and the battery is in the OFF position.) A MSG cue will also be present in the VHF com field if a dashed line appears in a field. (See subsequent discussion of PAGE function switch to review fault message.) If an attempt is made to load a frequency/channel into a dashed line, the RMS will initially display the selected data and then return to the dashed line if the problem still exists.

NOTE

- If the VHF or VOR field shows a Remote (RMT) display, it is an indication that the backup VHF or VOR control head is on.
- Occasionally, the UHF radio will power up in HAVE QUICK mode, denoted by an "A" in the hundreds digit of both the standby and active frequencies. This mode can be removed by pressing and holding the UHF field select switch for 3 seconds.

MEMORY (PRESET) DATA ENTRY, MEMORY FUNCTION SWITCH

Preset com/nav frequencies/channels are accessed by moving the cursor to the appropriate com/nav field then pressing the MEM function switch (Figure 4-5). The last preset channel used appears inside the cursor with the letter M and the applicable preset frequency/channel appears in the standby display. Pressing that field's transfer switch toggles the preset frequency into the active frequency.

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Figure 4-5. RMS Normal Operating Page – Memory

Until either tuning knob is rotated, the same frequency/channel will now appear in both the standby and active displays for that field.

Subsequent tuning knob rotation will cause the memory number and corresponding standby frequency/channel to change, leaving the active display unchanged. Preset frequencies/channels can also be input directly into the active position by first accessing the memory function as indicated and then pressing and holding the transfer switch “in” for 3 seconds. The cursor will highlight the memory channel as before and the applicable preset frequency/channel will be displayed as active. The standby frequency/channel will not be displayed. Rotation of either tuning knob will change the active preset frequency/channel directly.

To deselect the memory function (when not in direct tuning mode), move the cursor to the applicable field with the field switch and press MEM. The standby and active frequency/channel display will return with the cursor on the standby display. If the direct memory-tuning mode is in operation, the memory feature is deselected in the same manner but that transceiver will remain in the direct tuning mode (no standby data in that field). Select the direct tuning mode by pressing the transfer switch for that field. Twenty seconds after the last input to any field, the cursor will return to the VHF standby frequency if VHF com is not in a direct tuning mode.

TRANSPONDER AND TACAN MODE SWITCHES

The transponder and TACAN fields of the RMS each have a square symbol mode switch on the right side of the RMS. Pressing the transponder mode switch toggles it between its three modes in this order: standby (STBY), on (ON), and on with altitude reporting (ALT). The transponder does not transmit with weight on the landing gear even though ON or ALT is displayed. The mode switch associated with the TACAN toggles between its two modes in the following order: standby (STBY) and air-to-ground (A/G). The A/G mode is required for nominal TACAN operations.

NOTE

> RMS TACAN must be in A/G for the FMS to tune TACAN stations.

PAGE, SQ, DMEH, IDT, AND M/B FUNCTION SWITCHES

The RMS also provides five other function switches in addition to the MEM and DIM switches previously addressed. The PAGE switch permits access to CNI status messages generated by the RMS and additional special data pages. When the MSG prompt appears in the VHF com field, the RMS has detected an error in a component or frequency/channel. A dashed line will appear in the area normally displaying a frequency/channel if the transceiver fails to tune. To view a message relevant to the field with a dashed line, move the cursor to that field with the field select switch and press the PAGE switch. The page will indicate the detected fault and the appropriate action the crew should take. The actions are limited to checking the Morse code ident for nav radios or using the applicable system with caution. Pressing the transfer switch next to the RETURN cue will result in a return to the normal operating page. It is also possible to view a fault message without moving the cursor to a particular field. In this situation, press the PAGE switch with the cursor in any field. A blank diagnostic page will appear if there are no problems in the field where the cursor was located. Pressing the field switch adjacent to the RECALL prompt will cause the diagnostic page associated with the MSG to appear.

WARNING

Annunciation of a fault message may indicate a subtle error with a com/nav system that makes it unreliable for IFR operations.

The PAGE switch is also used to select special function pages of each CNI system. To access these pages, move the cursor to the desired field and press the PAGE switch twice. The first press selects the diagnostic page for that system (even if there are no errors). The second press of the switch brings up page #1 of that CNI system's special function pages. The number of each special function page will appear in the upper right corner adjacent to the uppermost transfer switch. Move the rectangular cursor to the page prompt with the upper right transfer switch and rotate either tuning knob clockwise (or counter clockwise) to view additional pages in ascending (or descending) order in a continuous loop.

NOTE

If the RMS has detected a system error (MSG cue), pressing the PAGE switch will bring up the RMS CNI status page. The page will list the system error(s) if the CNI field selected (cursor position) has system error(s). The status page will be blank if no errors exist with the CNI system selected. Pressing the PAGE switch once more will bring up the selected system's special function page.

The memory programming special function pages permit adding, deleting, or changing the order of preset channels/frequencies. The VHF MEMORY page is shown in Figure 4-6. Memory pages for the other systems (UHF, TACAN, and VOR) are similar to the sample VHF page. Channels/frequencies associated with memory (preset) numbers can be changed by moving the cursor to the channel/frequency with the field switch and changing the numbers with the tuning knobs as previously discussed. When the desired channel/frequency is reached, the transfer switch adjacent to the ACCEPT prompt is pressed to program the change. If this switch is not pressed, the previously stored number will return when the cursor is moved. If the transfer switch adjacent to the INSERT prompt is pressed after a new channel/frequency is selected, the new data will be inserted at the selected memory location causing the previous

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Figure 4-6. RMS Special Function Page VHF Memory

channel/frequency and all subsequent ones to roll to the next memory location. If all 20 com or 10 nav memory locations are full, data in the last position is deleted and will be lost if ACCEPT is selected.

The UHF radio's first special function page (Figure 4-7) has several options related to the emergency (Guard) frequency. Pressing the field switch next to the GUARD prompt toggles the main UHF radio between the selected frequency and 243.00 Mhz. Pressing the upper left field switch adjacent to the UHF MODE cue will toggle the radio between MAIN (main receiver only) and BOTH (main and guard receiver). The PAGE switch or the transfer switch next to the RETURN cue must be pressed to return to the normal operating page.

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Figure 4-7. RMS UHF Special Function Page

NOTE

> Pressing the field switch next to the TONE prompt will transmit a 1 Khz tone on the active UHF frequency for as long as the switch is held in. The TX cue will appear for the duration of the tone. The WB/NB selection should always be WB to permit optimum UHF tuning.

The transponder also has a special function page for verifying/changing the Special VFR code (1200). Although this code can be changed, 1200 is the nominal code. The transponder special function page is selected by moving the cursor to the transponder field and pressing the PAGE button until the special function page appears. The VFR code is changed by turning the tuning and data entry knobs. The RMS normal page is accessed by pushing the transfer switch next to the RETURN cue.

The SQ (squelch) switch can be used to provide an audio input for com radio volume adjustment. Move the cursor to the desired com field with a field switch and press the SQ switch. The SQ display will appear in the lower right portion of that field indicating the squelch of that communications transceiver is off. The audio produced may be used to verify and adjust com volume. If a transmission is made with squelch selected, the SQ prompt will be replaced during the time the mic is keyed with a TX display. Pressing SQ again will cause the receiver's squelch to be off and the SQ prompt will disappear.

The DMEH (DME Hold) switch provides the capability for the crew to hold the DME on one nav station before selecting a new nav source. This is particularly useful on a Localizer/ILS approach that does not have an associated DME. The DME can then be held on the approach (or other nearby) VOR before selecting the Localizer/ ILS frequency. When DMEH is selected, DME HOLD is displayed in the VOR field.

The IDT (identify position) switch provides an ident capability in addition to the I/P push button on each control stick. When the RMS or control stick ident buttons are pressed, the IDT prompt is displayed for approximately 25 seconds while the transponder transmits. The transponder continues to ident for approximately 20 seconds after the IDT prompt disappears.

The M/B (Main/Both) switch permits the crew to quickly select reception of only the main UHF radio receiver or the main and guard receivers without having to call up the UHF special function page. When only the main UHF receiver is being monitored, the word MAIN is displayed in the UHF field. When both main and guard receivers are being monitored, the word BOTH will appear below MAIN. This feature is selectable with all UHF operating modes (direct and memory).

INTERCOM AND RADIO OPERATIONS

The T-38N intercom is powered from the emergency 28-volt DC bus and is hot anytime either (or both) cockpit volume control knobs are pulled out. There is no requirement to activate a microphone switch. The intercom should be "on"(hot mic or VOX) during takeoff, landing, and any other time crew immediate communications are critical.

VHF radio transmissions are initiated by pressing down on the red microphone pushbutton (labeled VHF) located on the left center of each control stick. Both buttons are hot whenever the RMS or com backup control head is operational.

UHF radio transmissions are initiated by pressing in on the UHF microphone button (labeled AUDIO) located on the right side of each right engine throttle just below the speed brake switch. Both buttons are hot anytime the RMS is operational.

BACKUP CONTROL HEADS

In the event of an RMS failure, VHF communications and navigation may be regained from the 28 Volt DC bus with the backup com and nav control heads located in the front cockpit beside the RMS. The backup control heads operate the same VHF transceivers controlled by the RMS. In the event of a dual transformer-rectifier failure, only the backup VHF com control head will remain operational from the emergency bus.

BACKUP COMMUNICATIONS CONTROL HEAD

The backup VHF communications control head (Figure 4-8) displays VHF com frequencies on a 1-3/4 X 5/8 inch liquid crystal display (LCD). The backup control head is powered by the DC emergency bus. The controls consist of a three-position power knob, two tuning knobs, and a transfer switch. When the power knob is rotated from OFF to ON, the LCD readout appears within 2 seconds, displaying the last active and standby frequencies selected on the backup control head when power was last removed.

Figure 4-8. Backup VHF COMM Control Head

The tuning knobs are turned clockwise to increase the numbers and counter clockwise to decrease them. The knobs operate in a loop such that all of the numbers can be accessed by turning the knobs in either direction. The large knob changes the numbers on the left of the decimal (coarse), while the small knob changes the numbers on the right of it (fine). In normal use, the standby (lower) frequency is changed using the tuning knobs and then is toggled to the active (upper) position with the transfer switch (back to back arrow symbol). An ACT (active) cue is displayed in the upper left of the LCD next to the active frequency.

The active frequency may be changed directly by pressing and holding the transfer switch "in" until the standby frequency disappears (about 2 seconds). Rotation of the tuning knobs will then change the active frequency directly. The control head will remain in this configuration until the transfer switch is pressed and held "in" for an additional 2 seconds. If the transfer switch is held in for about 7 seconds, the control head will automatically select the VHF Guard frequency of 121.5 Mhz for the active frequency. The TST (test) position is used to open the squelch for audio verification. During radio transmissions, a TX cue will appear on the left side of the LCD. A FAIL 1 message in the standby frequency field indicates a radio failure. A FAIL 2 message in the lower field should appear only during transmissions to indicate a transmitter failure. Record the number for maintenance and the conditions when it was annunciated. Turning the control head off will leave the last standby and active frequencies set in non-volatile memory.

NOTE

- In the event of loss of the LCD display, the crew can still use the backup control head by holding the transfer switch in for 7 seconds (which selects the VHF guard frequency) and mentally keeping track of the number of rotations of the knobs.
- Use of the VHF backup control head with an operational RMS will cause the VHF radio portion of the RMS to display an RMT message and the frequency selected on the backup control head. VHF frequency selection from the RMS will be inhibited.

BACKUP NAVIGATION CONTROL HEAD

The backup navigation control head (Figure 4-9) displays VHF nav data on a 1-3/4 X 5/8-inch LCD. The controls consist of a four-position power/function knob, a transfer pushbutton, and two tuning knobs. When the power knob is rotated to the ON position, the LCD readout appears within 2 seconds displaying the last active and standby

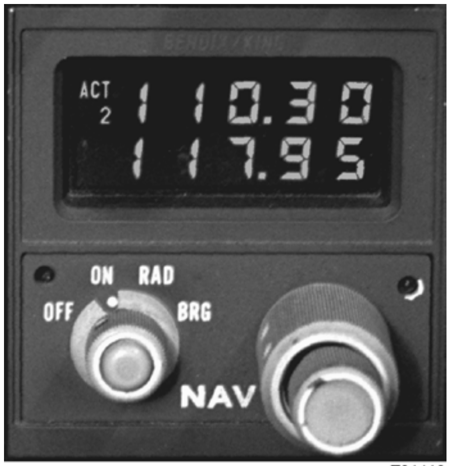

Figure 4-9. Backup VHF NAV Control Head

frequencies selected on the backup prior to power being removed. Rotation of the tuning knobs clockwise or counter clockwise increases or decreases the numbers, respectively, in a continuous loop. The large knob changes the numbers on the left of the decimal (coarse) while the small knob changes the numbers on the right (fine). With both frequencies displayed (power knob in the ON position), rotation of the tuning knobs changes the standby frequency only. The standby and active frequencies are toggled by pressing the transfer pushbutton located in the middle of the power knob. Pressing the transfer button in for 7 seconds tunes the receiver to 108.00 megahertz (Mhz).

When RAD (radial) is selected on the power knob, the active frequency remains in the upper LCD field and a digital readout of the radial from the selected nav station is displayed in the bottom field. With the power knob in the BRG (bearing) position, the magnetic bearing to the active station is displayed in the lower LCD field. With RAD or BRG selected, rotation of the tuning knobs changes the active frequency. If the active frequency selected is a localizer or ILS, the LOC cue will appear in the lower LCD field. An ACT (active) cue appears in the upper left of the display beside the active frequency. A dashed line in the lower field with RAD or BRG selected indicates station passage or insufficient signal. Failures within the backup control head will result in a FAIL message followed by a number (1-4). Record the number for maintenance and the conditions when it was annunciated. Turning the control head off will leave the last standby and active frequencies set in non-volatile memory.

NOTE

- In the event of loss of the LCD display, the crew can still use the backup control head by holding the transfer switch in for 7 seconds (which selects the VOR frequency 108.00) and mentally keeping track of the number of rotations of the knobs.
- Use of the VOR backup control head with an operational RMS will cause the VOR nav portion of the RMS to display an RMT message and the frequency selected on the backup control head. VOR frequency selection from the RMS will be inhibited.

ELECTRONIC FLIGHT INSTRUMENTATION SYSTEM

Electronic Flight Instrumentation System (EFIS) equipment on the instrument panel in each cockpit consists of a 5-inch electronic attitude director indicator (ADI), a 5-inch electronic horizontal situation indicator (HSI), an HSI control panel, ADI pushbuttons/indicators (PBIs), and forward/aft command and symbol generator 1/2 PBIs. A guarded EFIS CRT switch (Figure 4-10) is located aft on the front cockpit left console. Closing the

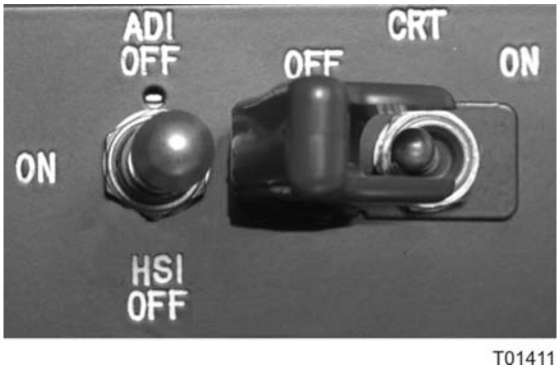

Figure 4-10. EFIS Power Switch

guard positions the power switch to ON. Adjacent to the EFIS CRT switch is a three-position toggle for the rear cockpit ADI and HSI. Both are nominally powered (ON) and either display may be turned off for instrument training.

Two symbol generators and associated switching equipment located in the aircraft avionics bay support EFIS operation. The symbol generators (a primary and a backup) drive the HSI and ADI and serve as sensor integrators for the EFIS. Information is provided to the EFIS from the flight director computer, weather radar, Inertial Reference System (IRS), and flight management system (FMS) for display on the HSI and ADI.

EFIS PUSH BUTTON INDICATORS

FWD/AFT PBI

The FWD/AFT Push Button Indicators (PBIs) transfer control of the ADI PBIs (see Figure 4-12), the SG1/SG2 PBI, and weather radar antenna tilt control between the cockpits. Illumination of the FWD or AFT legend on the button indicates which crewmember has control. The PBI may be used to take or give control.

Symbol Generator PBI

The symbol generator button selects symbol generator 1 (SG 1 – primary) or identical symbol generator 2 (SG 2 – backup) to drive the HSI and ADI displays. The SG 1 or SG 2 legend on the PBI illuminates to indicate which symbol generator is selected. Only the cockpit with command (FWD/AFT PBI illuminated) may change symbol generators. When SG 2 is selected, the SG 2 legend appears in yellow on the ADI and HSI.

CAUTION

In event of failure of the selected symbol generator, the other symbol generator must be manually selected.

HSI CONTROL PANEL

The HSI control panel buttons are provided to select HSI operating modes and displays. HSI control panel buttons are "hot" in both cockpits (unaffected by FWD/AFT PBI). Button activation in either cockpit changes both cockpits' displays. The controls are shown in Figure 4-11 and are described in the following paragraphs.

Figure 4-11. HSI Control Panel

TST/REF Button

The TST/REF button has two separate functions. It initiates the HSI self test and establishes the NAV map format.

SELF TEST

The HSI self test is initiated by pressing and holding the TST/REF button "in" for 3 seconds. A test pattern is displayed and the words SELF TEST PASS or SELF

TEST FAIL appear in the center of the test pattern. The self test display remains until the TST/REF button is momentarily pressed again.

NAV MAP FORMAT

When a NAV map mode is selected, the TST/REF button enables selection of the desired map format. Momentarily pressing the TST/REF button identifies the selected format on the display for 10 seconds. Repeatedly pressing the TST/REF button sequences through the 3 map formats. The identification of the selected format disappears from the display approximately 10 seconds after the TST/REF button is last pressed. The available map formats are selectable in the following order:

- FPL ID – Flight plan with full International Civil Aviation Organization (ICAO) identifiers.
- AIRPORT – Flight plan and airports with ICAO identifiers.

NOTE

Depicted airports have 7,000 feet of hard-surfaced runway available for landing.

- NAVAIDS – Flight plan and nav aids with ICAO identifiers.

HSI Button

The HSI button selects the 360-degree HSI display format. Repeatedly pressing the HSI button sequences through the three HSI display modes. Pressing the HSI button while in the arc display format changes the display to the full HSI compass rose format. The available HSI modes are selectable in the following order:

- HSI COMPASS ROSE
- HSI NAV MAP
- HSI NAV MAP WITH WEATHER

ARC Button

The ARC button selects an arc display format of approximately 85 degrees. Repeatedly pressing the ARC button sequences through the arc display modes. Pressing the ARC button while in the HSI display format results in an arc format presentation in the same mode as selected for the HSI format. For example, if the NAV MAP WITH WEATHER mode is displayed in the HSI format when the ARC button is pressed, the result is an arc presentation in the NAV MAP WITH WEATHER mode. The four arc modes are selectable in the following order:

- ARC COMPASS ROSE
- ARC NAV MAP
- ARC NAV MAP WITH WEATHER
- ARC COMPASS ROSE WITH WEATHER

NAV Button

The NAV button selects the primary navigation sensor. Repeatedly pressing the NAV button sequences through the three sensors. The type of sensor selected is displayed on the left side of the HSI (e.g., VOR, TACAN, FMS). When the VOR/ILS receiver is tuned to an ILS frequency, LOC appears instead of VOR. The distance shown in the upper-right corner, the selected course, the course pointer, and the deviation bar are then referenced to the sensor indicated on the left side of the display. The navigation sensors are selectable in the following order:

- VOR (VOR or LOC)
- TACAN
- FMS

RNG Buttons

The RNG buttons select the next higher or next lower HSI maximum display range while using an HSI map mode. When the lowest or highest selectable range is reached, the opposite button must be used to change the range. The available ranges are 5, 10, 20, 40, 80, 160, 240, 320, and 1,000 nautical miles. A dashed ring (or arc) and numerical range cue to the right of the ring (or arc) indicates one half of the selected range display. The outer edge of the compass rose display indicates the full range.

NOTE

Selecting 1,000 NM scale (500 NM displayed) modes the radar to standby.

Course Select Knob

Rotation of the course select knob adjusts the settings of the course pointer and digital course readout. Pulling the course select knob out causes the course pointer and digital course readout to indicate a direct course to the selected valid NAVAID. When FMS is the selected navigation sensor, the course select knob is inactive because the desired track to the next waypoint is automatically selected by the FMS.

Bearing Pointer Buttons

Each of the two bearing pointer buttons selects the display mode and navigation sensor for the corresponding pointer. Pointers #1 and #2 are identified by the single bar and the double bar, respectively, on the buttons. Repeatedly pressing a bearing pointer button sequences through the four available modes and navigation sensors. If the selected sensor also has distance information, the distance is displayed below the sensor name. Selecting the DECLUTTER mode removes all displayed information for the corresponding pointer. The modes and navigation sensors are selectable in the following order for each bearing pointer:

- DECLUTTER
- VOR
- TACAN
- FMS

NOTE

With LOC frequency selected in RMS, VOR is not available.

Heading Select Knob

Rotation of the heading select knob moves the heading bug on the HSI. Pulling the heading select knob out activates the heading sync feature which causes the HSI heading bug to slew to the present aircraft heading (lubber line).

Brightness Knobs

Rotation of these two concentric knobs adjusts the brightness of the EFIS CRT displays. The outer (large) knob adjusts the brightness of the upper CRT and the inner (small) knob controls the lower CRT. It may be necessary to hold one knob stationary while rotating the other knob if a crewmember desires to brighten/dim only one CRT.

ADI PUSH BUTTON INDICATORS

Four momentary alternate-action PBIs are provided on the instrument panel below the HSI in both the front and rear cockpit to select ADI operating modes and displays. The buttons are shown in Figure 4-12. The ADI PBIs illuminate in both cockpits but reflect the selections of the crew having command (FWD or AFT). The PBI functions are described in the following paragraphs.

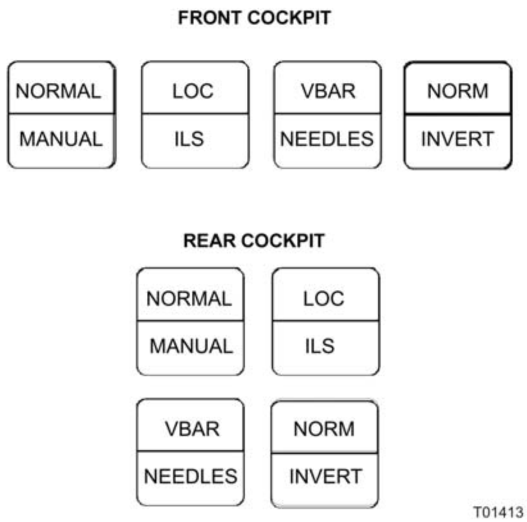

Figure 4-12. ADI PBIs

Steering Mode Button

The steering mode button selects either the normal or manual steering mode for the flight director computer. The NORMAL or MANUAL legend on the button illuminates to indicate which mode is selected. When MANUAL is selected along with the needles mode, bank steering information is displayed on the ADI based on the setting of the HDG bug. If the aircraft is flown in such a manner as to center the bank steering bar, the aircraft will roll in, turn to, roll out, and maintain the selected heading. This is the sole function of the MANUAL mode, and it will operate in this manner regardless of which primary navigation sensor is selected. When the NORMAL steering mode is selected, steering information is not displayed unless the primary navigation sensor is LOC or FMS.

LOC/ILS Mode Button

The LOC/ILS mode button selects either localizer (LOC) or localizer and glide slope (ILS) flight director steering with NEEDLES selected. The LOC or ILS legend on the button illuminates to indicate which steering method is selected. In LOC, the bank steering bar on the ADI is active and the pitch bar is not displayed. In ILS, both bars are active. With VBAR selected, the vbar symbol indicates both pitch and bank steering. The vbar symbol is not displayed with LOC selected. The setting of this button affects system operation only when the steering mode button is set to NORMAL, the VOR/ILS receiver is tuned to an ILS frequency, and LOC is selected as the primary navigation sensor. The PBI does not illuminate unless LOC or ILS is selected as the primary sensor with the HSI NAV push button and a localizer/ILS frequency is selected on the RMS.

LOC

With LOC selected, the course arrow and course window should be set with the published localizer front course. The HSI course deviation indicator then shows aircraft position relative to the localizer course and the ADI bank steering needle is active. The bank steering needle is valid for both front and back course localizer approaches with the published front course selected. The flight director can direct an intercept angle (angle between aircraft heading and inbound course) up to 45 degrees to the localizer course and a maximum bank angle of 35 degrees is required to center the needle. When the aircraft is within the area of glide slope reception, the glide slope indicator provides indication of the aircraft's position relative to the glide slope. However, the pitch steering bar is not displayed.

ILS

With ILS and NEEDLES selected, the bank required to center the bank steering needle is reduced to a maximum of 15 degrees, and the pitch steering needle is activated to provide pitch steering relative to the glide slope. Crosswind correction is also provided in this mode. If ILS and VBAR are selected, the vbar display indicates both pitch and bank steering. The aircraft's position relative to the glide slope is displayed on the glide slope indicator.

WARNING

Flight director errors may result in erroneous steering for course and/or glideslope. Raw course and glideslope data should be cross-checked to ensure validity of steering data. If errors are noted, flight director steering commands should be disregarded and the approach continued using raw data only.

VBAR/NEEDLES Button

The VBAR/NEEDLES button selects either the single steering cue (V-shaped bar) or the dual steering cues (crossed needles) for pitch and bank steering commands on the ADI. The VBAR or NEEDLES legend on the button illuminates to indicate which mode is selected. With VBAR selected, the standard aircraft symbol is displayed. When NEEDLES is selected, the aircraft symbol changes to a bullseye.

NORM/INVERT Button

This button determines where the ADI and HSI displays appear. With NORM illuminated, the ADI appears on the upper CRT and the HSI on the lower. With INVERT illuminated, the HSI is displayed on the upper CRT and the ADI appears on the lower CRT.

HSI STANDARD DISPLAYS

A typical HSI en-route display with a 360-degree format in a compass rose mode is shown in Figure 4-13. An HSI approach display in the same format and mode is shown in Figure 4-14 to present the HSI display elements associated with instrument approaches.

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Figure 4-13. HSI Compass Rose – Enroute

Figure 4-14. HSI Compass Rose – Approach

Color Standards

The HSI assigns specific colors to various functions to aid in interpreting displayed information. The following summary identifies the colors assigned to the listed functions.

- Warnings – Red
- Cautions – Yellow
- Scales and Associated Figures – White
- Selected heading and heading Bug – Orange

Primary Navigation Source Information:

- VOR or LOC – Yellow
- FMS – Blue (non-approach NAV data)
- FMS – Green (approach NAV data)
- TACAN – Green

Normal Compass Card

A 360-degree rotating white compass scale indicates aircraft heading referenced to a white triangular heading index (lubber line).

Aircraft Symbol

An orange aircraft symbol indicates aircraft position relative to the deviation bar or course line.

Heading

An orange notched heading bug is manually positioned on the compass scale by the heading select knob. It indicates desired heading and provides the selected heading reference for the manual steering mode. Once set, the heading bug rotates with the compass card. In the 360-degree HSI compass mode, a full-time digital readout of the selected heading is displayed in the lower right corner, below the vertical deviation scale position. In the arc compass mode, a digital heading readout is displayed inside the compass scale on the side nearest the heading bug when the bug is not completely in view. If the heading select knob is pulled out, the heading bug slews to the lubber line. A red X is drawn through the heading bug if a failure associated with the heading select knob on the display control panel is detected.

Course

The course pointer is manually positioned on the compass scale by the course select knob. Once set, it rotates with the compass card. An alphanumeric readout of the selected course (CRS) is presented in the upper left corner of the HSI display. The selected course indicates the desired navigation course to be flown. When TACAN or VOR is the primary navigation sensor, pulling the course knob out will cause the pointer and digital course readout on the HSI to slew a direct course to the selected sensor. When FMS is selected as the primary sensor, the course pointer is positioned to the desired track (DTK) by the FMS. With FMS selected and DTK displayed, the course select knob on the display control panel is disabled. If a heading failure occurs, the head and tail of the course pointer are removed, the course deviation scale is fixed in a horizontal position, and standard course deviation indicator (CDI) information referenced to the alphanumeric CRS display is provided. A red X is drawn through the CRS data if a failure associated with the course select knob on the display control panel is detected, or if the selected course or desired track received from the FMS is invalid.

Course Deviation Scale

The course deviation scale on the HSI consists of four small white circles spaced evenly on both sides of the aircraft symbol. It provides a reference from which quantitative data can be determined by the position of the course deviation bar. The scales that apply to the following navigation sources are:

- VOR/TACAN:
  - 1 dot = 5.0 degrees
  - 2 dots = 10.0 degrees
- FMS (Blue Enroute):
  - 1 dot = 2.5 nautical miles
  - 2 dots = 5.0 nautical miles

- FMS (Blue Terminal):
  1 dot = 0.5 nautical miles
  2 dots = 1.0 nautical miles
- FMS (Green Approach):
  1 dot = 0.15 nautical miles
  2 dots = 0.30 nautical miles

Course Deviation Bar

The course deviation bar represents the centerline of the selected navigation or localizer course relative to the aircraft symbol. If 3 seconds elapse without receiving valid data, a red X is drawn through the course deviation scale, and the course deviation bar and scale are removed from the display.

To/From Indicator

A solid white triangle near the center of the HSI display points toward the head (to) or tail (from) of the course pointer to indicate whether the selected course is to or from the station or waypoint. The to/from indicator is not displayed during LOC operation or when no valid navigation signal is being received.

Distance, Ground Speed, and Time-To-Station

Distance for the selected primary navigation sensor is located in the upper-right corner of the display. An alphanumeric readout shows distance in nautical miles (NM) from the aircraft to the selected primary navigation sensor station for VOR, TACAN, or LOC, or to the "TO" waypoint for the FMS. An alphanumeric readout of aircraft ground speed in knots (KT) and time-to-station in minutes (MN) is displayed below the distance readout when this information is available from the selected navigation sensor.

To identify operational DME that has not acquired lock-on to the selected station, dashes of the same color as the primary navigation sensor appear in the corresponding distance data field. If the associated equipment has failed or if information is not being received by the HSI, the dashes are red. In either case, the NM legend remains and the KT or MN legend is removed.

Bearing Pointers

Bearing pointer #1 appears on the HSI display as a rotating, light-blue, single-bar pointer. Bearing pointer #2 appears on the display as a rotating, magenta (purplish red), double-bar pointer. Each pointer points in the direction of its selected navigation sensor or FMS waypoint. If the sensor is not receiving valid data, the bearing pointer is not displayed and a red X is drawn through the legend at the lower-left (#1) or lower-right (#2) of the display.

When the sensor for a bearing pointer includes distance information, the distance is displayed below the name of the corresponding sensor. Distance #1 is located to the lower-left, below the #1 bearing pointer sensor name. Distance #2 is located to the lower-right, below the #2 bearing pointer sensor name.

With a magnetic-referenced compass card, true bearing from sources such as FMS may be displayed if valid magnetic variation is provided to the HSI. The true-sourced bearing information is converted to a magnetic reference. Likewise, with a true-referenced compass card, magnetic bearing from sources such as VOR may be displayed if valid magnetic variation is provided. The magnetic-sourced bearing information is converted to true reference. Magnetic variation is provided by the FMS. If magnetic variation becomes invalid, each bearing pointer being displayed with correction by means of magnetic variation is removed from the display and a red X is drawn through the sensor name at the lower-left or lower-right of the display.

Glide Slope/Vertical Navigation

When the selected primary navigation sensor is LOC and a valid glide slope signal is being received, a stationary white vertical deviation scale and a yellow vertical deviation pointer appear on the right side of the HSI display. The deviation pointer moves in relation to the scale to indicate glide path center relative to aircraft position. The letters GS are displayed in the pointer. The vertical deviation scale and pointer is in view at all times that LOC is selected/received as the primary sensor unless a back course is being flown. The glide slope scale is not displayed with a back course. If 3 seconds elapse without receiving valid data, a red X is drawn through the GS legend, and the vertical deviation pointer and scale are removed from the display.

Wind Vector Display

A full-time wind vector indicating the approximate wind direction and speed is displayed in the form of a white arrow in the upper left corner of the HSI display below the selected course. The wind vector is available only when valid data is provided by the FMS.

CAUTION

The information provided by the wind vector display is advisory only. It should not be used as critical flight data for approach because it becomes inaccurate during altitude changes.

Drift Angle Bug

The drift angle bug is a hollow, blue, triangular pointer that is generated by the FMS and rotates about the outside of the compass scale. Referenced to the lubber line, the drift angle bug represents drift angle left or right of the aircraft heading. With respect to the compass scale, the drift angle bug represents actual aircraft track. If the bug information becomes invalid, it is removed from the display.

HSI 360-DEGREE MAP DISPLAYS

The HSI 360-degree map modes can display waypoints, nav aids, airports, and weather radar information. A typical HSI display with a 360-degree format in a NAV map with weather mode is shown in Figure 4-15. Coupled with the FMS, up to nine of the nearest waypoints, nav aids, and airports with ICAO identifiers can be displayed given sufficient range scale. The operation of the compass card remains the same in map modes as in the standard display. However, the outside of the compass card performs a secondary function by becoming the outer range ring for the map display.

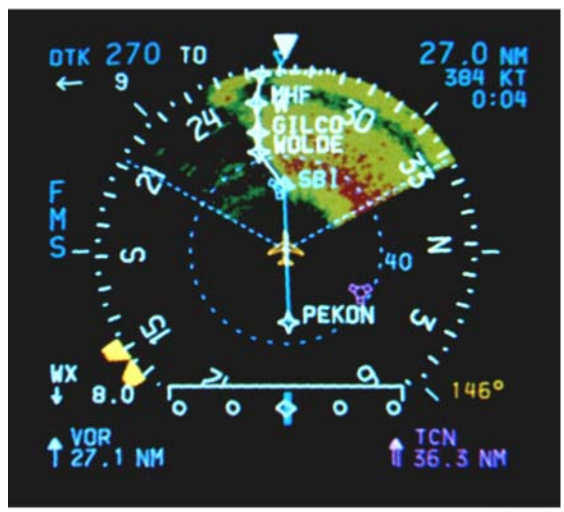

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Figure 4-15. HSI Compass Rose Map Display With WX Radar

Selected Course

The numeric readout of the selected course (CRS) in the upper-left corner of the HSI display functions in the same manner with a map mode as with the standard display. However, the standard HSI course pointer, to/from pointer, deviation bar, and deviation scale are removed from the display. When the selected primary navigation sensor provides distance and bearing information, the selected course pointer is replaced with a course line. If the primary navigation sensor facility is within map range, a symbol for the facility is displayed and a movable course line is drawn through its center. As the selected course is changed, the course line rotates about the facility symbol. The inbound "to" course line's color corresponds to the color associated with the sensor in use (green-TACAN, yellow-VOR, blue-FMS) and the outbound "from" course line is white.

If distance or bearing information from the primary navigation sensor becomes invalid, the facility symbol and course line are removed from the display, and "NO MAP" is displayed to show that insufficient information is present to calculate and plot the primary navigation sensormap. "NO MAP" is also displayed if the primary navigation sensor does not provide distance information (e.g., VOR, ILS). The lateral deviation scale remains as long as valid bearing information is present.

When operating with the FMS as the primary navigation sensor, a numeric readout of desired track (DTK), as selected by the FMS, is displayed in the upper-left corner of the HSI display. The navigation map presentation replaces the standard HSI course pointer, to/from pointer, deviation bar, and deviation scale with a flight plan map. The map shows the current "to" leg in blue and subsequent legs in white. Legs that have been traversed are removed from the map as each waypoint is passed (AUTOMODE only). A white CDI scale and blue pointer appear at the bottom of the display to show deviation right or left of the desired track. The number of waypoints shown on the map is determined by the selected range. Airports or navaids in the vicinity of the aircraft can also be displayed by means of the TST/REF button on the EFIS display control panel.

Course Deviation Indicator

In a map mode, a white course deviation scale and bar are presented in the lower center of the HSI display. The stationary scale provides a reference for the course deviation bar to indicate the position of the aircraft in relation to the selected course. This arrangement provides a conventional CDI presentation. With LOC selected in a map mode, "back course" is indicated when the selected course is 105 degrees from the aircraft heading. The center triangle in the course deviation scale points to the bottom of the display, and the letters BC are displayed in green.

To/From

In non-LOC map modes, a white TO or FR replaces the standard HSI to/from indication.

Bearing Pointers

A standard HSI bearing pointer is displayed in map modes when the selected bearing source does not include distance information or when the distance is greater than the selected map range. When a selected bearing source with distance information comes within display range, the associated bearing pointer is removed and the facility map symbol is displayed. The facility map symbol is removed if either bearing or distance information becomes invalid. However, if only distance information becomes invalid, the symbol is replaced with the standard bearing pointer.

Range Rings

A dashed range ring (or arc in ARC displays) and numeric value are displayed in the map modes to aid in determining the distance of weather radar returns and the position of airports or navaids in relation to the aircraft. The range ring (or arc) and its numeric value represent one half of the range of the displayed map but is usually the number referenced when describing the scale. The outer edge of the compass scale represents the full scale (twice the indicated distance). The available ranges, selectable by means of the RNG buttons on the HSI control panel, are 5, 10, 20, 40, 80, 160, 240, 320, and 1,000 nautical miles. In each case, one half of the selected range is displayed on the HSI.

NOTE

> When 1,000 NM scale is selected (500 displayed), the weather radar is automatically set to standby.

Weather Radar

When weather radar is selected for display, the weather information transparently overlays the existing navigation data on the HSI. Two dotted lines in a “V” shape from the aircraft symbol represent the radar scan limits of 60 degrees left and 60 degrees right.

When weather radar is selected, the HSI acts as a radar range controller by means of the RNG buttons on the HSI control panel. If the selected range exceeds the maximum range allowed by the radar, the word RANGE is displayed and the radar is placed in standby.

Two data lines are reserved for radar information in the lower-left corner of the display. The first line indicates the radar mode (STBY, TST, WX, AND WXA). The second line is a digital readout of the radar tilt angle in tenths of a degree, preceded by an arrow pointing up or down for tilt direction.

HSI ARC DISPLAYS

The HSI arc display format of approximately 85 degrees has an expanded compass scale presentation to enlarge the display of weather radar information and increase the resolution of navigation data. A typical HSI display with an arc format in a nav map with weather mode is shown in Figure 4-16.

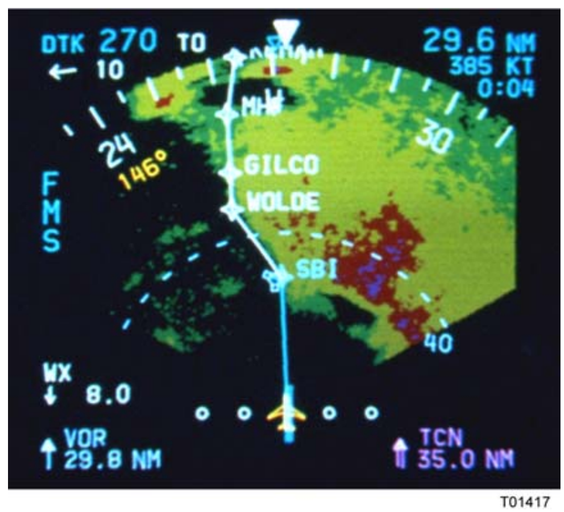

Figure 4-16. HSI Arc Map Display With WX Radar

Heading Bug

With the arc display format, heading bug operation is the same as with the 360-degree format. However, in the arc format, the orange digital readout of selected heading is displayed only when the heading bug is not completely in view. In such cases, the heading readout appears on the right or left side of the compass scale, depending on which side is closer to the position of the hidden heading bug.

Course Deviation Indicator

In the arc compass rose and arc compass rose with weather modes, the location and size of the course deviation indicator is altered. The scale is moved to the bottom-center of the display and is slightly smaller.

ADI STANDARD DISPLAYS

A standard ADI display is shown in Figure 4-17. The basic display has a blue sky background in the upper portion and a brown ground background in the lower portion. These backgrounds are separated by a white horizon line that moves up and down with the pitch of the aircraft and rotates clockwise or counterclockwise with the roll of the aircraft. Pitch and roll scales and a roll index pointer provide quantitative data in degrees.

When an unusual attitude occurs, the ADI shows red chevrons in the brown ground area between 40 and 85 degrees and in the blue sky area between 50 and 85 degrees to indicate the best attitude recovery direction. If a pitch or roll attitude failure occurs, the pitch scale, sky, ground, and roll index pointer are removed from the display, and "ATTITUDE FAIL" is displayed in red below the roll scale. Display of the amber letters DU (display unit) indicates a cooling problem for the ADI. Display of the SG cue indicates a cooling problem in the corresponding symbol generator.

Pitch Indicator

A pitch scale appears in the center of the display above and below the horizon line. From the horizon, it has graduations in each direction of 5, 10, 15, 20, 25, 30, 40, 50, 60, 70, 80, and 90 degrees. However, only that portion of the scale representing approximately 20 degrees upward and downward from the current pitch is visible at any one time. The pitch of the aircraft is indicated by the position of the center of the horizon line relative to the pitch scale.

Figure 4-17. ADI

Roll Indicator

A roll scale is located in the upper center area of the display. A yellow triangle pointer in the center of the scale marks the zero position. At zero degrees angle of bank, the tip of the white index aligns with the tip of a yellow fixed "mirror image" pointer. A white "sky pointer" roll index pointer rotates in relation to the white roll scale to indicate angle of bank. Graduation marks to the left and right of the center represent left and right roll positions of 10, 20, 30, 45, and 60 degrees. For easier recognition, the 30-degree marks are longer than the other marks and the 45-degree marks are in the form of white open triangles.

Aircraft Symbol

A stationary orange symbol representing the aircraft appears in the center of the ADI display. The relative positions of the moving horizon line and the fixed aircraft symbol indicate the pitch and roll attitude of the aircraft. The type of aircraft symbol that appears depends on whether VBAR or NEEDLES command bars are selected. When single cue command bars (VBAR) are selected, a delta aircraft symbol appears. When dual-cue command bars (NEEDLES) are selected, a bull's-eye aircraft symbol appears.

Heading Indicator

A white heading scale is displayed along the top of the horizon line. It has graduations every 5 degrees, and is labeled every 30 degrees in degrees of N, E, S, and W. The heading of the aircraft is indicated by the position of the stationary aircraft symbol relative to the moving heading scale. If heading information is not available or invalid, a red HDG cue is displayed above and to the right of the aircraft symbol.

Flight Director Command Bars

Flight director steering commands are displayed as either a single-cue v-bar or as dual-cue azimuth and elevation needles whenever the EFIS is configured for flight director steering. The steering cue option that appears is determined by the VBAR/NEEDLES PBI located below the HSI. The positions of the moving command bar(s) relative to the stationary aircraft symbol (v-shaped or bullseye) indicate the amount of roll and pitch needed to satisfy the flight director wind corrected commands. If the pilot flies the aircraft in such a manner as to keep the steering cue(s) centered, the aircraft will fly to and maintain the selected course and glideslope.

The command bars are present when the primary navigation sensor is FMS or LOC/ILS and NORMAL is selected on the NORMAL/MANUAL PBI. With FMS selected as the navigation source, flight director course steering is provided to the current waypoint in the active FMS flight plan. If the direct mode is selected in FMS, the command needle will provide steering direct to the selected waypoint. With LOC selected as the navigation source, flight director steering is provided to align the aircraft on the selected front course. When ILS is selected by means of the LOC/ILS PBI, the pitch command is also provided when a valid glideslope signal is available. With NEEDLES selected, the pitch steering bar will appear when ILS is selected. The maximum angle of bank commanded in FMS is 45 degrees, in LOC 35 degrees, and in ILS 15 degrees. The roll command bar is also valid for back course localizer approaches. Command bars are not provided for TACAN or VOR.

The red boxed FD annunciation on the ADI indicates invalid flight director data. No steering information will be displayed.

WARNING

> Flight director errors may result in erroneous steering for course and/or glideslope. Raw course and glideslope data should be cross-checked to ensure validity of steering data. If errors are noted, flight director steering commands should be disregarded and the approach continued using raw data only.

The flight director mode is also available to the pilot to fly a designated magnetic heading. The heading bug is rotated with the heading select knob on the HSI control panel to the desired heading. Select MANUAL on the NORMAL/MANUAL PBI and NEEDLES on the VBAR/NEEDLES PBI. If the pilot flies the aircraft to maintain the steering cue centered, the aircraft will roll in, turn to, roll out, and maintain the selected heading.

Rate-Of-Turn Indicator

A rate-of-turn indicator at the bottom of the ADI display shows left or right turn rate. The indicator consists of three white rectangular “boxes” that form a scale, and a solid white rectangular pointer. When the pointer is under the center box, the turn rate is zero. When the pointer is under the box to the left or right of the center box, the turn rate is 4 minutes for 360 degrees of turn.

ADI APPROACH DISPLAY

The ADI approach format, shown in Figure 4-18, is displayed when LOC is selected as the primary navigation source. The normal square full-screen sky/ground display is changed to an eight sided display that is reduced slightly in size to provide a high-contrast black background for associated scales and legends. When the LOC source is first selected, needle steering command is displayed for localizer only. This mode of operation is indicated by illumination of the LOC legend on the LOC/ILS PBI and NEEDLES on the VBAR/NEEDLES PBI.

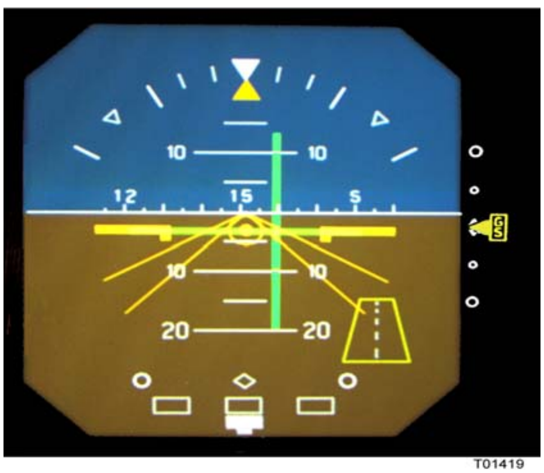

Figure 4-18. ADI Approach Display

When the ILS legend is illuminated, the VBAR or NEEDLES option may be used and steering commands are displayed for both localizer and glide slope. The glide slope scale and pointer appear on the right side of the ADI when an ILS or LOC is selected as the nav sensor.

Lateral Deviation Scale

When the selected primary navigation sensor is LOC, a white lateral deviation scale and a yellow runway indicator are presented in the lower portion of the ADI display. This scale is a times two expansion of the course deviation indicator that appears in HSI map modes. The runway moves laterally above the scale to represent the center of the localizer course relative to aircraft position. When the selected course and the aircraft heading differ by more than 105 degrees, the left/right sensitivity is reversed and a green BC is displayed to the left of the deviation scale center mark to indicate that back course information is being displayed. If lateral deviation information is not available or becomes invalid, the lateral deviation scale is removed and is replaced by a red X.

Glide Slope Deviation Scale

When the selected primary navigation sensor is LOC, a white glide slope deviation scale and a yellow pointer with GS legend are presented in a black background along the right side of the display. The selection of LOC or ILS on the LOC/ILS PBI has no effect on the glide slope scale. This scale is the same as the vertical deviation scale that appears in HSI compass rose modes when LOC is the selected navigation source. The pointer moves on the scale to represent the center of the glide path relative to aircraft position. If glide slope information is not available, a red X is displayed in place of the scale. If a back course is selected, the glide slope scale is not shown.

Mach Number Indication

Mach number computed by the Mini Air Data Computer (MADC) is displayed on the lower left side of the ADI.

Marker Beacon Indication

Marker beacon indicators appear in the lower left corner of the ADI display. They consist of a blue OM for outer marker, an orange MM for middle marker, and a white IM for inner marker. Each indicator is displayed for as long as its corresponding signal is being received.

EFIS Fault Annunciations

Table 4-3 lists various fault annunciations that may be displayed under abnormal conditions.

Table 4-3. EFIS Fault Annunciations

ANNUN	COLORS	FAILURE	LOCATION
"CHECK CONFIG"	Yellow	System Configuration Memory in SG Does not Match Aircraft Config Module	HSI
X on CRS Pointer	Red X	Course Select Knob Failure	Course Pointer
CP (Boxed)	Red	Control Panel BTN Stuck>10 sec	Head and Tail
DU (Boxed)	Yellow	Display Unit..Low Air Flow..OK for at least 30 minutes	HSI or ADI
FD (Boxed)	Red FD	Flight Director PWR or IRS Attitude Valid	ADI
X on FMS DTK Field	Red X	FMS Failure	HSI
	Cyan FMS	No Valid Data	
X on HDG BUG	Red X	Heading Select Knob Failure	Heading Bug
RCP (Boxed)	Red	Radar Control Panel Failure	HSI
SG (Boxed)	Yellow	Symbol Gen...Low Air Flow ...OK for at least 30 minutes	HSI and ADI
SG (Boxed)	Red	Partial Symbol Generator Failure...Data on HSI Needs Verified	HSI and ADI
SG	Large Red	Symbol Generator Failure	HSI
X OVER DATA FIELD	Red	Data Invalid or No Signal Received	Data Field
ANT FLT*	White	Measured Antenna Tilt Does Not Match the Requested Antenna Tilt	Lower Left HSI
RANGE	White	1000 NM Range Selected on EFIS..Radar in STBY	Lower Left HSI
STB LMT (Flashes on & off with ANT sweep)	White	Stabilization off or..Combination of Tilt, Roll, Roll Trim, and Pitch Exceeds 30	Lower Left HSI
TX FLT	White	Radar Transmitter Fault Detected	Lower Left HSI
WX FLT	White	Mismatch or Mode, Tilt, Gain, or Range Info Between EFIS and Radar RT>30 seconds	Lower Left HSI
WX OFF	White	Radar is OFF	Lower Left HSI
429 FLT	White	429 Data is Missing or Incorrect at the Radar RT	Lower Left HSI

* Antenna fault may be caused in flight due to turbulence. May be cleared by turning radar off then back on. Causes antenna to re-sync with display sweep.

FLIGHT MANAGEMENT SYSTEM

INTRODUCTION

This section of the flight manual provides operational procedures of software control number (SCN) 802 as it is used in Universal's UNS-1L Flight Management Systems in NASA's T-38N aircraft (see Figure 4-19). The FMS is powered on the 28 VAC bus.

Sensors

The FMS accepts primary position information from short and long-range navigation sensor(s). Inputs from a multi-channel, scanning DME, IRS, and GPS/ GLONASS navigation sensors can be utilized to determine the aircraft's position. In addition to the navigational inputs, the system also receives true airspeed and altitude information from the ADC, fuel flow data from the T-38N's fuel flow sensors, and heading and velocities from the IRS.

Best Computed Position

Primary position data received from each sensor is combined in a Kalman Filter, contained within the FMS, to derive a Best Computed Position (BCP). Utilizing this BCP, the FMS navigates the aircraft along the pilot-programmed flight path, which can include departure procedures [Standard Instrument Departures (SIDs)], airways, inflight maneuvers, holding patterns, arrival procedures [Standard Terminal Arrival Routes (STARs)], approaches, and runways.

The FMS best computed position is determined by using position inputs from all available navigation sensors and DME (distance information from the scanning DME). The DME system operates by searching the Navigation Database to determine which DME or TACAN stations are within range, then sequentially tunes each station. By interrogating multiple DME or TACAN stations, knowing the geographic coordinates of each station and correcting the distance computation for slant range using station elevation and aircraft altitude, the FMS is able to compute the position of the aircraft. This DME derived position is then integrated with position information from the GPS, True Airspeed (TAS) from the ADC, and heading information to derive the best computed position as a weighted average of the various sensor inputs. If the aircraft is out of DME range, the FMS will rely upon other sensors for position information. When available, IRS velocities are strongly preferred over GPS-position-rate velocities. After the best computed position is obtained, secondary navigational functions such as course to waypoint, Estimated Time of Arrival (ETA), distance to waypoint, wind, and groundspeed are computed for display.

Figure 4-19. UNS-1L Flight Management System

Flight Planning

Flight planning is accomplished by accessing the internal Navigation Database, which includes navigation and pilot-defined data, and company defined routes created on Universal's Offline Flight Planning Program. The pilot selects from waypoints, routes, airways, arrivals, departures, approaches and runways to create the desired flight plan. Accurate and quick flight planning is facilitated by features such as SIDs, STARs and approaches for use in terminal areas, and High and Low Altitude airways for the enroute phase. These operations are accomplished by selecting the appropriate data from computer-tailored lists, thus eliminating the need to type in actual or other time consuming data from the keyboard and reducing entry errors.

Maneuvers

Inflight maneuver capabilities include FMS controlled departures, procedural turns, turn anticipation, Direct-To functions, VNAV, holding patterns, selected crosstrack, Pseudo-VOR (PVOR), arrivals, and approaches.

Waypoint Sequencing

The FMS utilizes automatic turn anticipation for leg changes along the flight plan. Turns are commenced at a distance based upon groundspeed, leg change magnitude and roll steering bank limits for the present altitude. If a leg change incorporates an overfly waypoint, (denoted by an "*" following the waypoint name) the turn will commence over the waypoint.

Direct-To

The FMS provides maximum flexibility when defining direct-to leg changes. Direct-to (DTO) maneuvers can be to waypoints or airports on or off the flight plan. If a TO waypoint off the flight plan is chosen, the system will prompt the pilot to redefine the NX (next) waypoint in order to link the newly defined leg into the flight plan. The pilot may specify the turn direction when performing a DTO.

Selected Crosstrack

A course may be established to provide guidance with respect to an offset course, parallel to the leg defined by the FR/TO waypoints. XTK will indicate crosstrack from the selected crosstrack, the system will provide steering to fly the selected crosstrack and the HSI will be referenced to the parallel (offset) course only until the next waypoint sequences. Then SXTK automatically cancels.

Vertical Navigation

The Vertical Navigation (VNAV) function allows the flight crew to define a desired vertical flight profile along the flight plan. It also computes aircraft deviation from that profile. Crossing altitudes provide a nearly seamless transition from cruise, enroute descent, and approach phases of flight.

Two VNAV pages displaying six VNAV waypoints are available under the VNAV function key. Up to eight VNAV waypoints are automatically prefilled in reference to flight plan waypoints. Waypoints not on the flight plan cannot be accepted.

Additional VNAV features include a computed Top-of-Descent and Target Vertical Speed, support for holding patterns, and vertical direct-to. For the initial VNAV leg, flight path angle in degrees is displayed under the Target Vertical Speed data field.

Holding Patterns

Holding patterns may be programmed at any waypoint on or off the flight plan or stored in the Navigation Database as part of SID, STAR and approach procedure. If defined at a fix on the flight plan, the pattern may be either armed (ARM HOLDING) or directly activated (DTO HOLD). If the fix is not on the flight plan, the hold may only be activated directly. When armed, the aircraft will continue along the current flight plan and when the hold fix is reached, holding will automatically commence. If the hold is directly activated, the aircraft will proceed from present position direct to the holding fix and automatically perform the appropriate entry to the pattern (parallel, direct, or teardrop). Once established in the pattern, the FMS will fly the flight plan legs, compensating for existing wind conditions. ETA over the holding fix is constantly displayed.

Terminal Area Procedures

The FMS can fly published SIDs and STARs with procedural legs such as heading-to-radial, heading-to-altitude, course-from-fix-to-DME-distance, DME-arcs and fifteen additional leg types. SIDs and STARs can be easily linked into a flight plan by selecting from menus of procedures available at the departure and destination airports.

Approach Mode

The FMS approach mode provides the operator with ILS-like guidance while flying FMS approaches. During an FMS approach, the system provides signals like those of an ILS for flight director, though with the current flight director, only roll steering is provided.

VOR, RNAV, TACAN, Global Positioning System (GPS), Non-Directional Beacon (NDB), ILS, LOC, and Back Course (BC) approaches may be accessed directly from the navigation data. RNAV (GPS) (the "new" GPS approach) and NDB approaches can only be flown using GPS, whereas VOR, RNAV ("old" RNAV approach), and TACAN approaches may be flown as GPS overlays. ILS approaches can be linked to the flight plan; however, the aircrew must switch the NAV mode to LOC at the appropriate time.

Databases

FMS databases are categorized into the Navigation Database, the Pilot Defined Database, and the Company Routes Database.

Dual Cycle Database Loading

The UNS-1L has two separate database memory banks to hold the electronic database. This feature allows a future (i.e., effective date in the future) database to be loaded and stored until its effective date. At the first power-on cycle after the effective start date of the new database, it will automatically be used for navigation. The advantage of a dual cycle database is the next database cycle can be loaded into the FMS on the day it is received, rather than waiting until its effective start date.

Navigation Database

The self-contained worldwide Navigation Database, stored in non-volatile memory, provides the FMS with information for over 100,000 waypoints, navaids, airports, and over 12,000 SIDs, STARs, and approaches. The database includes VHF and NDB navaids with plain-language references, enroute and terminal waypoints, and High and Low Altitude airways. The database contains airports with runways of at least 6,000 feet. The subscription service provides Navigation Database updates on a 28-day cycle.

Pilot Defined Database

The Pilot Defined Database stores all data created by the pilot and has the capability to store up to approximately 200 pilot defined routes utilizing up to 2,500 legs. It also stores up to 200 waypoints, 100 runways, 100 approaches and alignment points, airport reference points, SIDs, STARs, and routes. Through the use of a personal computer software package called Universal Flight-Planning, user defined data may be created and loaded into the FMS via disk.

Company Database

A Company Routes Database is created using Universal's Offline Flight Planning Program and loaded via disk. A total of up to 2,500 routes and 250,000 route elements may be stored. Each route will consist of at least one but not more than 98 legs (route elements). Route elements, reference waypoints, airways, and terminal area procedures (SIDs, STARs, and approaches) are retrieved from the Navigation Database by use of reference pointers. A company route can be copied into the active flight plan where it can be edited, but the pilot cannot alter the basic route database. Requests for additions or modification to company routes should be directed to AOD.

Sensor Watchdog

A sensor "watchdog" automatically detects sensor information that appears erroneous, which could cause an error in the best computed position. This is accomplished by comparing each sensor, the unweighted average of all sensors, and deselecting faulty sensors. If the difference exceeds a preset value, the "watchdog" will activate the appropriate messages to alert the pilot and in extreme cases (i.e., sensor greater than 50 NM or diverging at > 50 knots) automatically deselect the sensor.

Navigation and Steering Outputs

The FMS provides desired track, bearing, crosstrack, lateral deviation, and related data to the flight guidance system for the HSI displays, and roll steering command for the autopilot/flight director system. The roll steering output limits for both "Direct To" and normal leg-to-leg changes are set to approximately 30 degrees. The roll rate is limited to 3 degrees per second.

Fuel

The aircraft's engine fuel flow system provides the inputs necessary to integrate real time fuel management information with navigational functions. During the pre-departure phase, the pilot inputs the fuel on board the aircraft to initialize the fuel management functions. During flight, the FMS automatically updates the fuel on board and gross weight, and provides continuous estimates of fuel requirements for the programmed flight plan based upon fuel flow and groundspeed. The FMS also provides specific range and endurance data to aid the pilot in optimizing fuel consumption to obtain maximum range or endurance.

NOTE

> Fuel display parameters are advisory only and do not replace primary fuel quantity or fuel flow gauges for normal operational decisions.

ANNUNCIATIONS

Messages

The FMS contains an array of messages that alert the operator to system status and flight plan sequencing. When a message is active, "MSG" will appear on the FMS displays and the message can be accessed by pressing the MSG key.

Remote Annunciations

Outputs are provided to cause the six external annunciators to alert the pilot of system status or flight plan sequencing. These annunciations are incorporated into the EFIS display:

MSG – A new message has been generated.

WPT – (Steady) Lateral waypoint alert. (Flashing) Vertical waypoint Flight Path Angle alert.

SXTK – FMS is in selected crosstrack mode.

APPR – FMS is in Approach Mode.

DG – No sensors are operational

GPS INTEG CAUTION LIGHT

The GPS INTEG Caution Light illuminates when the FMS Actual Navigation Performance (ANP) exceeds the Required Navigation Performance (RNP) for the phase of flight (Enroute, Terminal, or Approach). It also illuminates if the GPS Horizontal Integrity Limit (HIL) is exceeded. This indicates that FMS performance is degraded due to hardware problems or GPS satellite configuration. In either case, navigation performance should be monitored using other sensors (VOR or TACAN). GPS approach capability is not available with a GPS INTEG Light.

SYSTEM COMPONENTS

FMS Display

The FMS utilizes a 4-inch active matrix liquid crystal color flat panel display. The high-resolution display provides alphanumeric characters, icons, and graphics capabilities to facilitate on screen data recognition. This display allows for data display on eleven lines with 24 characters each in two different character sizes.

FMS Keyboard

The full alphanumeric keyboard contains dedicated function keys that when used in conjunction with the ten line select keys, provide the aircrew with all the controls necessary to communicate with the internal navigation computer and all associated sensors. The keyboard allows manual data entry, system mode selection, and control (selection and deselection) of navigation sensors.

FMS Navigation Computer

The FMS has a powerful central processing unit (navigation computer), navigation sensor interface circuits, flight guidance system interface, and the Navigation Database. The unit processes data from the DME, IRS, ADC, fuel flow, and GPS navigation sensors.

DME

The FMS's unique auto-scanning DME-DME-DME positioning function uses the internal Navigation Database to continually map the stations surrounding the aircraft (VORTACs, DMEs, ILS-DMEs, LOC-DMEs, TACANs). The FMS then automatically tunes and reads these, once every 4 seconds, utilizing the blind channel of the T-38's digital TACAN. Range information from all responding DMEs within approximately 300 nautical miles of the FMS position are corrected for slant range error then compared with those computed from the Navigation Database to verify reasonableness and to ensure DME position integrity is maintained. Flights that never leave areas of multiple DME coverage can expect exceptional position accuracy. Over-water flights will retain DME accuracy long into the flight, re-establishing this same accuracy well before landfall as DMEs are again received.

GPS/GLONASS

The GPS sensor is the source of three dimensional position and velocity, time, and status information. It is a 12-channel receiver that continuously processes measurements from all satellites in view simultaneously. Data can be received from both the US and Russian (GLONASS) satellite systems.

Configuration Module

A configuration module is installed on the FMS rear connector. It is programmed at the time of installation, and defines all the aircraft interfaces unique to the particular installation.

Air Data Computer

The FMS accepts digital air data from the ADC. True Airspeed, barometrically corrected or non-corrected altitude, and Static Air Temperature are utilized. Baro-corrected altitude is required for vertical guidance display during approaches and for VNAV below 18,000 feet.

Data Transfer Unit

The Data Transfer Unit (DTU) is designed to be connected to the aircraft via a connector adjacent to the EFIS ON/OFF switch and is used to update the FMS navigation database. The update data will refresh the entire navigation database with each update. The DTU may also load pilot-defined data created with off-line flight planning software.

GENERAL OPERATING PHILOSOPHY

Data is always entered into the system at a cursor location. When appropriate, the cursor location aligns with one of the ten line select keys that are used to control the cursor. The home position of the cursor is usually off of the display when a page is initially accessed, although some pages have a cursor default position on the screen. Pressing the ENTER key completes the entry of data. If there is a logical next field for data entry, the cursor will automatically advance to this next field when the ENTER key is pressed.

Selections are made with the line select keys whenever possible. In some cases a combination of line select keys and reference numbers are used on the same display page. This allows two levels of selection to exist simultaneously on the same display. For example, while the line select keys control the contents or nature of a list, an item from that list can be selected by using a reference number.

Some selections that change the active flight plan, guidance of the aircraft, or stored database require confirmation. Confirmation is accomplished by pressing the line select key a second time or by pressing the ENTER key. Selection of fields which do not require confirmation will cause the page or mode change to occur immediately when the corresponding line select key is pressed.

CONTROL AND DISPLAY

The FMS provides the operator with all the controls necessary to communicate with its navigation computer and associated navigation sensors. A dimmable eleven-line color flat panel display uses two character sizes and displays colors. Line select keys are located on either side of the display. Function keys are along the left and right edges of the display and an alphanumeric keyboard is below the display. The FMS Control Display Unit (CDU) provides for manual data entry, system mode selection, computed and raw data displays, control (selection and deselection) of navigational sensors, and system message displays.

Keyboard

ALPHABETIC AND NUMERIC KEYBOARDS

The alphabetic and numeric keys are used to input characters into a variable field marked by the cursor. The alphabetic keys are located immediately below the function keys and the numeric keys are to the right.

LINE SELECT KEYS

Normally, data is entered by using the line select keys to position the cursor, using the alphanumeric keys to input the desired data, and then pressing the ENTER key to complete the entry. Throughout this section, ‘LSK’ refers to these line select keys, numbered from top to bottom as 1 through (5 e.g., LSK[5L] refers to line select key 5 (bottom key) on the left side of the display).

<u>Control Keys</u>

PWR DIM Key

The PWR DIM key provides power-up, display dimming, and unit shutdown functions.

Pressing the PWR DIM key for initial power-up will energize the system and initiate self test of the navigation computer. When self test is initiated, the self test page will appear. The initialization page will automatically follow the self-test page if all tests are successfully completed. If a failure causes the system to be unusable, the Initialization page will not appear. Once the initialization page appears, no other page can be displayed until the initialization data is accepted.

When the system is on, pressing the PWR DIM key will display a control window on the right side of the active page. BRIGHT, DIM, CANCEL, DISPLAY, and OFF options are displayed and selectable using the line select keys.

NOTE

The BRIGHT/DIM keys provide display dimming only and do not dim the key backlighting. Dimming the key backlighting is accomplished with aircraft instrument dimming.

BRIGHT – Pressing the line select key for BRIGHT will cause the display to steadily brighten as the key is held down.

DIM – Pressing the line select key for DIM will cause the display to steadily dim as the key is held down.

NOTE

If the display is dimmed completely off and other keys are pressed or the location of the BRIGHT key cannot be remembered, press the ON-OFF DIM key twice to restore display.

CANCEL – Pressing the line select key for CANCEL will cause the control window to extinguish from the active display page.

DISPLAY – Pressing the line select key for DISPLAY will cause the display adjustment window to be displayed. The display adjustment window presents three options (UP, DOWN, and CANCEL) selectable using the line select keys. Selecting UP will cause the entire display to shift upwards by as much as one-half character to adjust the parallax for the line select keys. Selecting DOWN will adjust the display downwards an equal amount. Selecting CANCEL will return the display to the main (BRIGHT/DIM/CANCEL/DISPLAY/OFF) window.

OFF – Pressing the line select key for OFF will cause the CONFIRM OFF window to be displayed. This window has three options (CONFIRM OFF, CONFIRM STANDBY, and CANCEL) selectable using the line select keys. Selecting CONFIRM OFF will turn the system off. Selecting CONFIRM STANDBY will shut down the FMS but will retain all data for two hours. This option is only available in the front cockpit. Selecting CANCEL will return the display to the main (BRIGHT/DIM/CANCEL/DISPLAY/OFF) window.

PREV Key

The PREV (previous) key is used to cycle backward, one page at a time, through multiple pages of the same mode.

NEXT Key

The NEXT key is used to cycle forward, one page at a time, through multiple pages of the same mode.

BACK Key

When the cursor is over a data entry field, the BACK key serves as a delete or backspace key.

± Key

The “State Change Key” (±) is used in conjunction with the alphanumeric keys to enter data. It changes + to -, N to S, and L to R. It is also used in strictly alpha fields as a dash or period.

MSG Key

When a system message becomes active, “MSG” will appear on the far right side of the top line on the display. If the Position Uncertain message is active, “POS” will be displayed on the far left side of the top line on the display.

Pressing the MSG key will cause the MESSAGE page to be displayed showing the active messages. The current messages (those messages generated since the page was last accessed) will be displayed. After the messages are viewed, the display may be returned to the previous page by selecting the RETURN option on the MESSAGE page, by pressing the MSG key again, or by pressing the BACK key (see Figure 4-20).

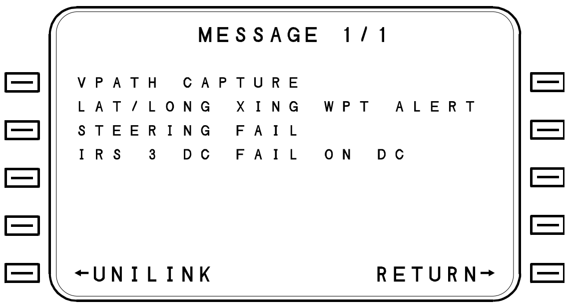

Figure 4-20. Message Page

ENTER Key

The ENTER key is used to store input data. The cursor marks variable parameters by means of reverse field printing (dark letters on a light background). Parameters that cannot be marked by the cursor are not variable and cannot be changed by the normal input processes. Each time the ENTER key is pressed, the variable marked by the cursor will be stored in memory. When the cursor marks a variable, it may be altered through the alphanumeric keys and then stored by pressing the ENTER key. Pressing the ENTER key completes entry of data and is required for all data entries.

Function Keys

Ten function keys are located along the left and right edges of the CDU. These keys are used to select the basic operating modes of the system for data entry or command inputs. When a function keys is pressed, the display will immediately change to the first display page of the selected mode. Where multiple pages exist, subsequently pressing the function key will cycle the display forward one page at a time (Pressing NEXT has the same effect). The following paragraphs describe the selectable modes in general terms. For a detailed description of each mode and the various display pages under each mode, refer to the function and page descriptions later in this section.

MENU Key

The MENU key is used to present a list of alternate formats or options for several pages including FUEL, FPL, PERF, or VNAV. The letter “M” in a box will appear on the title line of any page in which the MENU key is active. The only menu page used routinely is the FPL MENU. Refer to the applicable section for further details.

DATA Key

The DATA function is used to obtain information and status about the FMS, Navigation Database, and attached sensors which operate with the FMS. Although sensor control is completely automatic, selection and deselection of individual sensors may be accomplished using this function. The DATA function is also used to make additions, deletions, or changes to pilot defined locations.

DATA Page 1

Pressing the DATA key will allow access to the Data pages as described below. The initial DATA page allows selection of Navigation Data(base), Pilot Data(base), Company Data(base), Disk Menu, and Maintenance Menu. For further information, consult the NAVIGATION DATABASE section following.

NAV DATA – The NAV DATA line select key accesses the Navigation Database. Using these pages, the aircrew can interrogate the database to determine database contents, effective dates, data integrity, airport information, navaid, runway, SID, STAR, and approach information, etc.

PILOT DATA – The PILOT DATA line select key accesses the Pilot database. The pilot database is used for storing flight plans, waypoints, and certain procedures. When selecting and using pilot data, the names of waypoints, procedures, etc, will be shown in green with a "%" following the name. Any aircrew may alter the contents of pilot data items; caution must be used to ensure that valid data is being used.

CO DATA – The CO DATA (COMPANY DATABASE) line select key accesses the CO DATA page.

DISK – The DISK line select key accesses the Disk Menu page.

MAINT – The MAINT line select key accesses the Maintenance Page (see Figure 4-21).

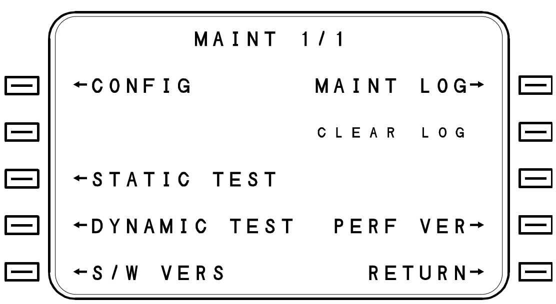

Figure 4-21. Maintenance Page

"CONFIG," "STATIC TEST," and "DYNAMIC TEST" options are available for installation check-outs. The MAINT LOG saves diagnostic history in non-volatile memory. Pressing the PERF VER line select key will display the performance database page when applicable.

S/W VERS – From the MAINT page 1/1, line select key [5L] accesses the S/W VERSIONS page (see Figure 4-22).

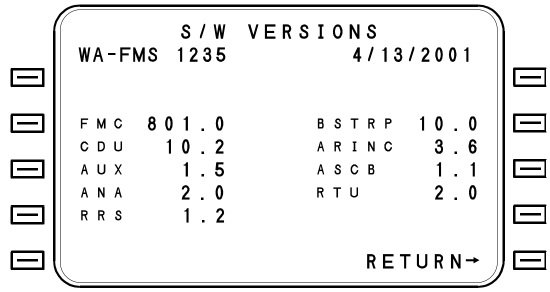

Figure 4-22. S/W VERSIONS Page

The system software version numbers are displayed as follows (for information only):

- **FMC** – The system software version number. The basic software version number (e.g., 801.0) is followed by a decimal point and additional number. The original software release will be .0, and any subsequent variations on that basic software will be .1, .2, etc. These variations of the basic software version will contain changes of minor impact only and will not require a new Operator's Manual, as operational features will be unaffected.
- **CDU** – The software version number for the Control and Display Unit.
- **AUX** – The software version number of the AUX processor in the FMS.
- **ANA** – The analog-to-digital input board software version number.
- **BSTRP** – Bootstrap software version.
- **ARINC** – The software version number of the ARINC board.
- **ASCB** – The software version of the ASCB Board.

This page displays all software versions applicable to the installation.

DATA Page 2

The second Data page provides a synopsis of input sensor operation (see Figure 4-23). The second line (following the page title) shows the most significant sensor and the (ANP/RNP=) associated with the FMS best computed position. Sensors that may be listed are:

Navigation Mode	Condition
GPS/DME	Valid GPS navigation data received, GPS sensor selected, more than 1 DME station received and DMEPOS variance less than 0.5 NM.
GPS	Valid GPS navigation data received and GPS sensor selected.
DME-DME	More than 1 DME station received and DMEPOS variance less than 2.2 NM.
DME	Only 1 DME station received and DMEPOS variance less than 2.2 NM.
IRS	IRS valid. Above conditions not met.
DR	TAS and HDG only valid sensor inputs.
NO SENSOR	No valid sensor inputs present and selected

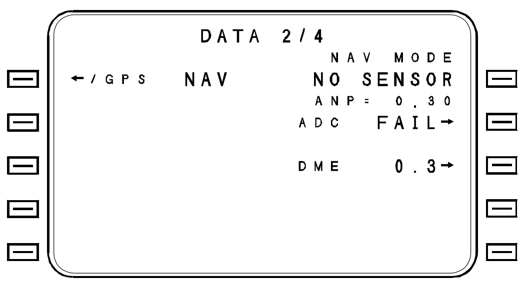

Figure 4-23. DATA Page 2

The estimate of position error is displayed under the NAV MODE sensor field. Refer to the estimate of position accuracy portion of this section for a description of the RNP/ANP.

Next to the line select keys are the status of the individual navigation sensors installed. The status displayed next to each sensor will be one of the following:

D – The associated sensor has been either manually or automatically deselected.

FAIL – The associated sensor has been detected as failed or the system has been turned on and no data was received within the specified timeout period. Each sensor has a specified timeout period, usually 2-3 seconds.

NAV – The associated IRS is in the navigation mode (alignment is complete) and navigational data is available.

TEST – Doppler, GLS, GNSS, or GPS is in self test mode.

Each individual sensor's status page may be displayed by pressing the line select key corresponding to the desired sensor. From this sensor status page, the sensor may then be deselected or reselected by pressing the line select key corresponding to the SEL (select) or DESEL (deselect) option.

ALT – GNSS is in altitude aiding mode.

ACQ – GNSS is acquiring satellite data.

INIT – GNSS is initializing.

DATA Page 3

This page shows the FMS system position and all long range sensors with their position differences expressed in radial nautical miles from the FMS position (see Figure 4-24).

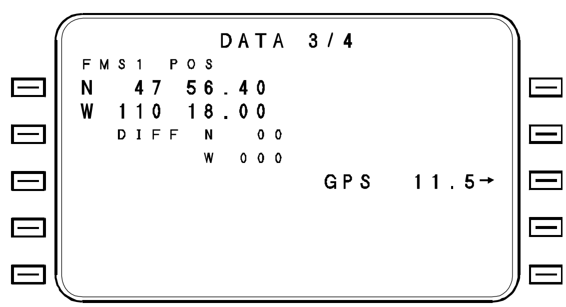

Figure 4-24. DATA Page 3

When the line select key corresponding to one of the sensors is pressed, that sensor's coordinates and position difference (broken into N-S and E-W components) are displayed just below the FMS position. The selected sensor will be displayed in small characters and the arrow will be removed from the display.

DATA Page 4

This is a general purpose data page (see Figure 4-25). If desired, manual entries may be made for date, time, and variation. Provisions are also made for a manual entry of heading data. A manual heading entry would only be made in the event of failure of all heading inputs. Advisory information is provided concerning software version numbers and current aircraft steering commands.

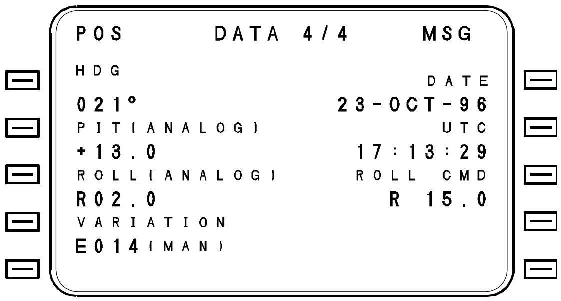

Figure 4-25. DATA Page 4

HDG – Displayed within parenthesis is the source of the heading data being used by the navigation computer. Next to this is the present aircraft heading. A "T" indicates that this is a true heading. With the cursor over the HDG entry field, pressing the LIST key will access the heading source page from which optional heading source selections may be made. If the heading is input manually, (MAN) will be displayed. Refer to section on Sensor Interface for more information.

PITCH – Display of analog pitch (degrees) being received from the IRS. "+" is up and "-" is down.

ROLL – Display of analog roll (degrees) being received from the IRS.

VARIATION – The magnetic variation is automatically computed and displayed between the latitudes of S60 and N73. (MAN), if displayed, indicates the variation has been manually input.

ROLL CMD – Display of roll steering command being sent from the navigation computer to the flight director. An "R" indicates a right roll and an "L" indicates left roll. The digits following the sign are the number of degrees of bank being commanded.

NOTE

Due to the type and age of the flight director technology, the commanded flight director roll angle (depicted here) may not match the displayed commanded roll angle.

DATE – The date shown is that corresponding to the date in Greenwich, England. Input of the date is numerical by Day-Month-Year; for example, 201092 would be 20th of October 1992. The date can be manually changed.

UTC – Universal Time Coordinated is entered as hours and minutes on a 24-hour format.

FUEL Key

The FUEL function provides access to all fuel management functions, including initialization of crew, fuel, and cargo pod state (on/off), fuel remaining at destination or any desired location, specific fuel consumption, etc. Once FUEL has been initialized, subsequent selections of the FUEL Key will result in the selection of FUEL Page 2. Correcting fuel states will require depressing PREV to access the FUEL initialization page, FUEL Page 1.

FUEL Page 1

FUEL page 1 is the fuel and weight entry page. It is used to determine the gross weight of the airplane by entering the values to be used in calculating the weight and to plan the fuel reserves required. The line select keys are used to position the

cursor over the data entry fields. Unit of measure is displayed as LBS or KGS and is programmed at installation. See Figure 4-26.

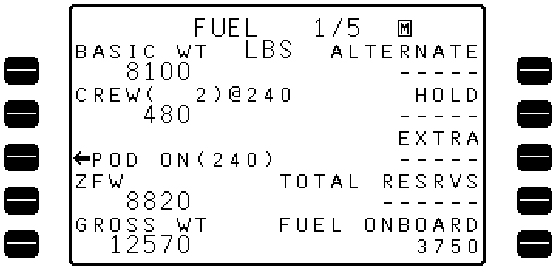

Figure 4-26. Fuel Page 1

BASIC WT – The basic operating weight of the aircraft (i.e., Empty Weight plus crew and provisions), up to six digits, max 999999. The BOW value shown in this field is programmed into the Configuration Module. Entry of a new weight will override the Configuration Module weight, and will be retained in memory for future use. One or two crew may be selected, and one can toggle POD ON or OFF. The cursor will initialize to LSK [5R]. Appropriate weights will be used for total weight computation.

ZFW – The Zero Fuel Weight is automatically calculated based upon the three prior entries. If desired, this value may be directly entered (max 999999). Calculated weights are limited to six digits.

GROSS WT – The sum of the ZFW and FUEL ONBOARD values. Gross weight will not be calculated until FUEL ONBOARD entry is made or confirmed. It is not possible to enter data in this field.

ALTERNATE – The fuel required to the alternate landing field.

HOLD – The fuel loaded for holding at the destination.

EXTRA – Additional reserve fuel loaded beyond that for alternate landing field and holding. Extra fuel generally does not change from flight to flight.

TOTAL RESRVS – The Total Reserves value is automatically calculated based upon the three prior reserve fuel entries. This value can be entered directly and is normally set to 600 lb.

FUEL ONBOARD – The total fuel on board value is stored in memory until manually changed. Confirmation is required following initialization.

FUEL Page 2

This page displays range and endurance estimates based upon departure time and current parameters. Manual FUEL FLOW and GS (groundspeed) entries may be made to evaluate their effect on the other parameters displayed. If all entries have been made on FUEL Page 1, then this will be the first page display when the FUEL Key is pressed from another mode. See Figure 4-27.

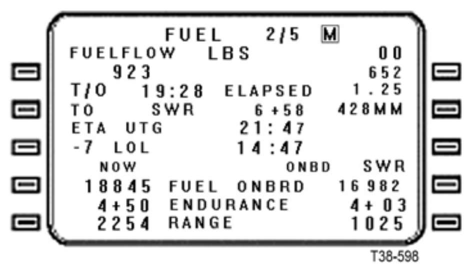

Figure 4-27. Fuel Page 2

FUEL FLOW – Cumulative fuel consumption in pounds. Placing the cursor over the FUEL FLOW entry field allows a manual fuel flow entry to be made. When a manual entry is made, the performance displayed on this page will be referenced to that value.

GS – The groundspeed expressed in knots. Placing the cursor over the GS entry field allows a manual groundspeed entry to be made. When a manual entry is made, the performance displayed on this page will be referenced to that value.

NOTE

If Fuel Flow or GS are manually entered, these values will be lost when the fuel function is exited.

T/O – Takeoff time.

ELAPSED – The time elapsed since takeoff.

TO – Time and distance to the final waypoint. The alternate landing field destination may be entered to show predictions for the great circle distance and bearing to the alternate. Press this key to bring cursor over destination ident and enter a new ident as an alternate. The LIST function will present an airport list. An (A) will appear next to the new destination.

ETA – The estimated time of arrival at the TO waypoint location. ETA is based upon the present time and the current groundspeed over the flight planned route. ETA is displayed in terms of UTC and LCL (local) time. The local time zone difference from the zero meridian can be entered up to ±13 hours. The ± key is used to toggle the sign with the cursor over the LCL entry field. The sign will prefill with a minus (-) when the longitude of the TO waypoint location is W and prefill with a plus (+) when the longitude is E.

FUEL ONBRD – To the left, under "NOW," is the present fuel on board the aircraft in pounds. The value is equal to the FUEL ONBOARD value last entered on FUEL page 1 (on the ground or in flight) minus the fuel used since that entry was made. To the right, under "OVHD (DESTINATION)," is the calculated fuel remaining over the destination based upon present fuel on board, present groundspeed, and present fuel flow.

ENDURANCE – Under "NOW," the amount of time in hours and minutes that the flight can continue with the present fuel flow. Under "OVHD (DESTINATION)," the estimated amount of time the flight could continue after the destination is reached based upon the calculated FUEL ON BOARD at that location and present fuel flow. ENDURANCE is based on using all available fuel on board the aircraft, including reserves.

RANGE – Under "NOW," the distance in NM that can be traversed with the present fuel flow, fuel on board, and groundspeed. Under "OVHD (DESTINATION)," the estimated distance in NM which could be traversed after the destination is reached. This range is based upon the calculated FUEL ON BOARD at that location, present fuel flow, and present groundspeed. RANGE is based upon using all fuel on board the aircraft, including reserves.

FUEL Page 3

FUEL Page 3 provides a summary of the fuel requirements for the flight plan. Manual FUEL FLOW and GS (groundspeed) entries may be made to evaluate their effect on the other parameters displayed. See Figure 4-28.

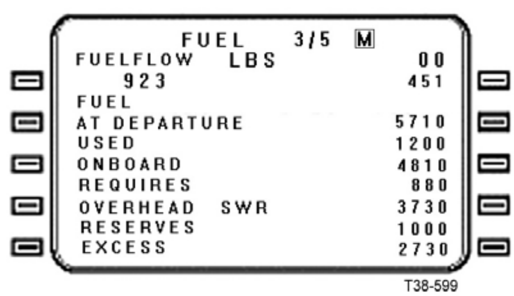

Figure 4-28. Fuel Page 3

FUEL FLOW – Cumulative fuel consumption in pounds (kilograms). Placing the cursor over the FUEL FLOW entry field allows a manual fuel flow entry to be made. When a manual entry is made, the performance displayed on this page will be referenced to that value.

GS – The groundspeed expressed in knots. Placing the cursor over the GS entry field allows a manual groundspeed entry to be made. When a manual entry is made, the performance displayed on this page will be referenced to that value.

NOTE

If Fuel Flow or GS are manually entered, these values will be lost when the fuel mode is exited.

AT DEPARTURE – The total fuel entered on FUEL page 1 prior to departure. This value will display dashes if a new fuel entry is made while airborne.

USED – The total fuel used. USED is set to zero whenever a FUEL ON BOARD entry is made on FUEL page 1 while on the ground.

ONBOARD – The fuel on board the aircraft is equal to the total FUEL ON BOARD value last entered on FUEL page 1 (on the ground or in flight) minus the fuel used since that entry was made.

REQUIRED – The estimated fuel required to the destination. Required fuel is based upon present fuel flow and ETE to destination.

OVERHEAD – The estimated fuel on board at the destination. OVERHEAD fuel is equal to ONBOARD minus REQUIRED. The figure flashes if its value is less than zero.

RESERVES – The total reserves value as entered on FUEL page 1.

EXCESS – Excess fuel at destination. EXCESS is equal to OVERHEAD minus RESERVES. The figure flashes if its value is less than zero.

FUEL Page 4

This FUEL Page displays projected landing weight based upon current fuel conditions. All fuel quantity and gross weight displays are computed values based upon the initial values input by the pilot and inputs from the engine fuel flow sensors. The values displayed on this page may not be changed and the line select keys have no function. See Figure 4-29.

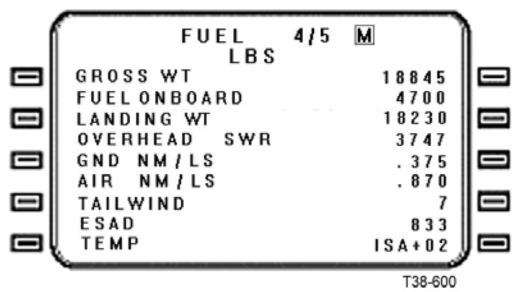

Figure 4-29. Fuel Page 4

GROSS WT – The current gross weight of the aircraft is based on zero fuel weight plus present fuel on board.

FUEL ONBOARD – The current fuel on board is calculated from the last fuel on board entry and fuel flow inputs subsequent to that entry.

LANDING WT – The landing weight is based on current gross weight minus fuel burn to destination (or the last waypoint prior to a gap). The estimated fuel burn is calculated using present ground speed and fuel flow.

OVERHEAD (DESTINATION) – The calculated fuel remaining over the destination (or the last waypoint prior to a gap) based upon present fuel on board, present groundspeed, and present fuel flow.

GND NM/LB – Ground nautical miles per pound of fuel. The value shown is based on the present groundspeed and fuel flow.

AIR NM/LB – Air nautical miles per pound of fuel. AIR NM/LB is based on TAS and fuel flow.

HEADWIND/TAILWIND – The wind component in knots.

ESAD – Equivalent Still Air Distance. This is the distance the aircraft would have flown since takeoff under zero wind conditions, or the air miles flown.

TEMP – The temperature in terms of the difference between the actual SAT (static air temperature) and the ISA standard SAT based upon current altitude.

FUEL Page 5

FUEL page 5 shows the fuel flow and fuel consumption in pounds per hour for each engine individually and cumulatively. The fuel flows shown are supplied by the aircraft's fuel flow sensors. The total fuel value is entered on FUEL 1/1 pages.

FLOW – The fuel flow in pounds per hour. The values shown are obtained from inputs from the engine fuel flow sensors. If the fuel flow for an engine drops to zero for 4 minutes, FAIL will be displayed. The fail can be removed and input restored by placing the cursor over the FAIL and pressing the BACK key and ENTER key. If fuel flow input has returned (such as after engine shut down and restart) it will be restored to normal operation. Manual FUEL FLOW entries can be made. Line select keys are used to position the cursor to enter fuel flows for the individual engines. If a manual fuel flow entry is made, (MAN) will be displayed. The maximum fuel flow entry for each engine is 20,000 pph. A manual fuel flow entry can be removed by pressing the BACK and then ENTER keys while the cursor is over then fuel flow entry field.

USED – The cumulative fuel used in pounds for each engine and the total for all engines. Manual FUEL USED entries may be made. Line select keys are used to position the cursor to enter fuel used for the individual engines. In the event of a power failure, the fuel used figures will be corrected by an amount equal to the present fuel flow times the duration of the power failure.

TUNE Key

At this time, the TUNE function is inoperative.

NAV Key

The NAV key is used to access the navigation function display pages. There are normally three Navigation pages; however, when another Navigation mode such as APPROACH is selected there will be four or more display pages, which are cycled through by pressing the PREV or NEXT function keys (pressing NAV and pressing NEXT is equivalent from and NAV page).

NAV Function

The NAV function and pages display all the navigation data normally required by the pilots, as well as provide a means of altering the current navigation leg. The navigational data displayed includes the current FR (from), TO (to), and NX (next) waypoints from the flight plan; the distance, course, and bearing to the TO waypoint; the parallel crosstrack left or right of the course; the wind direction and speed; the wind drift angle; the current groundtrack and groundspeed; and the position certainty value.

When the current navigation leg is valid (TO waypoint displayed on the NAV page) and the position is certain, the HSI flag will be out of view and the desired track and related data will be displayed. Roll steering outputs for flight guidance will be available if the navigation leg and velocity are valid. Groundspeed will be valid if heading and TAS are available to the navigation computer.

Normally, leg changes along a flight plan are automatic. Automatic leg changes will not occur if there is no NX waypoint on the NAV page. For example, no automatic leg change will occur when the TO waypoint is followed by a gap (*GAP* or *NO LINK*) or the TO waypoint is the last waypoint on the flight plan. In this situation, the message NEXT LEG INVALID will occur. When the aircraft passes the TO waypoint there will be no leg sequencing, TO/FROM will change to FROM, distance will begin to increase, and the message CURRENT LEG EXTENDED will be displayed. This presentation will alert the pilot that the aircraft is proceeding on an extension of the last valid desired track from the last waypoint.

Fifteen seconds prior to an automatic leg change (or arrival at the TO waypoint) the WPT ALERT message will become active and the WPT alert annunciator will illuminate steady. Pressing the MSG key will display the message. Automatic leg changes occur before the TO waypoint at a distance based upon groundspeed, leg change magnitude, and roll steering bank limit for the present altitude unless overfly (OVFLY) option selected. The maximum distance before the waypoint at which the leg change will occur is 12 NM. If the aircraft passes to the side of a TO waypoint, the leg change will occur abeam the waypoint. If the TO waypoint is designated as a fly-over waypoint (delayed automatic leg change), the leg change will begin over the waypoint. While Selected Crosstrack is active, leg sequencing may occur early or late with small course changes of 20 degrees or less. Automatic cancellation of Selected Crosstrack will occur when the course change is greater than 20 degrees. If the Selected Crosstrack function is used, the flight crew should monitor aircraft flight path and plan to manually cancel SXTK prior to or no later than the next waypoint as required.

When the approach mode is entered, leg changes at the approach waypoints are automatic. In the approach mode, the WPT ALERT message becomes active and the WPT alert annunciator illuminates steady 5 seconds prior to an automatic leg change. When the approach mode has been activated within 50 NM of the end-of-approach point (MAP or runway) and the required navaid is tuned, the FMS will generate the approach mode outputs. These will include bearing and distance to waypoint, desired track, crosstrack, lateral valid, approach annunciator, vertical deviation (glideslope), and vertical valid.

Estimate of Position Accuracy

The FMS computes and displays an estimate of position uncertainty to advise the user of the system's position accuracy. The estimate is the 95 percent probability that the FMS position is within a certain distance of the actual position. The FMS estimate is displayed as Actual Navigational Performance (ANP).

ANP is also a measure of the system's best estimate of error, calculated to allow for flight technical error, in hundredths of a nautical mile. For example, if ANP = 1.00 NM, then there is roughly a 95 percent chance that the FMS position is within 0.91 NM of the actual position.

The Required Navigation Performance (RNP) value is the limit to position uncertainty the system will allow for continued flight and are specified for each phase of flight. RNP values are derived from two sources: FMS default values or manual entry.

Manually entered RNP values override FMS default values. The FMS RNP values are acceptable up to and including the following limits for each flight phase:

Flight Phase	RNP Limit
Oceanic	6.0
Enroute	2.8
Terminal	1.0
Approach	0.5

A position uncertain message will be displayed when the ANP value is greater than these RNP limits.

NAV Page 1

The information presented on NAV Page 1/3 correlates with the information displayed on the HSI (see Figure 4-30). The page is accessed from any other mode by pressing the NAV function key. The page provides complete information about the current and next navigation legs, and allows the pilot to alter the current navigation leg or to select another lateral guidance mode.

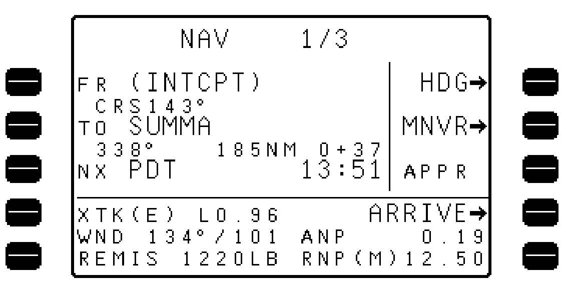

Figure 4-30. NAV 1/3 Page With ANP/RNP

The NAV Page 1/3 display is divided by a dark horizontal line. Information above the line is formatted in the manner of non-radar position report and includes:

FR – The FROM field displays the name of the current FROM waypoint and the time of waypoint passage. Under the way-point name the desired course, distance and ETE to the current TO waypoint appears. Desired course is the course (or desired track) between FROM and TO waypoints. Distance and ETE are from present position to the TO waypoint. Estimated Time Enroute (ETE) is distinguished from clock time by the use of plus (+) sign, clock times use the colon (:) separation.

TO – The name of the current TO waypoint and ETA. Under the TO waypoint is displayed the course, distance and ETE to the next (NX) waypoint. The following line displays the name of the NX waypoint and ETA.

On the right side of the page line select keys [2R] and [3R] are used to access or perform special functions:

[2R]—MNVR – Pressing this line select key will access the Maneuver Definition page. From this page, PVOR, SXTK and Holding Patterns can be defined and activated.

[3R]—ARM APPR or **ACT APPR** – Pressing this line select key will access the FMS APPROACH mode if there is an approach programmed into the flight plan. If the approach geometry is invalid, or the aircraft is outside 50nm from the airport, this selection will be shown in small white characters with no arrow. When the approach geometry is valid, an arrow will display for selection.

The following supplementary information appears below the line:

XTK – Crosstrack is the distance left or right of desired course. XTK is appended with (E), (T), or (A) indicating enroute, terminal, or approach HSI scaling. A manual selected crosstrack may be entered in this field.

WND – This field displays the filtered wind direction and wind speed as computed by the Nav function. The first value displayed is the wind direction in degrees and the second value is the wind speed, in knots.

Destination and Fuel Remaining – Below WND, the current destination or last fix in the FPL is shown with estimated fuel remaining at that point.

ARRIVE – Transfers control to the FPL-MENU-ARRIVE page for selection of approaches, STARS, etc.

ANP – This field displays the computed ANP value.

RNP – This field displays the RNP value. If the user manually enters a value for RNP, (M) is displayed next to the value indicating a manual entry. If no indication is displayed in parenthesis, the value is a system default value (refer to Estimate of Position Accuracy in this section). To manually enter an RNP, press LSK [5R] to highlight the field, then enter the desired value.

NAV Page 2

NAV Page 2 is accessed by pressing the NAV function key then the NEXT key while Navigation Page 1/3 is displayed (or NAV twice). This page displays FROM, TO, and NX waypoint information; and crosstrack, wind, and groundspeed information similar to NAV 1/3. In addition, headwind/tailwind, bearing to current terminator, and track angle error is displayed (see Figure 4-31).

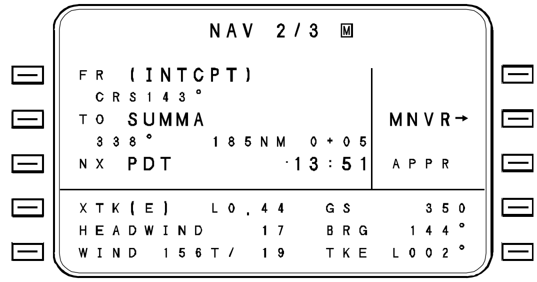

Figure 4-31. NAV Page 2

HEADWIND/TAILWIND – Displays wind component.

BRG – Displays the bearing to the current to waypoint.

TKE – Track angle error is the difference between the aircraft actual track and desired track. For procedural heading legs this displays field heading error which is the difference between desired heading and heading.

NAV Page 3

This page shows the FMS system position and position certainty associated with the FMS best computed position (see Figure 4-32). Shown beneath the quality factor is the most significant sensor. This line displays the RNP and ARP values.

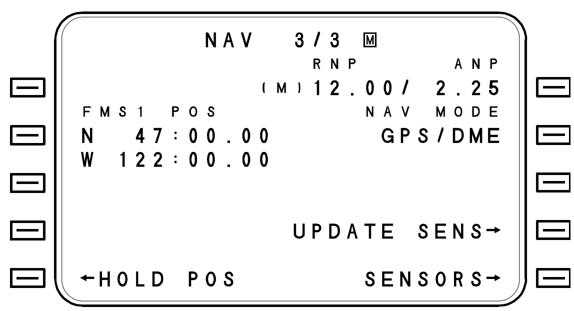

Figure 4-32. NAV Page 3/3

FMS1 POS – Pressing either line select key will access the Define Position page for entry of present position coordinates. <POS> will be displayed in the "WPT" entry field.

HOLD POS – Pressing this line select key will access the Hold Position page.

UPDATE SENS – Pressing this line select key will send current FMS Best Computed Position latitude/longitude to the IRS sensors for 10 seconds.

NOTE

- The IRS only accepts input during ground alignment.
- Pressing this key will cause no change in this page display.

SENSORS – Pressing this line select key will access Data Page 3.

DTO Key

The DTO key accesses the Direct To function and is specifically dedicated to changing the flight plan in response to "direct to" clearances. If the "direct to" location is off the flight plan, provisions are made to link the location into the flight plan. DTO is a direct in the flight plan, lateral sense; in VNAV operation, there is an equivalent in the vertical sense.

DTO Function

When the DTO page is displayed, a leg change from the present position (PPOS) direct to a flight plan waypoint, a database waypoint, a pilot defined location, or an airport may be made (see Figure 4-33). A DTO command will cancel approach mode and VNAV operation. If a DTO is activated during a Hold, the Hold is automatically cancelled and the DTO page is displayed. The turn direction will default to shortest turn; however, the pilot can override this by specifying LEFT or RIGHT direction. Pressing AUTO will cancel LEFT or RIGHT and return default to shortest direction.

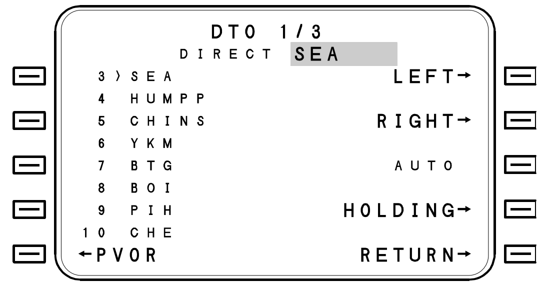

Figure 4-33. DTO Page

A waypoint may be selected from the flight plan by entering the reference number, entered by using the LIST function, or entered manually by typing in the waypoint identifier. When the ENTER key is pressed, the aircraft will steer directly to that waypoint unless the waypoint is a PVOR.

The right line select keys allow modification of the DTO function.

LEFT, RIGHT, AUTO – These keys allow the specification of a turn direction. AUTO specifies the shortest turn direction.

HOLDING – Pressing this key will access the Holding Pattern Page.

PVOR – Pressing this key will access the PVOR definition page for selection of a radial to be followed into the DTO waypoint. PVOR is nearly identical with PSEUDO-VORTAC operation of previous FMS sensors.

If a PVOR radial has been entered, the FMS will provide steering for a 45° intercept with the selected pseudo-VOR radial.

RETURN – Pressing this line select key will return the display to NAV Page 1.

FPL Key

The FPL function key is used to access the Flight Plan page(s) or to access stored arrivals and routes. The Flight Plan pages may be accessed in order to construct a new flight plan, alter the current flight plan, or to insert a SID, STAR, and approach into the flight plan.

Empty FPL Page

The Empty Flight Plan Page will be displayed whenever the FPL mode key is pressed and there is no flight plan in the system (see Figure 4-34). This page is used to build flight plans.

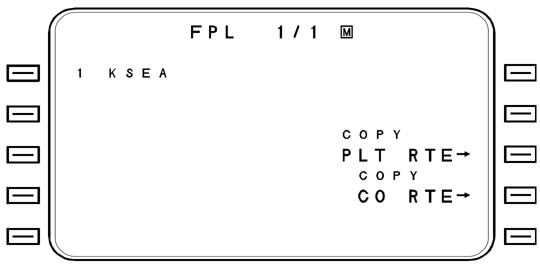

Figure 4-34. Empty Flight Plan Page

COPY PLT RTE – Pressing the COPY RTE line select key will cause a listing of routes appropriate for the initial waypoint position to be displayed. Entering the reference number of one of the stored routes will copy that route into the flight plan.

COPY CO RTE – If a Company Route Database is installed, COPY CO RTE is displayed as an option at LSK [4R]. Pressing this line select key displays the CO RTE Page.

Normal FPL Display Pages

The Normal FPL display pages are accessed by pressing the FPL function key when a flight plan has been defined. These pages show the flight plan waypoints, ETAs, altitudes (when defined in VNAV), bearings, and distances between waypoints. In the case of procedural legs of SIDs, STARs and approaches, path type and terminator are shown. The page also allows editing of the flight plan. Succeeding pages of the flight plan may be displayed by pressing the PREV or NEXT keys, as appropriate.

Overfly Waypoints – An asterisk (*) after the waypoint identifier indicates that it has been designated as an overfly waypoint. If a waypoint is designated as overfly, automatic leg changes are delayed until the aircraft is over the waypoint. Overfly waypoints are defined by pressing the OVFLY line select key while the cursor is over the desired waypoint. The overfly designation may be removed in the same manner by pressing CNCL OVFLY. Only geographic points (not procedural legs) may be designated as 'overfly'.

Waypoint Info Mode – When the cursor is placed over a waypoint, up to four options will appear in the right hand column (see Figure 4-35).

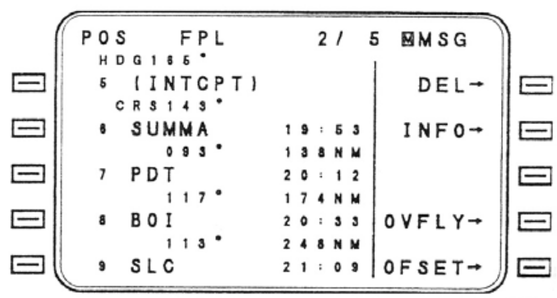

Figure 4-35. Waypoint Options Display

OVFLY/CNCL OVFLY – See above description of overfly waypoints.

DEL – Pressing this key twice will delete the selected waypoint from the flight plan.

INFO – Will display all information from the navigation or pilot database concerning the waypoint or navaid.

OFSET – If the highlighted waypoint terminates a leg type that can have an altitude constraint, then OFSET is displayed. Selecting LSK [5R] will display the Path VNAV page with the cursor over the corresponding vertical waypoint's offset field.

Flight Plan Summary Page

Available only during ground operations prior to departure, the Flight Plan Summary page provides a synopsis of distance, time, and fuel requirements for the planned flight (see Figure 4-36). This page is accessed from the Flight Plan (FPL) mode by using the PREV and NEXT keys. The FPL SUMMARY page is located following the last flight plan page.

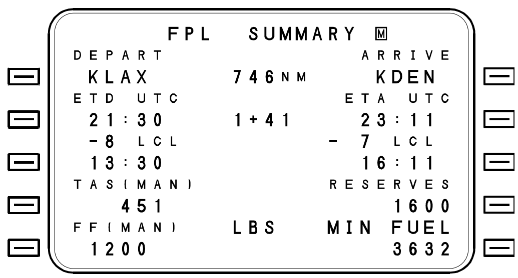

Figure 4-36. Flight Plan Summary Page

Manual TAS and Fuel Flow (FF) can be entered to show estimated time enroute and estimated fuel required. ETD (Estimated Time of Departure) can be entered so ETA (Estimated Time of Arrival) can be calculated. If winds are entered for various flight plan waypoints, more accurate ETAs will result. Local UTC offsets can be entered at the departure and arrival locations to display local times. Any of the four times may be entered, and the other three will be calculated based upon estimated time enroute.

FPL Menu Pages

The Flight Menu pages are assessed from any FPL page by pressing the MENU key (see Figure 4-37). The options on these pages allow the pilot to select various display formats for the flight plan way-points or to view the approach plan. It also allows the insertion of a SID (DEPART), STAR, and Approach (ARRIVE) into the flight plan, deletion of Flight Plan, Flight Plan Winds, Temperature Compensation for approach altitudes, and Inverting the flight plan (see Figure 4-37).

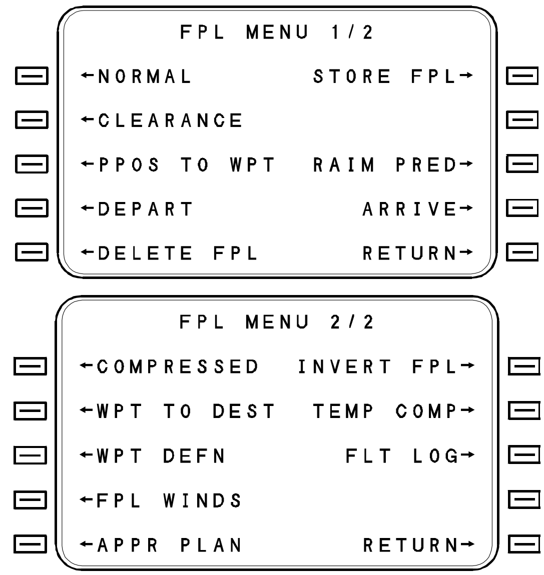

Figure 4-37. FPL Menu Pages

VNAV Key

The vertical navigation key provides access to the VNAV function, which allows the flight crew to define a desired vertical flight profile along the flight plan route. It then computes the aircraft deviation from that profile for display.

VNAV Function

The flight profile is defined by two waypoints with reference altitudes, by the aircraft present position plus one waypoint ahead of the aircraft, or by one waypoint ahead of the aircraft and a target vertical speed. A flight profile which results in a climb will provide VSR (Vertical Speed Required) information only. Vertical waypoint identifiers are prefilled automatically with the current flight plan waypoints (but with no offsets or altitudes). VNAV altitudes at flight plan waypoints may also be programmed on the Flight Plan pages.

LIST Key

The LIST key is used to provide a list of options appropriate to the data to be entered. While performing data entry, pressing the LIST key presents a list of selections appropriate to the entry being made.

MENU Key

The MENU key is used to present a list of alternate formats or options for the FUEL, FPL, or VNAV being displayed. The letter “M” in a box will appear on the title line of any page in which the MENU key is active. Refer to the applicable section for further details.

PERF Key

Press the PERF key to access PERF 1/1, which 1/1 provides a synopsis of pertinent inflight performance information (see Figure 4-38).

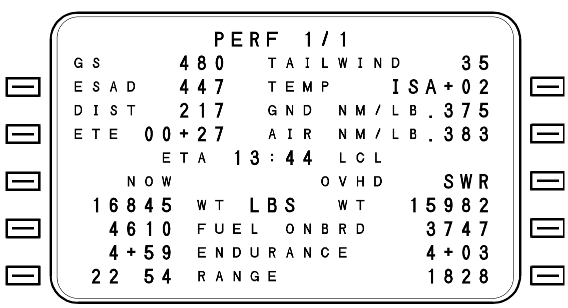

Figure 4-38. PERF 1/1 Page

INTRODUCTION TO DATABASE INFORMATION

This Database Section contains information regarding the Offline Flight Planning Database, Navigation Database, Pilot Defined Database, and Company Routes Database. A Data Transfer Unit (DTU) is used to load databases into the FMS. All databases involve the same instructions for loading.

FLIGHT PLANNING DATA

Offline PC-created flight plan data can be loaded into the FMS via the DTU. Flight Plan types consist of company routes, pilot routes, pilot waypoints, pilot SID/STARs, and pilot approaches.

MAINTENANCE DATA

The FMS stores a diagnostic history of all configured sensors. Whenever a sensor failure is detected, a maintenance log is created automatically. The crew can also create a manual maintenance log. Automatic maintenance log entries will only be made during flight but manual entries can be made in the air or on the ground.

The creation of a maintenance log is indicated 1 minute after touchdown by the appearance of a “NEW MAINT LOG EXISTS” message. If this occurs, generate a maintenance action upon return from flight.

Navigation Database

NOTE

All data contained in both the worldwide and regionalized Navigation Databases is compiled and supplied by Jeppesen. This includes the original data contained in each new system and the update data periodically supplied in disk format. While every effort is made to ensure that the stored data is accurate, it is the user’s responsibility and prerogative to reference Jeppesen’s or others’ publications in order to verify the accuracy of the data that is to be used.

Navigation data consists of airports, intersection, VOR and NDB navaids, plain language descriptions of airports, and High and Low altitude airways as well as SIDs, STARs, Approaches (including NDB and GPS overlay), and Runway coordinates.

The FMS provides the plain language or geographical name for all Navigation Database navaids and airports that it stores and uses. These plain language names will be provided to the pilot as a special LIST feature for APTs, VORs and NDBs. Plain language names up to 15 characters in length are displayed on the LIST page and up to 24 characters on the Waypoint select pages. This helps eliminate difficulty in correlating airports and navaid names with their identifiers. Many airports and navaids have no correlation with the named geographical location. The database is USA-and-Canada-only database, available with airports containing at least 6,000 feet of runways.

All databases provide or have provisions for the following:

VORs – The station identifier, class, frequency, and geographic coordinates of all VOR stations worldwide or regional, as applicable.

DMEs – The station identifier, geographic coordinates, frequency, and elevation of every DME, TACAN, VORTAC, and ILS-DME world wide.

NDBs – The station identifier and geographic coordinates for all NDB stations.

Airports – The airport identifier and geographic coordinates for all airports having at least a 6,000-foot hard surface runway and an instrument approach procedure.

Approaches and Runways – Approaches, approach transitions, missed approach procedures, and runways. The approaches are provided with any approach transition that may be applicable to that particular runway. If an approach transition exists, it is coded with the path terminator type of procedural legs found in SIDs and STARs. The FMS contains the approaches, approach transitions, and runways that are provided by the Navigation Database supplier for a given region. The approaches specify the applicable runway, the inbound approach course, the approach type, the Final Approach Fix (FAF), the Final Approach Capture Fix (FACF), the FAF altitude, and the FACF altitude and required navaid. The runway landing thresholds are defined with lat/long coordinates to 0.001 minute, and touchdown elevation to the nearest foot.

The following approach types are included in the database: ILS, LOC, BC, RNV, VOR, VOR/DME, TACAN, NDB, GPS, and GLS. The letter “G” following approach listing in the database indicates that GPS can be selected for navigation.

NOTE

Not all published procedures are contained in either the DOD FLIP or the Jeppesen database. Before departure, check that the required procedures are available.

High and Low Altitude Airways – High and Low Altitude Airways are available to the pilot for selection during flight planning. When an Airway starting point and ending point are entered, all navaids and intersections between these two points will be loaded into the flight plan. This procedure is repeated to completely define the airway routing.

Intersections – The geographic coordinates of all enroute and terminal area intersections, waypoints, and turning points.

Procedural Holding Patterns – Holding patterns associated with stored procedures (SIDs, STARs, and Approaches) are included. Procedural holding patterns are coded with their appropriate leg terminator, either altitude, fix, or manual.

SIDs and STARs – Standard Instrument Departures (SIDs) and Standard Terminal Arrival Routes (STARs) consist of procedural legs, which begin and end at prescribed locations or conditions. The path of these legs can be flown along a heading, a course, a great circle path, or even a constant DME arc. The termination of a leg can occur at a specific geographic fix, at a VOR radial crossing, or when the aircraft attains a certain altitude. There are a total of 20 types of procedural legs, which may be utilized in the definition of a SID or STAR.

The FMS presents SIDs and STARs in an easy-to-use menu format. The pilot need only select the reference number associated with the departure/arrival procedure chosen. The entire procedure will then be inserted into the flight plan. The legs that comprise the procedure will each be detailed on the flight plan page with all the information needed to describe its path and terminator. Before selecting any departure or arrival, the pilot may view the detailed procedure through the DATA mode on the FMS.

Navigation Database Interrogation Waypoints

Any waypoint in the Navigation Database is opened for interrogation by typing its identifier on the Database Menu page (DATA/NAV). The following information is available for each identifier in the database:

NOTE

The data in the Navigation Database is not available for manual update and cannot be changed by the pilot.

The type of identifier is displayed as APT for airports, ENR for enroute (high-altitude or low-altitude) intersections or turning points, NAV for navaids, NDB for non-directional beacons, or TER for terminal area waypoints.

- The latitude and longitude coordinates will be displayed for all identifiers (APT, ENR, NAV, NDB, and TER).
- The type of navaid, if the identifier is a navaid, will be displayed as VOR, DME, NDB, VOR/DME, TACAN, VORTAC, or ILS/DME as applicable.
- The class of navaid, if applicable, will be displayed as LOW, TERM (terminal), HIGH, or UNDF (undefined).
- The frequency of the navaid will be displayed if the navaid is a VOR, DME, VOR/DME, TACAN, VORTAC, ILS/DME, or NDB.
- The station elevation will be displayed if the navaid is a DME, VOR/DME, TACAN, VORTAC, or ILS/DME.
- The declination (orientation relative to true North) of the navaid will be displayed if the navaid is a VOR, VOR/DME, TACAN, or VORTAC.
- If there are two or more locations with the same identifier, a fraction (such as 01/02) will be displayed below the type of identifier. The fraction 01/02 indicates the data displayed is for the first of two locations with the same name. The value 01/01, if displayed, indicates the location/identifier is unique.

NOTE

The Navigation Database contains mileage breaks or turning points (unnamed intersections) which are identified on enroute charts only by an "X." To interrogate a mileage break up to and including 99 DME from the associated navaid, input the navaid identifier then the DME distance to the point. For example, if the mileage break were 54 DME from PDX, then the proper entry would be PDX54. To interrogate a mileage break 100 DME or farther from the associated navaid, input the last two digits followed immediately by the navaid identifier. For example, if the mileage break were 110 DME from FST, then the proper entry would be 10FST.

Flashing Identifiers and Route Elements

Navigation Database items used in defining pilot data are checked for movement and deletion when the Navigation database is loaded. A flashing identifier or element signifies that, subsequent to the time the route was created, it has been moved or otherwise affected by a NAV Database change during an update process.

If an approach waypoint moves 0.1 to 0.25 arc minute, the affected airport, approach, transition identifiers, and leg terminators will flash. If the waypoint moves more than 0.25 arc minute or is not found, the affected airport, approach, and transition identifiers will flash, and leg terminators will be replaced with a flashing *GAP*.

If a waypoint or runway used in a final approach is moved or deleted, the pilot approach is deleted. Deleted approach identifiers will flash and be preceded with a "D" on the Pilot Approach Directory Page.

If a SID or STAR waypoint moves 0.25 to 0.5 arc minute, the affected airport, runway, SID/STAR, transition identifiers, and leg terminators will flash. If the waypoint moves more than 0.5 arc minute or is not found, the affected airport, runway, SID/STAR, and transition identifiers will flash, and a flashing *GAP* is inserted in pilot routes containing SIDs/STARs and flight plans.

If a Navigation Database waypoint in a pilot route moves 0.5 to 1.4 arc minute, the affected route identifier and leg terminator will flash. If the waypoint moves more than 1.4 arc minute or is not found, the route identifier will flash, and a *GAP* will be inserted into the pilot route.

To remedy a flashing waypoint, place the cursor over the waypoint and press ENTER. To remedy a flashing *GAP*, reenter the waypoint if it is still in the Navigation Database, then delete the *GAP* from the route or edit the flight plan to establish a new routing.

Terminal Procedures

Selection of NAV DATA line select key [1L] from DATA 1/4 Page (see Figure 4-39), will display DATA/NAV 1/2, from which SID, STAR, APPROACH, RUNWAY, and AIRWAY information can be reviewed and selected. The data selected under any menu will be for display only, and cannot be modified by the pilot. Information pertaining to the active Navigation Database is displayed on the right side of the screen.

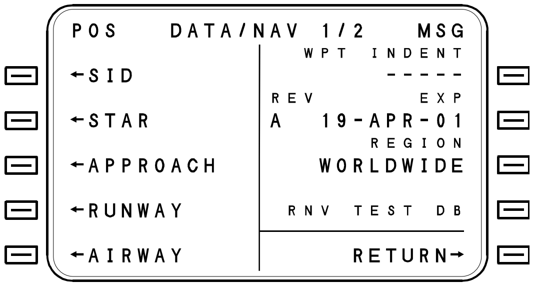

Figure 4-39. DATA/NAV 1/2 Page

SID

This page allows the user to enter an airport, runway, SID and transition to review (see Figure 4-40).

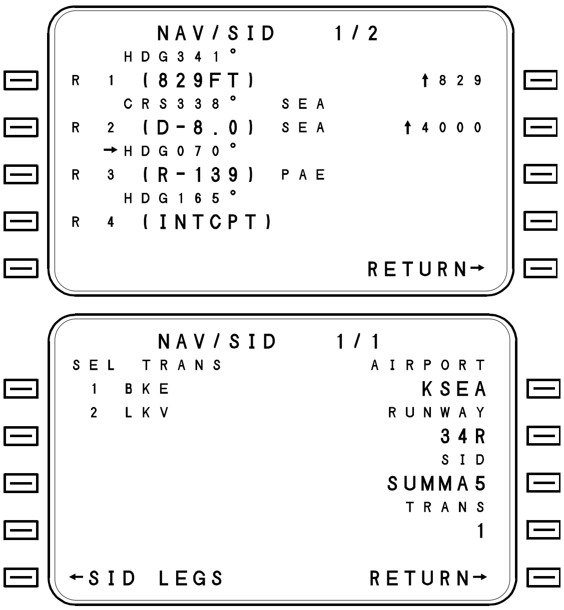

Figure 4-40. NAV/SID Pages

NOTE

A pilot defined SID is distinguished from a NAV defined SID by a percent symbol, %, next to its identifier.

SID LEGS – Pressing this key will access the NAV/SID LEGS pages which show all procedural legs that make up the selected SID (see Figure 4-41). The following pages show the legs for the KSEA Rwy 34R, SUMMA5 departure with PDT transition.

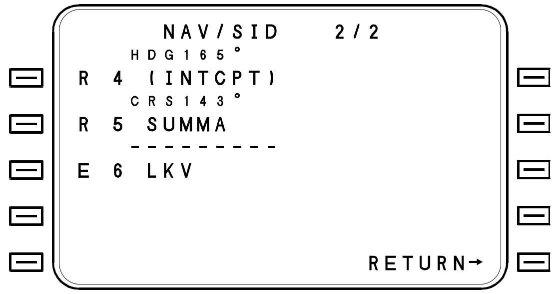

Figure 4-41. NAV/SID LEGS Page

STAR

This page allows the pilot to enter an airport, runway, STAR and transition to review.

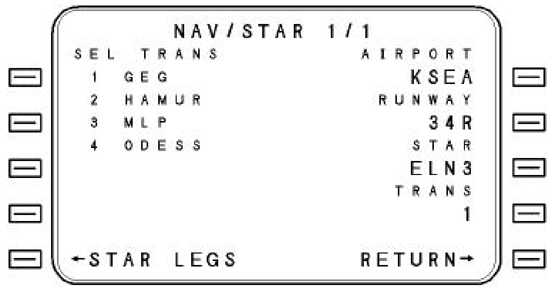

Figure 4-42. NAV/STAR 1/1 Page

NOTE

A pilot defined STAR is distinguished from a NAV defined STAR by a percent symbol, %, next to its identifier.

STAR LEGS – Pressing this line select key will allow preview of the procedural legs that comprise the selected STAR. The following screen shows the legs for the KSEA Rwy 34R, ELN3 STAR with GEG transition (see Figure 4-43):

Figure 4-43. NAV/STAR 1/3 Page

APPROACH

This page allows the pilot to enter an airport and approach to review (see Figure 4-44).

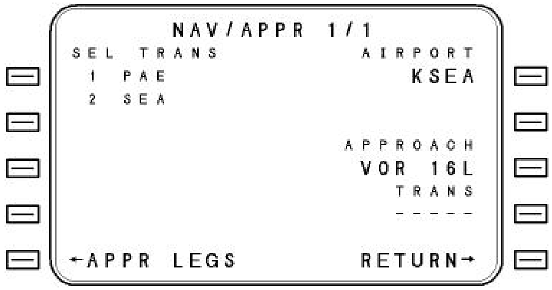

Figure 4-44. NAV/APPR Page

NOTE

> The following approaches are available to the user: GLS, GPS, NDB, ILS, BC, LOC, RNAV, VOR, and TACAN. Any other approach type is not displayed. ILS, BC, and LOC approaches will not transition to approach mode.

APPR LEGS – Pressing this LSK will allow preview of the approach legs for the selected approach, as shown in the following example (see Figure 4-45):

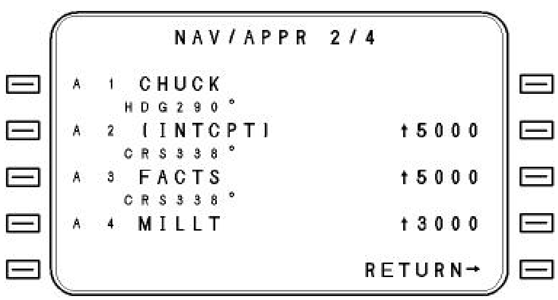

Figure 4-45. APPR LEGS Page

Pressing PREV and NEXT will allow viewing of all pages in sequence.

NOTE

> Approach stepdown fixes will not be shown if the altitude for the stepdown fix lies below the straight line flight path angle extending from the FAF altitude to an altitude 50 feet above the MAP.

RUNWAY

This page allows the pilot to enter an airport runway to review (see Figure 4-46).

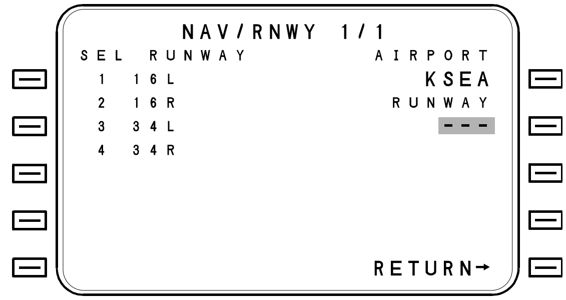

Figure 4-46. NAV/RNWY 1/1 Page

NOTE

> A pilot defined runway is distinguished from a NAV defined runway by a percent symbol, %, next to its identifier.

After selecting a runway, the Navigation Runway Definition Page (NAV/RNWY 1/1) displays all runway data (see Figure 4-47).

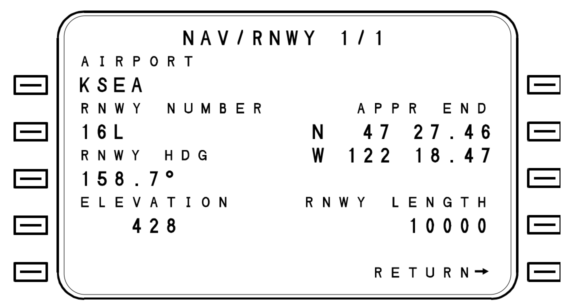

Figure 4-47. Navigation Runway Definition Page

AIRWAY

This page allows the pilot to enter a VOR navaid and review the High and Low Altitude Airways accessible at the navaid (see Figure 4-48).

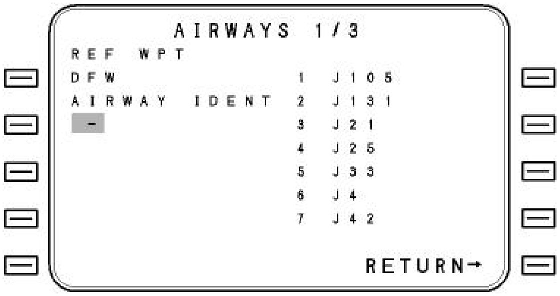

Figure 4-48. AIRWAYS 1/3 Page

Selecting the airway of interest will result in the following display of all navaids and intersections, which are on the airway (see Figure 4-49).

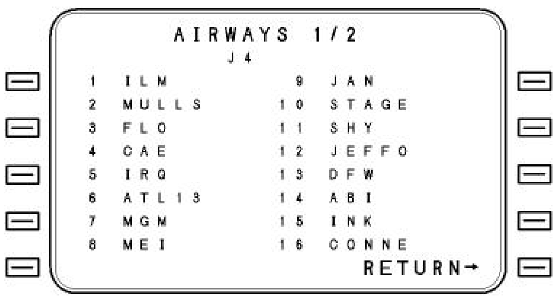

Figure 4-49. AIRWAYS 1/2 Page

Company Database

Company Routes Data

A company routes database can be created using Universal's Offline Flight Planning Program. A total of up to 2,000 routes and 250,000 route elements may be stored. The actual number of routes and route elements depends on the size of navigation data stored in the FMS. Each route will consist of at least one but not more than 98 legs (route elements). Route elements, reference waypoints, airways, and terminal area procedures (SIDs, STARs, and Approaches) from the Navigation Database by reference pointers. Company defined waypoints and airports are also supported and can be loaded with the company routes database. Company routes can be given names of up to eight characters in length.

Company Routes Directory Page

The Company Routes Directory page(s) is accessed by selecting CO ROUTE, LSK [5L], from the Pilot Data page. These pages allow the user to select a company route to review. The number of pages depend on the number of company routes in the directory.

SELECT ROUTE – Enter the reference number of the company route to review, then press ENTER to confirm. A valid entry will display the Normal Company Route page for the associated route. An invalid entry will flash (see Figure 4-50).

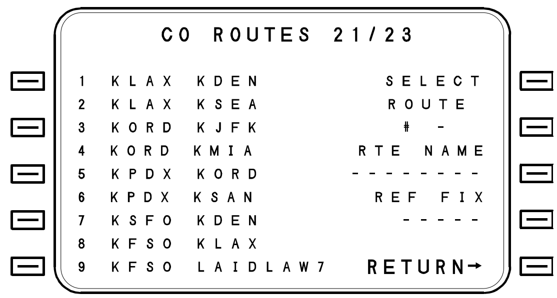

Figure 4-50. Normal Company Route Page

RTE NAME – Enter the eight-letter name of the company route to review then press ENTER. Entering a valid company route name will display the associated route on the Normal Company Route page. If more than one match for an entered company route name is found, the Company Routes Directory page will display all routes using that name (see Figure 4-51). An invalid entry will flash.

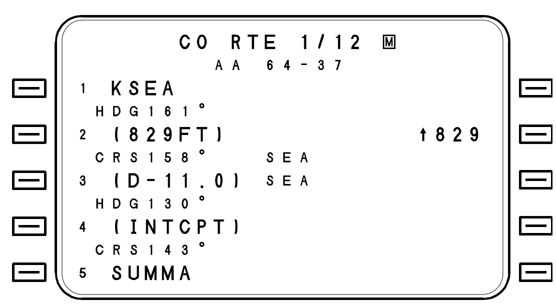

Figure 4-51. Company Routes Directory Page

REF FIX – Enter a reference fix in this field, either with the alphanumeric keys or via the LIST function. The FMS searches the Navigation and Pilot Databases for the reference fix entered. If the reference fix name is found, the Waypoint Identification pages for all matching records will be displayed. If an identifier not recognized by the FMS is entered in the reference fix field, the Define Position page shall be displayed.

Normal Company Route Page

The Normal Company Route pages are accessed from the Company Directory page by entering a valid route. This page allows the user to review a company route. Pressing any LSK [1L] thru [5L] places the cursor over the adjacent terminator identifier, if one exists. Selecting a terminator identifier will display the INFO prompt at LSK [2R]. Pressing LSK [2R] to select the INFO prompt will display the Waypoint Identification page.

Copy Company Route

Pressing the COPY CO RTE option from the Empty Flight Plan page accesses this page.

- Enter the route reference number at LSK [2R]. Press ENTER. Entering a valid route reference number will display that route on the Normal Flight Plan pages.
- Enter the Company Route Name at LSK [3R]. Press ENTER. Entering a valid company route name shall result in that route being displayed on the Normal Flight Plan pages.
- Enter a Reference Fix at LSK [4R], either with the alphanumeric keys or via the LIST function. The FMS will search the Navigation and Pilot Databases for the reference fix entered in this field. If the reference fix name is found, the Waypoint Identification pages for all matching records will be displayed. If an identifier not recognized by the FMS is entered in the reference fix field, the Define Position page shall be displayed (see Figure 4-52).

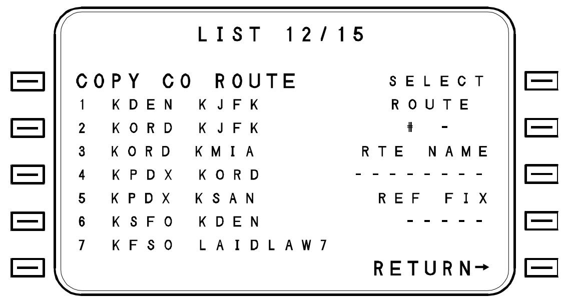

Figure 4-52. Define Position Page

Pilot Database

The pilot can create and store a substantial amount of Pilot Defined Data, including Waypoints, Alignment Points, Airports, Runways, Routes, Approaches, SIDs, and STARs. Additionally, it will include the reference databases that are associated with the SIDs, STARs, Approaches, and Runways. This data can be saved on disk for future use and reloaded into the FMS. Instructions for saving and loading Pilot Defined Data are provided at the end of this section.

Pilot-defined data provides or has provisions for the following:

Pilot Waypoints – 200 locations are reserved for pilots to input identifiers and geographic coordinates of any point desired (see Figure 4-53). These pilot defined locations can be parking ramp coordinates, VFR airports, or any other location. Once input, each pilot defined location will be retained in the database until it is manually removed.

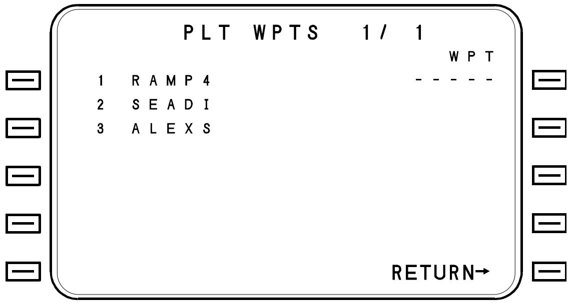

Figure 4-53. Pilot Waypoints Page

Routes – Up to 200 routes (ordered sequence of waypoints or legs) may be defined and stored in the database. There may be up to 98 waypoints or legs in any one stored route; however, the total number of route leg segments may not exceed 2,500.

Pilot Runways – The geographic coordinates and elevation of pilot defined end-of-approach points may be input and stored in the system's non-volatile memory. The number of runways, which may be defined and stored, is limited to 100.

Pilot Approaches – Memory space is allocated for the pilot to define VFR, VOR, TACAN, ILS, LOC, BC, and RNV approach courses and glidepaths to the pilot defined end-of-approach points. GPS, GLS, and NDB approaches cannot be pilot defined. The number of approaches, which may be defined and stored is limited to 100.

Pilot Defined Departures and Arrivals – Pilot defined departures and arrivals can be created using procedural legs. These are accessible in the same manner as the prestored SIDs and STARs described above. The FMS will store 100 pilot defined departures and arrivals.

Pilot Data Page

This page allows the user to access the pilot defined database (see Figure 4-54).

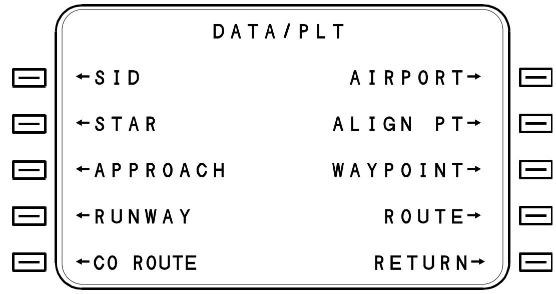

Figure 4-54. Data/Pilot Page

The database includes SIDs, STARs, Approaches, Runways, Company Routes, Airports, Alignment Points, Waypoints, and Routes. For each of these selections, except Company Routes, it is possible to create/define new data entries or delete existing ones. No modifications can be made to the Company Route data. To access the Pilot Data Menu page:

Press the DATA function key to access Data Page 1.

Press the PILOT DATA line select key.

Pilot Defined Waypoints

The PLT WPTS directory page(s) is accessed from the Pilot Data Menu page by selecting the WAYPOINT, LSK [3R], option. When the page is accessed, a list of all pilot defined waypoints stored in the database will be presented alphabetically. The PREV and NEXT keys provide access to other PLT WPTS pages. Entry of an invalid WPT at LSK [1R] will display the Define Waypoint page, from which a waypoint may be defined. Refer to the Define Position pages in this section.

Pilot Waypoint Identification Page

Entry of a valid waypoint identifier or reference number in the WPT field on the Directory page will cause the Pilot Waypoint Identification Page to be displayed. This page allows the user to view waypoint information as well as delete or modify the waypoint.

Delete – Pressing LSK [5L] twice will delete the pilot defined waypoint from the database.

If the waypoint's defining data has been affected by a Navigation Database update, LSK [5L] will prompt ACCEPT. Pressing LSK [5L] will confirm the changes to the waypoint definition.

Modify – Pressing LSK [4R] will display the DEFINE WPT page from which the user may change waypoint location (see Figure 4-55). Refer to the Define Position pages of this section.

NOTE

If waypoints are used in RTEs, FPL, SID, STAR or Approaches, the MODIFY line select key will be replaced by an IN USE XXX and may not be modified. DELETE will not be displayed.

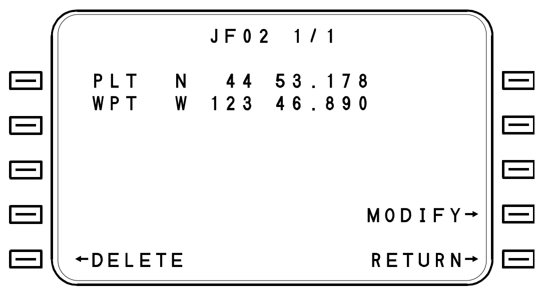

Figure 4-55. DEFINE WPT Page

Return – This LSK will return the display to the Pilot Waypoints Directory.

If the alignment point has been defined using the radial/distance or radial/radial method, the reference waypoint coordinates are displayed on this page.

Pilot Defined Routes

Route Construction

Up to 200 pilot defined routes may be constructed and stored in the database. The maximum number of legs that can be included in any one route is 98; however, the total number of legs in all the stored routes may not exceed 2,500. A SID, STAR, and Approach may be included in the route.

NOTE

Other than the "Create a Route" section, the following procedures are used for building active flight plans as well. From the blank FPL page with only the departure airport identified, the SIDs, STARs, LIST, etc. operations are identical to that shown below.

Create a Route

1. Press the DATA function key, then Pilot data LSK [2L].
2. Select ROUTE, LSK [4R] to display the Pilot Routes page.
3. Select CREATE ROUTE, LSK [3R], to display an empty PLT RTE page.
4. Use the List or direct entry method to enter the identifier of the first waypoint or airport in the route. Press ENTER. If the airport or waypoint is in the database, the applicable identification page will prompt the user to accept the entry.
5. The cursor will advance to the next identifier entry field. Continue entering waypoints to complete the route.

Add Departure SID

With the departure airport defined as the first waypoint, use the following procedure to link a SID to the route:

1. Press DATA, then Pilot Data line select key.
2. Select the ROUTE, LSK [4R]. Enter the reference number for the chosen route then press ENTER.
3. The Pilot Route page will display. Press the MENU function key. Select DEPART, LSK [4L].

4. The DEPARTURE 1/1 page will appear with a list of runways for that airport.

NOTE

If the departure airport has no SIDs or Runways in the database, then NONE is displayed.

5. Select the reference number of the departure runway. Press ENTER.
6. Select the reference number of the desired SID. Press ENTER.
7. Select the reference number of the desired enroute transition. Press ENTER.
8. Press PLT RTE line select key to return to route pages.

Add Waypoints Using LIST-AIRWAYS Feature

With the route page displayed (usually the last page as the route is being built), position the cursor over the first blank field following an intersection or navaid that is in the Navigation Database (see Figure 4-56).

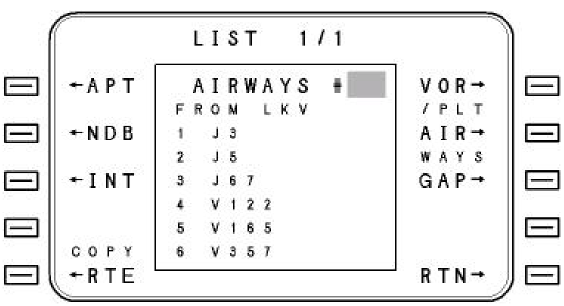

Figure 4-56. LIST-AIRWAYS Page

NOTE

If the cursor had been placed after an airport or an off-airway intersection or navaid, the AIRWAYS selection on the LIST page will be displayed in small green font indicating that the selection is not available.

1. Press the LIST function key and press the AIRWAYS line select key [2R]. A list of airways through the previous navaid/intersection will be displayed.
2. Enter the reference number of the desired airway. The airway termination page will then be displayed showing intersections and navaids that make up the selected airway. The closest twelve points will be displayed on the first page, the next closest twelve on page two, etc. Select the reference number of the termination fix, or type in the identifier.
3. All waypoints between the initial and termination points will be automatically entered into the route.
4. The cursor will automatically be positioned over the next blank field. Repeat steps 1 and 2 to complete the route using additional airways.

Add STAR and Approach

Make sure that the last waypoint of the route is the destination airport. Proceed as follows to add a STAR and Approach, if desired.

1. Press DATA, then Pilot Data line select key.
2. Select the ROUTE, LSK [4R]. Enter the reference number for the chosen route then press ENTER.
3. The Pilot Route page will display. Press the MENU function key. Select ARRIVE, LSK [4R].
4. The ARRIVAL 1/1 page will appear with a list of runways for that airport.

NOTE

If the airport has no STARS or Approaches in the database, then NONE will be displayed.

5. Enter the reference number of the arrival runway. Press ENTER.

6. Enter the reference number of the desired STAR. Press ENTER.
7. Enter the reference number of the desired STAR transition. Press ENTER.
8. Enter the reference number of the desired Approach. Press ENTER.
9. Enter the reference number of the Approach transition. Press ENTER.
10. Press PLT RTE line select key to return to route pages.

Edit Stored Routes

Once a route has been constructed and stored in the database, it can be accessed at any time for editing. Route editing is always accomplished on the Normal Route Display page (e.g., the PLT RTE or the CO RTE page). The following procedure can be used to access the Route Display page for editing:

1. Press the DATA function key. Select Pilot Data, LSK [2L].
2. Select ROUTE, LSK [3R] to access the Route Directory Page.
3. Enter the reference number of the desired Route. The first page of that Route will be displayed.

Insert Gap into Route

A gap is a break in the route designed to prevent the navigation computer from making an automatic leg change. Gaps have no effect until the route is copied into the flight plan. From the Normal Route Display Page (e.g., the PLT RTE or the CO RTE page), insert a gap:

1. Use the NEXT and PREV function keys to display the desired waypoint.
2. Use the line select keys to position the cursor over the waypoint that will follow the GAP.
3. Press the LIST function key to access the normal LIST page.
4. Press the GAP line select key. The display will return to the ROUTE page and the gap (*GAP*) will have been inserted.

Gaps are deleted from the route in the same manner as waypoints. To delete a gap from the route, refer to the DELETE WAYPOINT(S) FROM ROUTE procedure in this section.

CAUTION

When a GAP has been inserted, the flight plan will *not* auto-sequence to the next leg. The aircraft will continue to fly over the TO way-point on last desired track (0° roll steering) with NAV and VNAV flags out of view on the HSI. It is the responsibility of the pilot to take appropriate action to continue accurate navigation of the aircraft. The pilot may go “Direct To” or edit the gap out of the flight plan.

Designate Route Waypoint as Fly-Over Waypoint

A flyover waypoint is a waypoint that will cause the navigation computer to delay making an automatic leg change until the aircraft is over the waypoint. Flyover waypoints defined in a route have no effect until the route is copied into the flight plan. A flyover waypoint is indicated by an asterisk (*) following the waypoint identifier on the Route display page. From the Normal Route Display Page (e.g., the PLT RTE or the CO RTE page), the following procedure may be used to designate (or cancel) a waypoint as a flyover waypoint:

1. Use the NEXT and PREV function keys to display the desired waypoint.

2. Use the line select keys to position the cursor over the waypoint to be defined as a flyover waypoint.
3. Press the OVFLY line select key. An asterisk (*) will appear after the waypoint identifier indicating that it is a flyover waypoint.

The waypoint flyover designation is removed in the same manner as it was created; i.e., pressing the CNCL OVFLY key with the cursor over the flyover waypoint identifier.

Add Waypoint(s) to Route

From the Normal Route Display Page (e.g., the PLT RTE or the CO RTE page), add a waypoint to the route:

1. Use the NEXT and PREV function keys to display the desired portion of the Route.
2. Use the line select keys to position the cursor over the waypoint that will follow the new waypoint.
3. Enter the new waypoint using the LIST function or by typing in the identifier. When the new waypoint is entered, it will be inserted in the position selected and the waypoint under the cursor will advance to the next position.

Edit Route Name

From the Normal Route Display Page (e.g., the PLT RTE or the CO RTE page), edit the Route Name:

1. Press ENTER to place cursor over the Route Name field.
2. Type in the new route name, then press ENTER.

NOTE

This function is not available from the active flight plan page (FPL).

Delete Waypoint(s) from Route

From the Normal Route Display Page (e.g., the PLT RTE or the CO RTE page), delete waypoint(s) from the route:

1. Use the NEXT and PREV keys to display the desired waypoint.
2. Use the line select key to position the cursor over the waypoint to be deleted.
3. Press DEL line select key twice.

NOTE

If it is desired to delete the remainder of the route, enter a reference number greater than the reference number of the last waypoint on the route (for example, 98). Do not enter 99, or the entire flight plan will be deleted.

Change Waypoint in Route

A waypoint in a route is changed by adding the new waypoint ahead of the old waypoint (waypoint to be changed) and then deleting the old waypoint. From the Normal Route Display Page (e.g., the PLT RTE or the CO RTE page), change a waypoint in a route:

1. Use the NEXT and PREV function keys to locate the desired waypoint.
2. Position the cursor over the first waypoint to be changed.
3. Enter the new waypoint using the LIST function or by typing the identifier. When the new waypoint is entered, it will be inserted at the position selected and the waypoint under the cursor will advance to the next position.
4. Enter the reference number associated with the waypoint that will follow the added waypoint. The changed waypoints will be removed from the route.

Route Menu Page

The Route Menu page is accessed by pressing the MENU function key from any Pilot Route or Company Route page (see Figure 4-57). MENU pages for active flight plans are similar.

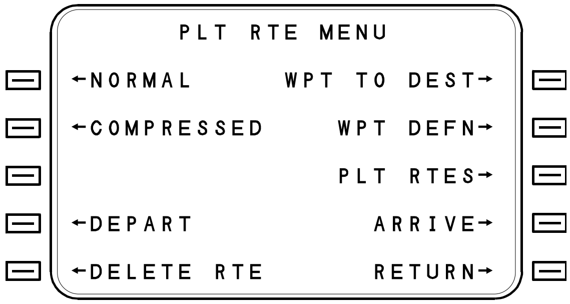

Figure 4-57. Pilot Route Menu Page

NORMAL – Pressing LSK [1L] displays the Normal Pilot Route pages if the Route Menu page was accessed from the Pilot Route pages. The Normal Company Route pages are displayed if the Route Menu page was accessed from Company Route pages. The Normal Route page shows the route waypoints, bearings and distances between waypoints. In the case of procedural legs of SIDs, STARs, and Approaches, path type and terminator are shown. The page also allows editing of the route. Succeeding pages of the route may be displayed by pressing the PREV or NEXT keys, as appropriate. When the cursor is placed on a waypoint, up to three options appear on the right side of the screen:

Del – Pressing this key twice will delete the selected waypoint from the route.

Info – Will display all information from the pilot database concerning the waypoint or navaid.

Ovfly – Overfly waypoints are defined by pressing the OVFLY line select key while the cursor is over the desired waypoint. The overfly designation may be removed in the same manner by pressing CNCL OVFLY. Only geographic points (not procedural legs) may be designated as 'overfly'.

COMPRESSED – Pressing LSK [2L] displays the Compressed format route pages. The Compressed Route pages allow the user to view more waypoints of the route on a single page to quickly review long Pilot or Company Routes.

DEPART – Pressing LSK [4L] displays the Departure page. Refer to FMS Operations in Section II.

DELETE RTE – Pressing the Delete Route line select key twice will delete the selected route. This option is unavailable when the Route Menu page is accessed from the Company Route pages.

WPT TO DEST – Pressing LSK [1R] displays the Waypoint to Destination pages. The WPT to DEST Route pages allow the user to view the Company or Pilot Route distance from various route waypoints to the destination.

WPT DEFN – Pressing LSK [2R] displays the Waypoint Definition pages. The WPT DEFN Route pages allow you to view the coordinates of the Company or Pilot route waypoints.

PLT RTES – Pressing LSK [3R] displays the Pilot Route Directory pages if the Route Menu page was accessed from the Pilot Route pages. The Company Route Directory pages are displayed if the Route Menu page was accessed from Company Route pages.

ARRIVE – Pressing LSK [4R] displays the Arrival page. Refer to FMS Operations in Section II.

<u>Define Position Pages</u>

The Define Position pages provide the means to define the coordinate location of a pilot defined waypoint. The location may be defined by directly entering the coordinates, by selecting FMS or GPS present position coordinates, or by defining the position in reference to another known waypoint location. The page title will reflect the category of waypoint being defined (ALIGN, ARPT, RNWY, WPT, POS, TACT).

DEFINE WPT Page

The Define Waypoint page is accessed by entering an undefined waypoint name point in any waypoint field except those for align points, airports, and runways. It is also accessed from the Position Menu by pressing LSK [1L].

DEFINE POS Page

The DEFINE POS page is accessed by pressing the FMS position field line select key on the NAV 2/2 page or the DATA 3/5 page (see Figure 4-58).

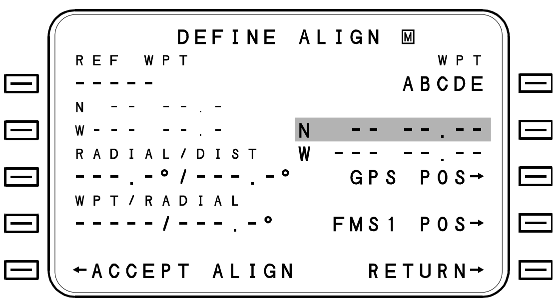

Figure 4-58. DEFINE POS Page

REF WPT – The reference waypoint from which a radial and distance may be used to define the location of the new pilot defined waypoint is entered here. The identifier will flash if it is not in either the NAV or the Pilot Defined Database. A fix may be entered either manually or by using the LIST key.

REF Waypoint Coordinates – If a REF WPT entry is made, these will be the coordinates of that waypoint location. However, a REF WPT entry need not be made because coordinates may be directly entered here from which radial and distance may be taken.

RADIAL/DIST – The cursor is first placed over the RADIAL field; however, if reference coordinates are not defined at line select key [2L] then [3L] is inoperative. When the reference coordinates are defined, the RADIAL/ DIST fields are prefilled with the radial and distance of the coordinates at line select key [2R]. When the cursor is over the RADIAL field containing a valid entry and ENTER is pressed, the cursor will advance to the DIST field. If a manual entry is made in the DIST field, then the coordinates of the entered radial and distance from the reference waypoint are computed and displayed at [2R]. The cursor will advance to ACCEPT. If ENTER is pressed without a DIST entry, then the coordinates will still be computed (rho/theta) but the cursor will advance to the WPT field of the WPT/RADIAL line.

WPT/RADIAL – The cursor is placed over the WPT field when reference coordinates are defined at [2L] and a valid radial is at [3L]. Any database fix may be entered either manually or by using the LIST key. A valid entry will advance the cursor to the RADIAL field. A valid radial entry will blank the DIST field at [3L]. The coordinates will be computed and displayed at [2R] using the two radial entries (theta/theta). Theta/theta position computation will compute and display the distance at [3L]. The ACCEPT option will appear after the name and coordinates for the waypoint have been defined at [2R].

ACCEPT – When valid coordinates are displayed for the WPT position, this option will become available. The ACCEPT line select key must be pressed twice to enter the defined waypoint into the database.

WPT – The name of the waypoint being created or modified. The coordinate fields will be prefilled if waypoint is being modified, otherwise it will be blank.

WPT Coordinates – This field shows the coordinates of the waypoint being defined. Position coordinates may be entered into this field directly or the field will display coordinates resulting from the reference waypoint computation.

GPS POS – Pressing this line select key will accept, at the instant it is pressed, the GPS present position coordinates to define the position of the waypoint.

FMS# POS – Pressing this line select key will accept, at the instant it is pressed, the FMS present position coordinates to define the position of the waypoint.

Definition Methods

Positions can be defined by any of the five following methods:

Latitude/Longitude – The coordinates of the pilot defined waypoint are entered directly.

Radial/Distance – A reference waypoint (which can be a waypoint, VOR, NDB, or airport) is identified and a radial/distance offset is specified.

Radial/Radial – Two reference waypoints are identified, and the radial from each is specified. This method is useful, for example, in identifying the unnamed intersection of two airways.

GPS Position – The present GPS position data are used to define the waypoint.

FMS Position – The present FMS position data (best computed position) are used to define the waypoint.

To define a position by **Latitude/ Longitude:**

1. Press LSK [2R] to highlight the latitude field.

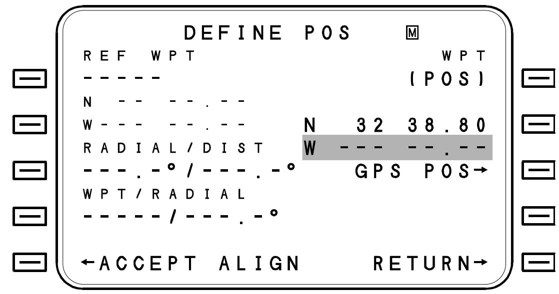

Figure 4-59. DEFINE POS Page

2. Enter the latitude (using the ± key as necessary to toggle the hemisphere between N and S). Press ENTER.
3. The cursor will be expanded to enclose the longitude field.
4. Enter the longitude (again, the ± key will toggle the hemisphere between E and W). Press ENTER.
5. The prompt ACCEPT WPT will appear in the cursor block next to LSK [5L]. Press either LSK [5L], or the ENTER key.

NOTE

The MENU key will provide the option of changing the entry resolution between tenths of arc-minutes, hundredths of arc-minutes, or thousandths of arc-minutes.

To define a position by **Radial/Distance**:

1. Enter the name of the waypoint, navaid, or airport from which the new waypoint will be derived in the REF WPT field. Press ENTER.

2. The confirmation page will display the location (and other applicable data) for the reference waypoint. The ACCEPT prompt will appear next to LSK [5L]. If there are two or more locations or facilities with the same identifier, the page title will indicate 1/2, 1/3, etc., and additional locations can be viewed by pressing the NEXT key. When the desired location of the reference waypoint is displayed, press the ACCEPT line select key or the ENTER key.
3. The cursor will move to the RADIAL field. Enter the radial (degrees and tenths – leading zeroes not required) from the reference waypoint on which the newly defined waypoint lies. Press ENTER.
4. The cursor will move to the DISTANCE field. Enter the new waypoint distance from the reference waypoint (nautical miles and tenths – leading zeros not required). Press ENTER. The coordinates of the newly defined waypoint will be displayed.
5. The ACCEPT WPT prompt will appear next to LSK [5L]. Press either the ACCEPT WPT line select key, or the ENTER key.

To define a position by the **Radial/Radial** method:

1. Enter the name of the first reference waypoint, navaid, or airport from which the new waypoint will be derived at LSK [1R]. Press ENTER.
2. The confirmation page will display the location (and other applicable data) for the reference waypoint. The ACCEPT prompt will appear next to LSK [5L]. If there are two or more locations or facilities with the same identifier, the page title will indicate 1/2, 1/3, etc., additional locations can be displayed using the NEXT key. When the desired location of the reference waypoint is displayed, press the ACCEPT line select key or the ENTER key.
3. The cursor will move to the RADIAL field. Enter the radial (degrees and tenths – leading zeroes not required) from the reference waypoint on which the newly defined waypoint lies. Press ENTER.
4. The cursor will move to the DISTANCE field. Do not make an entry in the distance field if you desire a Radial/Radial waypoint definition. Rather, press LSK [4L] to identify the second reference waypoint. Enter the name or identifier of the second reference waypoint. Press ENTER.
5. The confirmation page will again appear displaying the location for the second reference waypoint. The ACCEPT prompt will appear next to LSK [5L]. Press ACCEPT LSK or the ENTER key.
6. The cursor will move to the RADIAL field. Enter the radial (degrees and tenths – leading zeroes not required) from the second reference waypoint on which the newly defined waypoint lies. Press ENTER. The coordinates of the newly defined waypoint will be displayed.
7. The ACCEPT WPT prompt will appear next to LSK [5L]. Press either the ACCEPT WPT line select key, or the ENTER key.

NOTE

If the reference waypoint has been deleted in a NAV Database update, the REF WPT and RADIAL/DIST fields will display dashes.

To define a waypoint by the **GPS Position** or **FMS Position** method:

1. Press LSK [2R] to highlight the latitude field. The GPS POS and FMS POS legends adjacent to the [3R] and [4R] line select keys will illuminate in large orange font, indicating that these options have become available.
2. Press GPS POS or FMS POS as desired.

NOTE

The GPS POS option is only available when the GPS sensor is in NAV mode and supplying valid data. FMS position will be available any time the FMS has valid position data, regardless of the source.

SENSOR INTERFACE

The FMS is capable of interfacing with a variety of sensors which provide data used for navigation. These sensors range from complicated devices capable of autonomous navigation to simple ratio sensors. The philosophy is to allow the pilot to control the function of each sensor for use by the FMS. The following table summarizes sensor selection and deselection occurring at various events.

Table 4-4. Sensor Selection and Deselection

Powerup On Ground	Select any GPS that is in navigation or altitude mode. All other sensors are deselected.
Powerup In Air	Select all sensors.
On Ground	Select GPS if in navigation or altitude aiding mode and deselect GPS if not.
Takeoff	Select all sensors except those previously manually deselected.
Non-VFR Approach Armed	If a GPS or GPS overlay approach contained in the navigation database is in use, deselect all sensors except GPS and ADC.
Approach Canceled (In Air)	Reselects all previously deselected sensors.
Landing	Deselect all sensors except GPS that is in nav or altitude aiding mode.

Air Data

ADC Status

The ADC status page, accessed from DATA 2/4, LSK [2R], displays the status of the air data computer (ADC) (see Figure 4-60). The ADC is automatically deselected during ground operations and is automatically selected at liftoff. The ADC can be manually deselected or reselected by using line select key [4R].

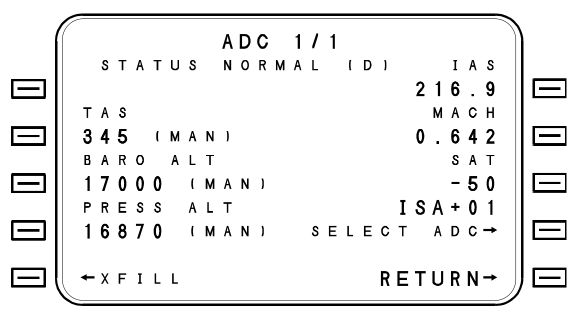

Figure 4-60. ADC Status Page

The top of the page shows the page title (ADC) and the status of the system. The status field (beneath ADC) will show NORMAL if the ADC is operational and selected, FAILED if the ADC has failed, and (D) if the ADC has been deselected.

TAS – The true airspeed being used by the navigation computer. Dashes will be displayed if there is no TAS input, (MAN) will be displayed if the TAS is in manual. A manually selected TAS overrides a sensor supplied TAS input and will be used even if the ADC is deselected or failed. A manual TAS entry is deleted by pressing the BACK and ENTER keys while the cursor is over the TAS entry field.

BARO and TAS ALT – The altitude in feet as supplied by the air data computer. Dashes will be displayed if there is no altitude input, (MAN) will be displayed if the altitude is in manual. A manually selected altitude overrides a sensor supplied altitude. A manual ALT entry is deleted by pressing the BACK and ENTER keys while the cursor is over the ALT entry field.

IAS – The indicated airspeed in knots as supplied by the air data computer. IAS will not be displayed on installations which do not receive IAS from the air data computer.

MACH – The Mach value as supplied by the air data computer. Mach will not be displayed on installations which do not receive Mach from the air data computer.

SAT – The static air temperature received from the air data computer. Dashes are displayed if there is no input data.

ISA – As displayed on the ADC page, is the difference between SAT and ISA for the current altitude.

DESEL ADC/SELECT ADC [4R] – This line select key is used to alternately select or deselect the ADC sensor. If deselected, (D) will be displayed following the sensor status.

Short Range Sensor

Distance Measuring Equipment

If DME is configured, the DME-DME status and data is displayed on the DME Status page (see Figure 4-61). This page is accessed from Data Page 2, LSK [3R].

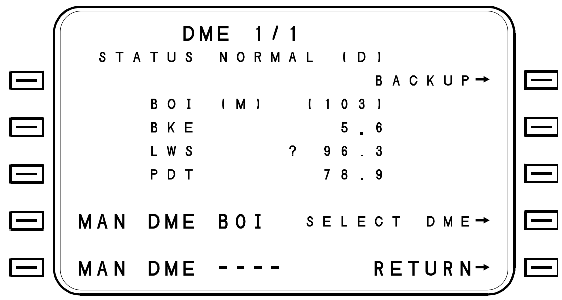

Figure 4-61. DME Status Page

An (M) following a station identifier indicates a manually selected station. Manually selected DMEs are automatically deselected when the range exceeds 300 NM. The letter I preceding the three-letter designator indicates ILS-DMEs and LOC-DMEs. The distance display is as follows:

- Distance is expressed to the nearest one-tenth nautical mile.
- Dashes indicate no response from the DME station.
- A question mark (?) indicates the distance received from the DME is questionable. The system will not use this input.
- Parentheses ( ) are used for manually selected DME stations to indicate that the distance shown is a computed distance from the aircraft to the DME station, not an actual DME measurement. The parentheses disappear when a DME lock-on is established.

DESELECT DME/SELECT DME – Pressing LSK [4R] will allow manual selection/deselection of DME as desired. When deselected, D will appear following DME Status.

During system initialization and ground operations, the DME will be deselected. Upon takeoff, the DME will automatically be selected. In the event of an aircraft weight-on-gear switch failure, the DME will automatically be selected when the TAS reaches 150 knots.

Manual DME Station Selection

Normally, the DME-DME Status page will display four lines showing four different DME stations and their respective distance readings. As the computer automatically tunes all of the available DME stations in the vicinity of the aircraft, the four stations displayed will continually change.

This procedure provides the pilot with the option of directing the computer to tune, and constantly display, one or two specific DME stations.

1. Access Data Page 2 by pressing the DATA function key and pressing NEXT. Select the DME option to display the DME Status page.
2. Press the MAN DME line select key to position the cursor over the MAN DME entry field.
3. Enter the identifier of the desired DME. The symbol (M) will be displayed after the identifier on the tuned DME listing to indicate a manual selection.

NOTE

When initially selected, the FMS estimate of what the DME distance should be will appear in parenthesis. When a DME lock-on is established, the parenthesis will be removed.

Return To Automatic DME Station Selection

1. Access Data Page 2 by pressing the DATA function key and pressing NEXT. Select the DMS option to display the DME Status page.
2. Press the MAN DME line select key to position the cursor over the MAN DME entry field.
3. Press the BACK and then ENTER keys to delete the manual input.

NOTE

Manually selected stations will be automatically deselected and automatic station selection resumed at over a 300 NM range.

Long-Range Sensors

GPS Sensors

The FMS uses GPS as a heavily weighted position sensor in its Kalman Filter. The FMS complies with all aspects of TSO C-129a Class B1 and C1 in regards to waypoint displays, scaling, integrity monitoring, predictive RAIM, etc. using its internal GPS. A position difference greater than 50 NM or a divergence at greater than 50 knots will cause automatic deselection of the GPS from the position solution.

GPS Management

GPS sensors are automatically selected at power up on the ground or any time while on the ground. Additionally, GPS is selected at power up in the air. The GPS can be manually selected or deselected at any time. Only one GPS sensor at a time will provide a position to the FMS. GPS satellites can be manually deselected by the crew. A page is available which presents a list of deselected satellites. Individual satellites may be added to or removed from the deselection list.

GPS Integrity

Receiver Autonomous Integrity Monitoring (RAIM)

A key element of FAA approval for GPS equipment is Receiver Autonomous Integrity Monitoring (RAIM). RAIM requires that additional usable satellites be available to the system.

RAIM provides a function analogous to the flag for VOR or ILS equipment. In these systems, the system integrity is provided by ground station equipment, which continuously monitor the transmitted signal. If the ground monitor equipment detects an out-of-tolerance condition, it shuts down the transmitter (or effects a transfer to standby equipment). The signal loss causes the flag to be set in the cockpit instruments. Since GPS does not incorporate this type of signal monitoring, the airborne equipment must be capable of detecting out-of-tolerance conditions itself.

RAIM requires at least five usable satellites. RAIM is implemented by dropping one satellite at a time out of the navigation solution to permit evaluation of its pseudo-range data. Position is calculated using the remaining four satellites. Range to the satellite under evaluation is then calculated on the basis of that position and the current almanac data for the satellite in question. Received pseudo-range is compared to the calculated data for a validity test.

The FMS implements the functions required to provide a GPS Integrity monitor. The GPS Integrity monitor is implemented within the FMS as a separate function from the FMS sensor monitor. It will independently monitor and display the Integrity status for each configured stand-alone and hybrid GPS sensor using criteria based upon the current phase of flight. It will also alert the aircrew with messages, annunciators, and, under some conditions, the nav flag when the monitor data for the GPS that is currently being used for navigation is either unavailable or in an alarm state.

The GPS integrity monitor is defined for three phases of flight, each with a specified Alarm Limit and Time to Alarm. The Enroute phase is the default phase, and is active whenever the Terminal and Approach phases are not active. The Terminal and Approach phases are defined the same as for the POSN UNCERTAIN message. Each phase of flight limit and alarm time is specified as:

Phase of Flight	Alarm Limit	Time to Alarm
Enroute	2.0 NM	27 sec
Terminal	1.0 NM	7 sec
Approach	0.3 NM	7 sec

The RAIM based integrity monitoring function provides the status of each configured GPS sensor when the GPS sensor is transmitting valid HIL and that data is less than or equal to 15.9 NM. If RAIM is available, the GPS Integrity status will be RAIM when the HIL data is less than the phase of flight criteria (see above chart) and the Satellite Failure Detected bit is not set. The GPS Integrity status will be ALARM when the Satellite Failure Detected bit is set for the time specified for the phase of flight.

Radio Based (DME) Integrity

GPS integrity is further monitored by the DME-DME position solution. In those cases where satellite-based RAIM is insufficient due to poor geometry or unhealthy satellites, the integrity monitoring will revert to RADIO on the GPS Status page (assuming a good DME-DME position). Under this condition, GPS will continue to be used as the primary position sensor, with no associated messages to the pilot.

GPS INTEG Annunciator

The FMS provides a logic signal to annunciate GPS INTEG (on the caution/warning panel) whenever the integrity of the GPS position cannot be assured to meet minimum requirements for the particular phase of flight (enroute, terminal or approach).

NOTE

Whenever the GPS INTEG annunciator is illuminated, the pilot should monitor his GPS position by cross-reference to other navigation sensors, if available. GPS-based approaches can not be flown whenever the GPS INTEG annunciator is illuminated.

Pilot notifications of GPS sensor problems are for the GPS sensor, which is currently being used by the FMS for navigation. This notification is in the form of a GPS Integrity annunciator, the FMS Nav Flag (Approach Lateral Valid Flag), and FMS messages. The GPS Integrity annunciator FMS discrete output is used to light an external annunciator.

The following table lists the FMS/NMS navigation status and associated pilot actions to be taken when the GPS INTEG annunciator is active.

Table 4-5. FMS/NMS Navigation Status

Flight Phase	NAV Flag Condition	GPS NOT NAV Message	POSITION UNCERTAIN Message	Pilot Action
Domestic Enroute	Valid	Not Issued	Not Issued	Normal systems cross-checks
	Valid	Active (DR Nav Mode)	Not Issued (<2.8 NM off-trk)	Use most reliable Nav source
	Invalid	Active (DR Nav Mode)	Active (>2.8 NM off-trk)	Use other Nav system
Terminal	Valid	Not Issued	Not Issued	Normal systems cross-checks
	Valid	Active (DR Nav Mode)	Not Issued (<1.0 NM off-trk)	Use most reliable Nav source
	Invalid	Active (DR Nav Mode)	Active (>1.0 NM off-trk)	Use other Nav system
Approach before FAF	Valid	Not Issued	Not Issued	Do not continue
	Invalid if <2 NM from FAF or Integ=Alarm	Not Issued	Not Issued	Do not continue
Approach after FAF	Invalid if Integ=NONE for >5 min or Integ=Alarm	Not Issued	Not Issued	Approach based upon GPS alone. Use other Nav sources.

GPS Status

The GPS Status and data are on the GPS Status pages. These pages are accessed from Data Page 2 by pressing the appropriate line select key [2L] (see Figure 4-62).

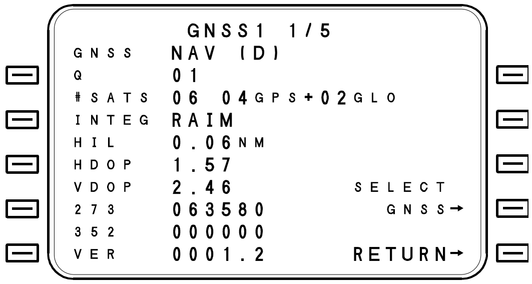

Figure 4-62. GPS Status Page

- **NAV** – GPS is in NAV mode.
- **ACQ** – GPS is acquiring satellites.
- **INIT** – GPS is initializing its position from internal almanac.
- **ALT** – GPS is using altitude to supplement poor satellite geometry.
- **TEST** – GPS is in TEST mode.
- **FAIL** – GPS has failed, or 429 data not received from GPS.
- **DGPS** – GPS is in the differential mode (GLS-1250 only).

ESE – If the FMS is configured to display, ANP/RNP Q factor will be replaced by ESE.

 # SATELLITES – The number of satellites currently being tracked by the GPS. For the GNSS-2400, this number is further broken down into GPS and GLO satellites.

This page also shows ARINC 429 data on labels 273 and 352 from the GPS sensor. This page is to be used for diagnostics and troubleshooting.

SELECT/DESELECT GPS – Used to manually select or deselect the GPS sensor.

INTEG – GPS Integrity status is displayed on this line and defined below.

- **RAIM** – Receiver Autonomous Integrity Monitoring.
- **RADIO** – Radio based (i.e., DME-DME) integrity monitoring.
- **NONE** – No integrity monitoring available. GPS position accuracy is not affected and will continue to be used for navigation. However, the pilot should monitor the FMS accuracy by comparing to other nav sources, if available.
- **ALARM** – Integrity monitoring indicates a GPS error outside limits.

HIL – Horizontal Integrity Limit in nautical miles. RAIM is available when HIL is equal to or less than 2 NM enroute, 1 NM terminal or 0.3 NM approach.

HDOP – Horizontal Dilution of Precision.

VDOP – Vertical Dilution of Precision.

VER – The internal GPS software version.

These pages display the satellites most likely to be in current use by the GPS. Each line displays:

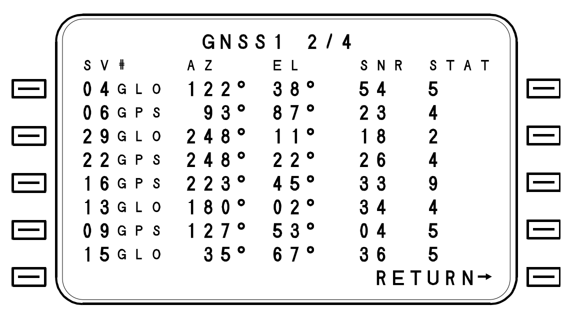

Figure 4-63. GNSS1 2/4 Page

SV# – Satellite Vehicle Number. GLO or GPS designate GLONASS or GPS satellites respectively.

AZ – Azimuth (deg). Azimuth will always be true direction from the aircraft.

EL – Elevation (deg). Elevation is in degrees above the horizon (90º is directly overhead the aircraft position). EL may be negative, indicating a satellite below the horizon.

SNR – Signal to Noise Ratio. SNR is a number from 0 to 63 in dB Hz.

STAT – Status. Status is a number from 0 to 9 and is defined as follows:

Status		Definition
0	–	Satellite is assigned to a channel
1	–	FIND command issued
2	–	Waiting to receive almanac and ephemeris data
3	–	Waiting to receive complete pseudo range data block
4	–	Performing the acquisition/ tracking process
5	–	Fast sequencing of satellite signal (tracking mode)
6	–	Satellite is not assigned to a channel
7	–	Lost satellite lock during sequencing process
8	–	Waiting for clock message
9	–	Satellite not found
D	–	Satellite is deselected

This page displays GPS satellites which have been deselected (see Figure 4-64).

In addition to displaying a list of deselected satellites, this page is also used to manually select or deselect satellites.

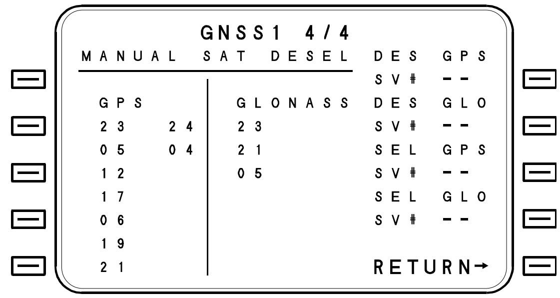

Figure 4-64. Deselected GPS Satellites

A list of satellites appears showing the satellite vehicle (SV) number and the status of each. Status is shown as DES (deselected), REQ (requested for deselection by the FMS) or AUTO (automatically deselected by the GPS).

The crew can deselect a satellite by pressing line select key [1R] to bring the cursor over the DESEL SV# field. The satellite vehicle number is typed in at the cursor location and entered by pressing the ENTER key. The list status will read REQ until the GPS acknowledges the deselection at which time the status becomes DES.

The crew can reselect a satellite by pressing line select key [3R] to bring the cursor over the SELECT SV# field. The satellite vehicle number is typed in at the cursor location and entered by pressing the ENTER key. The satellite will be removed from the list once the GPS acknowledges.

Satellites may be deselected individually by entering the SV# in the DES GPS or DES GLO field. Up to 14 satellites of each type may be manually deselected. Entering a 99 in these fields will deselect all the satellites of that type and ALL will display in the list of deselected satellites.

To reselect the satellites, enter the SV# or 99 in the SEL GPS or SEL GLO fields. If ALL satellites have been selected using 99, they cannot be reselected individually.

Inertial Reference System

The inertial sensor will accept latitude/ longitude position information from the FMS only during the alignment mode; i.e., during the initialization procedure. While in the alignment mode, the IRS will use the last position it receives from the FMS. The data are available for 10 seconds after depressing ACCEPT or ENTER. Once in the NAV mode, the IRS will not accept an update. Manually updating the IRS's position while enroute is not necessary. The IRS Status page displays the status of the installed IRS. This page is accessed from Data Page 2.

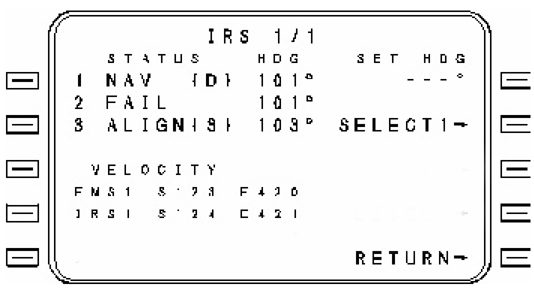

Figure 4-65. IRS Data Page

STATUS – This is the operational status of the IRS. The status displayed will be one of the following:

ALIGN – Indicates that the IRS is in the alignment process. The aircraft should not be moved. If the IRS is in the align mode and is selected, then time to NAV information in minutes is displayed in parenthesis.

NAV – Indicates the IRS is in the normal navigational mode.

ATT - Indicates the IRS is available for attitude outputs only. Navigational outputs are not being provided.

FAIL - Indicates the unit is not operational.

HDG – The true heading received by the navigation computer from the IRS. Dashes are displayed if no valid data is available.

VELOCITY – Position movement broken into N-S/E-W velocity components.

FMS – The FMS best computed position velocity components.

IRS1 – The velocity components being received by the navigation computer from the IRS.

SET HDG – For use with the IRS when selected to ATTITUDE after a reversionary alignment. In the ATTITUDE mode, the IRS will output both attitude and heading. The heading output is similar to uncorrected DG; that is, it must be manually set, and checked approximately every 15 minutes.

1. Press the SET HDG line select key to position the cursor over the SET HDG entry field.
2. Enter the desired heading. When the heading is entered, it will be sent to the IRS for the next 10 seconds. Inertial sensors will accept latitude/longitude position information from the FMS only while in the alignment mode; that is, during the FMS initialization procedure. Heading will be accepted under reversionary operations only. Manually updating the IRS's position information while enroute is not necessary or possible. The IRS position coordinates are displayed by the FMS for comparative purposes only.

IRS Deselect/Reselect

1. Access the IRS Status page by pressing the DATA function key and then pressing any IRS # line select key.
2. Press the appropriate DESEL # or SELECT # line select key to deselect or select the desired IRS. When an IRS is deselected, the appropriate IRS STATUS field will indicate (D). When an IRS is selected, the appropriate IRS STATUS field will indicate either NAV, ALIGN, ATT or FAIL.

For example: IRS 1 is deselected by system no. 1: IRS 1 does not shut off, quit navigating or stop supplying data. System 1 simply disregards the IRS 1 inputs in its own best computed position computations. Deselection of a sensor by any or all FMSs never shuts down that sensor or causes it to cease its own position computations.

Heading Source

The heading source is displayed on Data Page 4 (General Data). The only heading source available is the IRS.

Manual Heading Input

In the unlikely event that the IRS heading source has failed, the following procedure may be used to manually enter a heading.

1. Access Data Page 4 (General Data) by repeatedly pressing the DATA function key. The current HDG (heading) source is listed in parentheses.
2. Press the HDG line select key to position the cursor on the HDG entry field.
3. Enter the desired heading. When the heading is entered, (MAN) will be displayed to indicate that HDG is a manual input.

Magnetic Variation

The VAR WARNING message is displayed when operating above 72 degrees 45 minutes north latitude or below 59 degrees 45 minutes south latitude. This message occurs 15 minutes latitude prior to leaving the valid region for the magnetic variation model. This gives the crew time to enter a manual variation or take other action if operating an aircraft without a true heading source.

Manual Variation Input

1. Access Data Page 4 (General Data) by repeatedly pressing the DATA function key.
2. Press the VARIATION line select key to position the cursor on the VARIATION entry field.
3. Enter the desired variation. If required, use the ± key to change the E/W prefix prior to making the entry. When the variation is entered, (MAN) will be displayed to indicate that VARIATION is a manual input.

Cancel Manual Variation Input

1. Access Data Page 4 (General Data) by repeatedly pressing the DATA function key.
2. Press the VARIATION line select key to position the cursor on the VARIATION entry field.
3. Press the BACK and then ENTER keys to cancel the manual variation and to return to automatic computation of variation.

MESSAGES

This section contains the FMS system messages. Each message the system can display is detailed below, including any action(s) that may be necessary by the crew to correct the abnormality. A box around the procedures following the message definition indicates crew action. No action is specified for messages that are of an advisory nature only.

MSG Key

If the Position Uncertain message is active, "POS" will be displayed on the far left side of the top line on the CDU display. When a new system message becomes active, "MSG" will appear on the far right side of the top line on the CDU display. Pressing the MSG key will cause the MESSAGE page to be displayed showing the active messages. The current messages (those messages generated since the page was last accessed) will be displayed at the top of the list. After the messages are viewed, the CDU display is returned to the previous page by selecting the RETURN option on the MESSAGE page or by pressing either the MSG or BACK keys.

System Messages

System messages are presented in System messages are presented in alphabetical order on the following pages. Messages specifying the sensor number (GPS or GNSS) are listed below with the number symbol (#) in place of the sensor number. However, the sensor number is used in the actual message. All messages are suppressed for the first 30 seconds after takeoff in order to minimize distractions to the pilot.

A/D CODE # – The A/D (Analog/Digital Board) self test failed during self test. "#" is the error code from 1 to 9. This message will only come on following system initialization. Heading and fuel flow inputs may be affected and should be checked if the system must be used. Codes are as follows:

1 – A/D Program Checksum Fail
2 – +15 VDC Self test Fail
3 – -15 VDC Self test Fail
9 – No Communication between A/D board and FMS

ADC ALT REQD FOR APRCH – An approach has been attempted, but MAN altitude is being used by the system.

ADC ALT REQD FOR VNAV – A VNAV problem has been entered, but MAN altitude is being used by the system.

ADC INPUT FAIL – An Air Data Computer failure is detected.
Manual entries of TAS and altitude may be made on ADC 1/1.
Check circuit breaker for ADC or ACU if installed.
Press the DATA key until DATA 2/4 is accessed.
Press the line select key at ADC to access ADC 1/1.
At the TAS field, enter current true airspeed. A manual TAS overrides any ADC input.
At the BARO ALT field enter the current BARO altitude.
TAS and Altitude inputs must be updated as required.
If a second FMS is installed, air data may be crossfilled from the other system.

NOTE

Without valid air data inputs to the FMS, VNAV is not available and any leg type terminators requiring altitudes will not be sequenced.

AIRPORT DATABASE FAIL – A problem has been found in the airport section of the navigation database. Verify airport coordinates of interest. There is a high probability that the system will fail the initial self-tests the next time it is turned on. After landing and shutdown, turn the system off and then on again in order to troubleshoot.
Reload the navigation database.

AIRWAY DATABASE FAIL – A problem has been detected in the Airways database.
Reload the navigation database.

ALT INVALID FOR VNAV – A VNAV problem is defined, but (1) only pressure altitude is available and the aircraft is below 18,000 feet, or (2) altitude has failed.

ALTITUDE INVALID – The altitude portion of the Air Data Computer is not usable. A manual entry of altitude may be made on the ADC Status page.
Press the DATA key until DATA 2/4 is accessed.
Press the line select key at ADC to access ADC 1/1.
At the BARO ALT field, enter the current BARO altitude.

ANALOG BOARD FAIL – A failure is detected on the Analog Board. The outputs to the HSI may be affected, and depending upon installation, heading and fuel flow in some systems may also be affected. Verify on the DATA pages that the heading, TAS, and altitude inputs are reasonable.
Press the DATA key to access DATA 2/4.
Press ADC prompt to access ADC page and verify TAS and altitude.
Press DATA key to access DATA 4/4.
Verify HDG.
If HSI is analog type, do not use for navigation display.

APPROACH DATABASE FAIL – A problem has been detected in the approach database.
Reload navigation database.

APPROACH IN USE – The currently accessed approach is in use in the flight plan and cannot be modified or deleted.

ARINC # FAIL – ARINC #1 or 2 board failure is detected. This message will only occur following the self test on system initialization. Communication with other onboard systems may be affected.

ARPT NAME DATABASE FAIL – A failure has been detected in the airport geographical names database. Access to some airport names will be prevented.
Reload navigation database.

ASCB FAIL – ASCB board failure has been detected during or after power-up self test. Message will remain on MSG page until the condition clears.

ASCB TX INOPERATIVE – The ASCB board will not transmit. Message will clear when acknowledged or when condition clears.

ASCB LEFT BUS FAIL – ASCB left system bus has failed. FMS operation may be degraded. Message will clear when acknowledged or when condition clears.

ASCB RIGHT BUS FAIL – ASCB right system bus has failed. FMS operation may be degraded. Message will clear when acknowledged or when condition clears.

AUXILIARY BOARD FAIL – The Auxiliary Board has failed self test.

BACKUP DATABASE FAIL – The backup navaid database has failed.

BARO ALT NOT AVAILABLE – Barometric altitude is not available from installation of an ADC without barometric altitude or from loss of barometric altitude. Message will clear after acknowledgement or when the condition clears.

CLOCK TIMER FAIL – The clock timer on the CDU board has failed self test.

COMP ARPTS DATABASE FAIL – A part or all of the company airports database has failed.

COMP ROUTE DATABASE FAIL – A part or all of the company route database has failed.

COMP WPTS DATABASE FAIL – A part or all of the company waypoints database has failed.

CONFIG DATA FAILED – The FMS configuration data has failed.

CONFIG MODULE FAILED – Communication with or data in the configuration module has failed. Attempt to store configuration to determine cause.

CONFIG UPDATE REQUIRED – Configuration Module and FMS configuration data has failed requiring the FMS to be configured for installation.

CSDB SELFTEST FAIL – CSDB serial ports have failed self test. VOR, DME, or RTU function may be disabled.

CURRENT LEG EXTENDED – Presented when the aircraft flies past the terminator of the current leg and no next leg is defined which results in guidance displayed being to an extension of the current leg. TO/FROM will show FROM and distance from waypoint will increase.

DATABASE CORRECTING – A minor failure has been detected in the database and an error correcting process is being run. Access to the database is restricted until the correction process has been completed and the database tests successfully.

DATABASE EXPIRED – The current date is past the NAV Database Expiration Date as displayed on the Initialization page and DATA page.
Load current navigation database.

DATABASE FAIL – A part or all of the navigation database has failed.
Reload navigation database.

DATABASE FULL – The particular pilot database is full.

DEAD RECKONING MODE – (DR) TAS and Heading are the only sensors being used for navigation.

DEMONSTRATION MODE – The aircraft identification is configured as "DEMO" and sensor data is simulated internally. Do not use this FMS for navigation.

DISCRETE I/O FAIL – Self test of the discrete I/O has failed.

ENROUTES DATABASE FAIL – The database containing enroute intersections has failed.
Reload navigation database.

FMC BATTERY LOW – Self test has detected that the FMC battery is low. Navigation is still allowable; however, at shutdown the position, date and time may be lost.
Grip the FMS.

FMS NETWORK COMM FAIL – Indicates the FMS's internally programmed ethernet address has failed. The FMS will operate normally but cannot communicate with the DTU or other network Line Replacement Units (LRUs).

FMS PART NUMBER MISMATCH – The FMS installed has a different part number than the configuration stored.
Verify installation is correct.

FPL CAPACITY EXCEEDED – The pilot attempted to enter more than 98 waypoints in a flight plan.

FUELFLOW FAIL – A fuel flow failure is detected. Manual fuel flow entries may be made.
Press the FUEL key until the FUEL FLOW page is accessed. Check the fuel flow displays for reasonableness. Enter manual fuel flows if necessary. Update the fuel used values manually if required.

FUEL FLOW SELFTEST FAIL – Self test of the fuel flow measurement circuitry has failed.

FUEL NOT CONFIRMED – The FMS was started up in the Standby mode and the fuel has not been confirmed on FUEL page 1.

GLONASS DEPENDENT NAV – The FMS is in GPS nav mode, the GNSS sensor is in nav mode and the total number of GPS satellites is less than four and at least one GLONASS satellite is in use.

GNSS 1 DESELECT – The sensor monitor has determined that the specified GNSS data is unreasonable and has deselected the GNSS sensor for use in navigation. The message will be removed after it is displayed once.

GNSS 1 DIFFERENCE > xxNM – The sensor "Watchdog" has sensed that the latitude/longitude position as determined by the GNSS differs from the FMS best computed position by an amount that warrants pilot attention. "xx" can be 6, 12, 18, or 24 NM.

GNSS 1 FAIL – A Fail status has been determined for the indicated GNSS.
Press the DATA key to access DATA 2/4. Place cursor over sensor to access the Sensor Status Page.
Check the sensor status.

GNSS 1 NOT NAV – The specified GNSS has changed to a not navigational (neither DGPS, Navigation, Altitude aiding nor Fault) condition. This message will be removed after it is displayed once or when the GNSS goes into NAV or altitude aiding mode. GNSS status page will show the cause of the change.
Press the DATA key to access DATA 2/4. Place cursor over sensor to access the Sensor Status Page.
Check the sensor status.

HIGH GROUNDSPEED FOR ARC – An AF or RF is the current leg and the groundspeed is too high for the aircraft to stay within the bounds of the arc.

HIGH GNDSPD FOR HOLDING – In holding mode, the current groundspeed is excessive for holding airspace. This may be due to either high winds or high TAS. The pilot should lower airspeed if feasible.

ILLEGAL FACILITY TYPE – The entered facility is of an invalid type for this approach.

ILLEGAL WAYPOINT – A waypoint that is more than 6° from being on the inbound course or is greater than 99.9 NM from the FAF has been entered into the first optional waypoint position in the approach definition pages. Or, a turn center waypoint has been entered for a pilot defined RF leg that creates a radius greater than 32 NM.

INVALID ARINC VERSION – Two ARINC circuit boards are installed which do not have the same software version number.

INVALID CONFIGURATION – The FMS configuration is unknown. This message can only occur on the ground.

INVALID FUEL CONFIG – The fuel flow sensor configuration is invalid or incomplete. The fuel flow function will be disabled.

IRS HEADING FAIL – The IRS heading has failed while in use as the FMS heading source. This message is suppressed while the aircraft is on the ground. Press the DATA key to access Data 4/4. Place cursor over the HDG field. Press the LIST key to access a display of alternate heading sources. Select an alternate heading source.

IRS INPUT FAIL – The IRS input has failed or its status word indicates failure.

LAT/LONG XING WPT ALERT – This is displayed 15 seconds prior to sequencing time for latitude or longitude intersection.

MANUAL LEG CHANGE REQD – The aircraft is on a CA, FA, or VA leg and barometric altitude is not available to the FMS. The crew must make a manual leg chance to sequence the waypoint.

MEMORY BANK # FAIL – In dual cycle memory bank FMSs, either memory bank 1 or memory bank 2 has failed and all databases in that failed bank are not usable.
Reload the navigation database in the other bank.

MODE KEYS INOP – DISK PAGE – A disallowed mode key was pressed while any disk function page is displayed, other than Disk Menu.

NAV DATABASES FAILED – All segments of the navigation database failed simultaneously. This message replaces all individual segment messages.
Reload navigation database.

NDB DATABASE FAIL – A problem has been found in the NDB database. Access to this database will not be permitted.
Reload navigation database.

NDB NAME DATABASE FAIL – An error was detected in the NDB plain language name database.
Reload navigation database.

NEW MAINT LOG EXISTS – This message is displayed 1 minute after landing when any diagnostic history event has been recorded during the previous flight. Notify Maintenance Control.

NEXT LEG UNDEFINED – A GAP is in the next flight plan waypoint position. The flight plan must be edited by the pilot to eliminate the GAP. If the GAP is not eliminated, the aircraft will fly to the current TO waypoint, and after waypoint passage will continue to fly the same desired track with the TO/FROM flag now indicating FROM. The WPT annunciator will remain illuminated after waypoint passage and a **CURRENT LEG EXTENDED** message will appear on the message page.

NOTE

The gap placed at the end of the approach before the destination airport does not trigger this message.

Press the FPL key to access the flight plan. Edit the flight plan to remove GAP.

NEXT VNAV LEG INVALID – Next lateral leg is not valid for VNAV. This message will apply to procedural legs in SIDs, STARs and approaches which are “floating waypoints”, e.g., heading to intercept a VOR radial.

NO HEADING – No heading information is being received. This message will not be displayed while on the ground. If a valid heading source was available, it

should have already been automatically selected.
Press DATA key to access DATA 4/4.
Press HDG to place the cursor over the heading field.
Press LIST key to access HDG SRC page.
Change heading source if desired.
If no other heading source is available, manually input the aircraft's heading on DATA 4/4.

NO RAIM @ FAF – RAIM may not be available at the Final Approach Fix (FAF) or HIL is greater than 0.3 NM.

NO RAIM @ MAP – RAIM is not available at the Missed Approach Point (MAP) or HIL is greater than 0.3 NM.

NO SATELLITE INTEG – GPS integrity monitoring is not available for 27 seconds in Enroute and for 7 seconds in Terminal phase of flight. In Approach phase after FAF, GPS integrity monitoring is not available and HDOP is greater than 4.0 for 7 seconds.

NONVOLATILE MEMORY FAIL – The non-volatile memory has failed the power-up test. Some or all of the NVM parameters may be lost. This message can only occur following system initialization.

PERF DATABASE FAILED – The performance database has failed. Advanced performance features will be disabled. Reload performance database.

PERF DB ID MISMATCH – The performance database ID entered on the configuration pages does not agree with the performance database ID on the disk that is loaded.

PERF T/O GW UPDATE REQD – The current gross weight differs more than 2.5 percent from the value entered in the gross weight field. Press “BACK” “ ENTER” to update or, enter a manual value in the gross weight field.

POSITION CORRECTING – This message normally occurs when reacquiring DMEs following an overwater or other non-DME environment flight segment. Best Computed Position is in the process of being corrected.

POSITION UNCERTAIN – The FMS position is uncertain (not verified).
If configured for ANP/RNP, ANP values have reached the maximum limit per phase of flight. The RNP value in use may be a manual RNP or System RNP.

PROGRAM CHECK FAIL – A problem has been found in the program software. Monitor the system closely. There is a high probability that the system will fail the initial self-tests the next time it is turned on.
After landing and shutdown, turn the system off and then on again in order to troubleshoot.

ROUTE CAPACITY EXCEEDED – An attempt has been made to create a route with over 98 waypoints.

ROUTE DATABASE FULL – An attempt has been made to create over 200 routes, or to use over 3,000 waypoints in all routes.

RUNWAY DATABASE FAIL – The runway database has failed.
Reload navigation database.

RUNWAY IN USE – This runway is in use in an approach or flight plan and cannot be modified or deleted.

SATELLITE POS ALARM – GPS error is outside of phase of flight limits for specified time.

SID DATABASE FAIL – The SID database has failed.

SOFTWARE CONFIG MISMATCH – The loaded version of software does not match the installation compatibility version number stored in the configuration module.

SPEED TOO FAST FOR TURN – RF leg is current lateral guidance leg and the groundspeed is too high for the aircraft to stay within bounds of the arc.

STAR DATABASE FAIL – The STAR database has failed.
Reload navigation database.

STEERING FAIL – Roll steering self-test failure (continuous). This failure may be reset.
Press the DATA key to access DATA 4/4. Position the cursor over the ROLL CMD line. Press the BACK key then the ENTER key to reset.

TACTICAL DATABASE FULL – All 98 available tactical waypoint slots have been used.

TAS INVALID – The True Airspeed portion of the Air Data Computer is not usable. A manual input of TAS may be made on the ADC Status page. Press the DATA key until DATA 2/4 is accessed. Press the line select key at ADC to access ADC 1/1. At the TAS field, enter current true airspeed. A manual TAS overrides any ADC input.

TERMINALS DATABASE FAIL – The terminal intersection database has failed.
Reload navigation database.

TEST MODE – The system is in test mode.

TOP OF DESCENT ALERT – Estimated time to TOD is less than 2 minutes.

VARIATION WARNING – The aircraft is out of the auto-variation model range (above N72 degrees, 45 minutes and below S59 degrees, 45 minutes latitude), there is no manual input, and the TRUE MAGNETIC switch is in the MAGNETIC position.
Press the DATA key to access DATA 4/4. Press the VARIATION line select key to place the cursor over the variation field. Enter a manual East or West variation.

VERIFY MANUAL RNP – A manual RNP has been entered and then a flight phase transition occurs and the new RNP limit is less than the manually entered RNP. Or, a manual RNP has been entered and a leg with a lower database RNP value is sequenced to in a linked flight plan.

VERTICAL WPT ALERT – This message appears approximately 15 seconds prior to a VNAV mode vertical leg change. The WPT and MSG annunciators on the instrument panel flash, along with the FMS MSG light. Pressing the MSG key will change the flashing WPT to steady, turn off the MSG light, and show the VNAV WPT ALERT message.

VHF NAME DATABASE FAIL – The VHF plain language name database has failed.
Reload navigation database.

VHF NAVAID DATABASE FAIL – The navaid database has failed. The backup navaid database, containing navaids and airports, will be used.
Reload navigation database.

VNAV DISCONNECT – An altitude or flight level has been entered on a FPL page that has resulted in a VNAV disconnect. Return to the PATH VNAV page to re-activate VNAV. This message will clear after it is read.

VPATH CAPTURE – This message is annunciated 15 seconds prior to sequencing Top of Descent or initiating the capture to vertical path from a tactical mode.

WAYPOINT ALERT – The aircraft position is within 15 seconds of a leg change while enroute (or 5 seconds while using approach procedural legs), prior to the TO waypoint. The MSG light will not illuminate for this message. The instrument panel WPT alert annunciator will illuminate to alert the pilot of an impending leg change.

WAYPOINT IN USE – This message occurs when attempting to delete a waypoint from the pilot defined database which is in use on the flight plan.

400 Hz REF FAIL – 400 Hz (AC) power has failed and there is no input to the analog roll steering. This message is suppressed if the system is installed in an "all digital" aircraft. It remains on the message page as long as the condition exists.

+3 VOLT PWR SUPPLY FAIL – Self test for power supply has failed.

+5 VOLT PWR SUPPLY FAIL – Self test for power supply has failed.

+8 VOLT PWR SUPPLY FAIL – Self test for power supply has failed.

-8 VOLT PWR SUPPLY FAIL – Self test for power supply has failed.

WEATHER RADAR SYSTEM

WARNING

> Dangers from ground operation of aircraft weather radar equipment include the possibility of injury to personnel and ignition of combustible materials by radiated energy. The weather radar system should be operated on the ground only by qualified personnel. With power available, the weather radar will be transmitting whenever the function selector is in the ON position, a weather radar display mode is selected, and the HSI range scale is less than 1,000 nm (500 displayed). The weather radar should not be operated while the aircraft is in a hangar or other enclosure unless the radar transmitter is not functioning or unless an absorption shield is used to dissipate the radiated energy. The radar should never be operated in the ON position with personnel or combustible materials closer than 6 feet and 15 feet respectively, to the radome. Personnel should not be allowed to stand directly in front of a transmitting but non scanning radar dish even if outside the 6 foot boundary.

The color weather radar system provides a graphical display on the HSI that shows the relationship of the selected course to significant weather. Intensity of precipitation is depicted on the HSI by areas of colors associated with precipitation rates. The major components of the weather radar system are the radar receiver-transmitter and the antenna assembly mounted in the nose of the aircraft. The antenna is a 12-inch flat plate design creating an 8-degree radar beam (Figure 4-66). The radar scan is 60 degrees left and right of the aircraft, and the antenna can be commanded to elevations of ±15 degrees from level. The radar display is gyro-stabilized to 30 degrees angle of bank. The radar is operated primarily by means of the radar control panel located on the left console panel in the front cockpit and the antenna elevation control located on the left instrument panel in both cockpits. Other controls that affect HSI display of radar data are located on the HSI control panel in both cockpits. The HSI control panel functions are addressed in the description of the electronic flight instrumentation system.

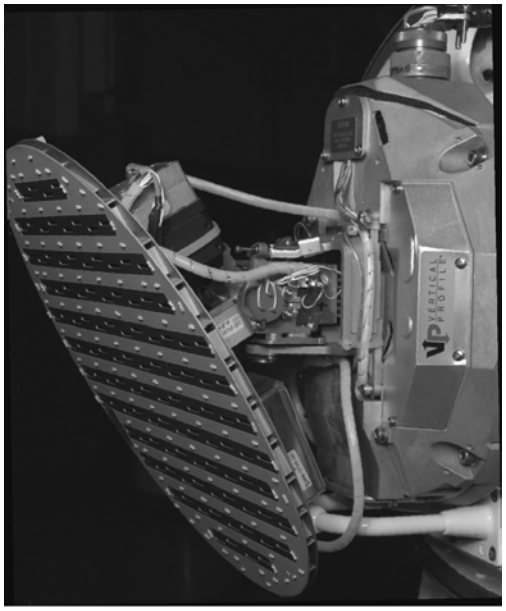

Figure 4-66. Weather Radar

RADAR CONTROL PANEL

The selectors and controls on the radar control panel are identified in Figure 4-67.

Figure 4-67. WX Radar Control Panel

Function Selector

The function selector is a four-position rotary switch that selects the following weather radar operating functions:

OFF

When OFF is selected, primary power is removed from the weather radar system.

STBY

The STBY (standby) function places the system in a condition in which no radar transmission occurs and the antenna is parked in its downward position. This function is normally used for initially applying power to the system and preparing it for operation. It is also used to keep the system ready without operating the transmitter.

TST

The TST (test) function tests the basic operability of the system and displays a test pattern on the HSI. The test pattern is illustrated in Figure 4-68. No radar transmission occurs when this function is selected.

ON

The ON function places the system into normal operation. Radar transmission occurs whenever the radar is in the ON position, an HSI radar mode is selected, and the HSI full scale range is less than 1,000 NM. When ON is selected and the radar is radiating, the cue for the selected radar mode appears on the HSI radar annunciator line.

Figure 4-68. WX RADAR TEST PATTERN

The radar automatically goes to STBY when the scale range of 1,000 nm is selected or when a non-radar display is selected (e.g., nav map or compass rose).

Weather Mode Button (Wx)

When this button is pressed, the Wx mode is selected, and Wx appears on HSI radar annunciator line (lower left) and the radar displays areas of precipitation.

Weather Alert Mode Button (WxA)

When the WxA mode is selected, WxA appears on HSI radar annunciator line (lower left) and areas of high precipitation normally represented on the display as magenta colored flash between magenta and black.

Ground Map Mode Button (GND MAP)

When this button is pressed, the ground mapping mode is selected, and MAP appears in the lower left corner of the display. In the ground mapping mode, the magenta color is not used and the GAIN control is enabled.

Radar Control Panel Tilt Knob

The tilt function of this control has been disabled. When the knob is pulled outward, stabilization of the radar based on IRS pitch and roll data is discontinued.

Instrument Panel Antenna Tilt Knob

A radar antenna tilt knob, placarded ANTENNA TILT, is located on each instrument sub panel next to the FMS. When the knob is moved out of the detent at 0 degrees, it manually adjusts the tilt of the weather radar antenna from a maximum of 15 degrees down to a maximum of 15 degrees up. Ten degrees of knob rotation is approximately equal to one degree of antenna tilt. The antenna tilt angle is displayed on the second line of the radar data in the lower-left corner of the HSI when weather radar is selected. The antenna tilt knob is active only in the cockpit indicated by the illuminated portion of the FWD/AFT PBI.

Gain Control

The gain control functions only when the ground map mode is selected. It enables manual adjustment of the radar receiver gain to achieve best results for ground mapping. In the Wx and WxA modes, receiver gain is preset and is not affected by this control.

CAUTION

Always return the gain control to its fully clockwise position after using a reduced gain setting. Failure to do so could prevent detection of significant adverse weather if it is later attempted to monitor weather while using the ground map mode.

WEATHER RADAR DISPLAY

The desired HSI weather radar presentation format is obtained by means of the HSI button or the ARC button on the HSI control panel. The HSI button is pressed successively until a NAV map with weather is displayed in a 360-degree HSI format. An arc format with a NAV map or compass rose presentation is obtained by pressing the ARC button. The Wx, WxA, or ground map mode is selected on the radar control panel.

A weather radar display represents the targets detected by reflection of the radar pulses. Only precipitation or other dense objects such as earth or solid structures offer enough reflectivity to be detected. Therefore, the radar does not detect clouds, storms, or turbulence directly. Instead, it detects the precipitation that may be associated with dangerous thunderstorms and turbulence. The best radar reflectors are wet hail and raindrops, with larger drops being better reflectors than smaller ones. The relative reflective levels of various forms of precipitation are:

Wet Hail ....MOST REFLECTIVE
Rain ↑
Ice Crystals
Wet Snow
Dry Hail ↓
Dry Snow......LEAST REFLECTIVE

Weather information transparently overlays the existing navigation data on the HSI. In the Wx and WxA modes, the radar receiver gain is calibrated so that the colors indicate specific levels of target intensity. Table 4-6 shows the meanings of these levels and their approximate relationship to the Video Integrated Processor (VIP) intensity levels used by the National Weather Service. In order, from the greatest target intensity to the least, the colors are magenta, red, yellow, and green. Black represents areas of virtually no target detection.

When weather is selected for display, the HSI acts as a weather radar range controller by means of the RNG buttons on the EFIS display control panel. If the selected range exceeds the maximum or minimum range of the radar, the word RANGE is displayed. If the 1,000-nautical-mile HSI range (500 displayed) is selected, the weather radar is placed in standby.

TILT MANAGEMENT

WARNING

Improper use of the tilt control could prevent detection of significant adverse weather.

Effective antenna tilt management requires consideration of the following:

- The center of the radar beam is referenced to the horizon by data provided from the IRS.
- Adjusting the antenna tilt control causes the center of the radar beam to scan above or below the IRS plane.
- The curvature of the earth and the 8 degree beam width are factors in determining tilt angle at long distances.
- If the tilt setting is too low, ground or sea returns will be excessive. If it is too high, excessive ground or sea returns are eliminated, but the radar beam could be passing over the top of a weather target.

NOTE

The antenna tilt knob on the radar control panel is not operational.

Table 4-6. Radar Display and Thunderstorm Levels Versus Rainfall Rates

Display Level	Rainfall Rate		Video Integrated Processor (VIP) Categorizations				Remarks
	mm/Hr.	In./Hr.	Storm Category	VIP Level	Rainfall Rate mm/Hr.	Rainfall Rate In./Hr.	
4 (Magenta)	Greater Than 50	Greater Than 2	Extreme	6	Greater Than 125	5	Severe turbulence, large hail, lightning, extensive wind gusts, and turbulence.
			Intense	5	50 – 125	2 – 5	Severe turbulence, lightning, organized wind gusts, hail likely.
3 (Red)	12 - 50	0.5 – 2	Very Strong	4	25 – 50	1 – 2	Severe turbulence, likely lightning.
			Strong	3	12 – 25	0.5 – 1	Severe turbulence, possible lightning.
2 (Yellow)	4 – 12	0.17 – 0.5	Moderate	2	2.5 – 12	0.1 – 0.5	Light to moderate turbulence is possible with lightning.
1 (Green)	1 – 4	0.04 – 0.17	Weak	1	0.25 – 2.5	.01 – 0.1	Light to moderate turbulence is possible with lightning.
0 (Black)	Less Than 1	Less Than 0.04					

Detecting weather targets at long enough ranges to provide adequate time to plan an avoidance path requires that the tilt angle be set for a sprinkle of ground target returns. An antenna tilt knob (Figure 4-69) is located in each cockpit on the left sub panel. FWD/AFT PBI illumination determines which crewmember controls antenna tilt. By slowly raising the tilt angle, weather targets will emerge from the ground returns in accordance with their height above the ground. To minimize ground returns when closely examining weather targets below aircraft altitude, select the shortest range that allows full depiction of the area of interest.

Figure 4-69. WX Radar Antenna Tilt Knob

PITOT-STATIC SYSTEM

The pitot-static system (Figure 4-70) measures total and static air pressure by means of two identical probes mounted on the sides of the aircraft near the front cockpit. Total pressure is supplied to the air data computer and air speed indicators. Static pressure is supplied to the air data computer, the barometric altimeters, the airspeed indicators, and the rate of climb indicators. Pitot-static probe anti-icing is performed by an electrical heating element in each probe that is activated when the pitot heat switch is turned on. This switch also activates the AOA vane and temperature probe heaters. Total and static pressure lines from each pitot-static probe are teed together. If one pitot-static probe becomes obstructed, air data will not be significantly affected.

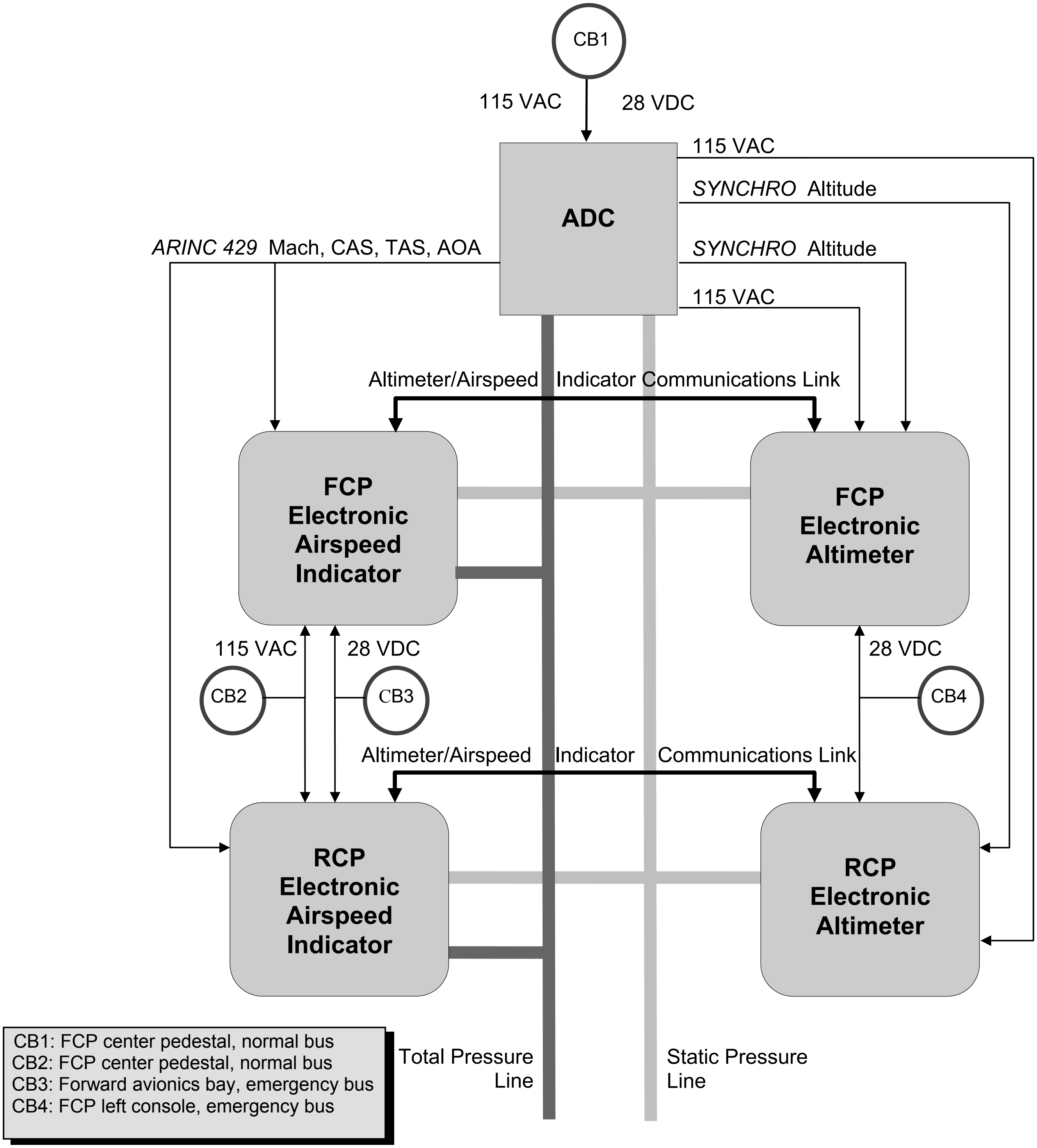

Figure 4-70. T-38N Electronic Air Data System Block Diagram

AIR DATA COMPUTER SYSTEM

The air data computer, powered by the 28 VDC bus, calculates certain flight parameters based on aircraft and environmental inputs (Figure 4-72). These inputs include static and total air pressure from the pitot-static system, angle-of-attack (AOA) position from the AOA transmitter, temperature from the air temperature sensor, flap position, landing gear position (up or down), and barometric setting from the front cockpit altimeter. 115 VAC is supplied to the ADC and is routed to the altimeters and mach/airspeed indicators. In the event of an ADC failure, 115 VAC power is removed from the altimeters and airspeed indicators, forcing the indicators to the RESET mode. The air data computer performs the following:

- Supplies corrected pressure altitude to the altimeters when they are in NORMAL mode.
- Outputs AOA ratio to the AOA indicators.
- Operates the AOA indexers.
- Performs the altitude and airspeed portions of the landing gear warning system.
- Provides the airspeed compensator function of the stability augmentation system to adjust rudder deflections as a function of airspeed.
- Provides outputs of pressure altitude, barometric corrected altitude, calibrated airspeed, true airspeed, mach number, static air temperature, rate of climb, and angle of attack ratio to various instruments.

The FMS receives barometric corrected pressure altitude and true airspeed. The altitude alerter receives barometric corrected altitude and static air temperature. Pressure altitude is output to the transponder. Mach number is output to and displayed by the EFIS and electronic airspeed indicator. Calibrated airspeed and angle of attack ratio are also output to the electronic airspeed indicator. Rate of climb output is not currently used by any T-38N instruments.

The T-38N cockpit instruments and related equipment associated with the air data computer system are described in the following paragraphs.

MADC FAIL Caution Light

This light illuminates when the air data computer detects a fault in the operation of the air data computer. If the altimeters do not revert to the standby mode, the altitude information from the air data computer is reliable.

SOLID STATE BAROMETRIC ALTIMETER

A digital LCD servo-barometric altimeter, shown in Figure 4-71, is located to the right of the ADI on the instrument panel in both the front and rear cockpits. The dual mode pressure altitude indicator has a range of -1,000 feet to +80,000 feet.

Figure 4-71. Barometric Altimeter

Using data from the air data computer and operating in the servo (NORMAL) mode, it displays corrected altitude. The momentary NORMAL/STBY select switch at the lower-right corner of the unit is used to select the NORMAL or STBY mode of operation. Electrical malfunctions will cause the unit to revert to operation as a pressure-actuated altimeter, and cause the standby warning flag to appear.

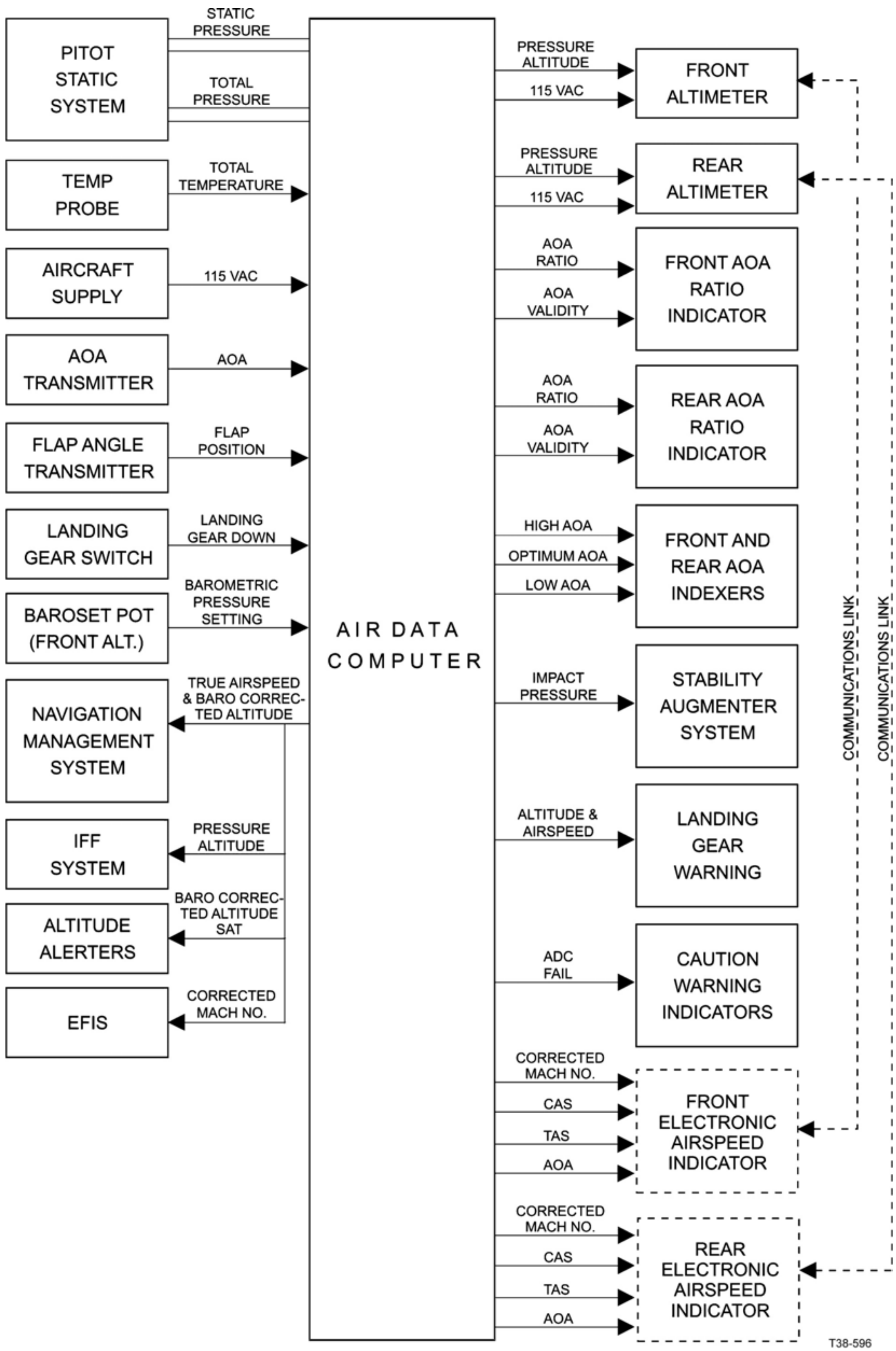

Figure 4-72. Air Data Computer System

Barometric pressure is set by means of the knob at the lower left of the unit. The placard ME/TEST adjacent to this knob is a maintenance feature and cannot be accessed by the crew. The barometric pressure set in the front cockpit altimeter is also provided to the air data computer.

NOTE

A communications link exists between the airspeed indicator and electronic altimeter. With the altimeter in NORM, the ADC is providing corrected altitude. With the altimeter in STBY, and an "A" displayed, the altitude is corrected via the airspeed indicator communications link.

The altimeters are powered by 115 VAC from the ADC and can also be powered by the 28 VDC emergency bus in the event AC power is lost. In the event of a failure to the LCD "thousands" digits, they can be transferred to the right side of the LCD by holding the NORMAL /STBY switch in STBY for approximately 5 seconds. Lighting for the altimeter is controlled by the cockpit instrument lighting knob. The LCD intensity is fixed.

ELECTRONIC AIRSPEED AND AOA INDICATOR

The electronic airspeed indicator is shown in Figure 4-73. It displays corrected airspeed, mach (above approximately .60 mach), TAS, and AOA. The electronic indicator displays corrected airspeed by way of a mechanical needle and digital LCD readout. The electronic airspeed indicator is powered primarily by the right 115 VAC bus but will also operate from the 28 VDC emergency bus. A speed "bug" control is located on the lower left face of the indicator. It is used to rotate the speed "bug" around the outer pointer scale. A TEST button near the speed "bug" control is provided for maintenance personnel. Indicator lighting is controlled by the instrument lighting rheostat. Back-lighting for better day illumination is provided when the instrument lighting rheostat is off.

The airspeed indicator has a NORM/ STBY paddle switch used to select the source of corrected airspeed data. Selection of NORM or STBY is independent in each cockpit. In NORM, the indicator receives and displays corrected airspeed data from the ADC – this is the normal mode of operation. In STBY, the airspeed indicator displays corrected airspeed using internal correction curves provided a communications link with the electronic altimeter is intact. An intact link is identified by an "A" next to the thousands digits on the altimeter when the altimeter is in STBY mode. A broken link is identified by a series of dashes in the airspeed indicator mach window when the airspeed indicator is in STBY mode. The communications link may be intentionally broken by holding the airspeed NORM/ STBY paddle switch in STBY for more than 3 seconds. The link can be reestablished by holding the airspeed NORM/ STBY paddle switch in NORM for more than 3 seconds. Significant errors in airspeed can occur in the uncorrected mode (see Figure A1-1).

Figure 4-73. Electronic Airspeed Indicator

NOTE

Due to pitot-static errors with uncorrected airspeed, add 5 knots to final approach and landing speeds and 60 feet to all altitude minimums.

While in the NORM mode, the NORM/STBY paddle switch may be used to swap the digital airspeed readout between TAS and calculated airspeed (CAS) by momentarily toggling the paddle switch toward NORM. When TAS is selected, a TAS cue appears to the upper right of the airspeed digital display.

The electronic airspeed indicator also displays AOA as a percent of stall in a 47-segment LCD on the inner arc of the indicator. AOA ranges are identical to the current analog system described later in this section. The AOA indicator is unaffected by the airspeed indicator mode.

NOTE

A flashing airspeed indicator STBY cue indicates there is greater than 8 knots difference between the ADC and indicator CAS. Toggling the paddle switch to NORM stops the flashing.

ALTITUDE ALERTER

An LCD altitude alerter, shown in Figure 4-74, is located to the left of the ADI on the instrument panel in both the front and rear cockpits. It operates off of the left 115/200 VAC bus. The alerter provides two user-selectable modes of operation, altitude alerting and minimum descent altitude (MDA) alerting. In altitude alerting, both aural and visual annunciations of approach to, and departure from, the user-selected altitude are given. In the MDA mode, the alerter gives audio and visual annunciations of approach to, and departure from, a minimum altitude. The reference altitude for both modes may be set in either cockpit by rotating the altitude knob on the left side of the display. This will override the altitude previously set for that mode in both cockpits. Volume levels for the tone and voice aural warnings are preset by maintenance personnel.

The two alerter modes are selectable from either cockpit via the mode select/warning light push button on the right side of the display. Mode selection in either cockpit will change modes in both cockpits. The altitude alerter may also be individually configured in each cockpit to display outside static air temperature, cabin altitude, or a declutter mode which displays only the selected altitude. (In the MDA mode, only SAT and declutter are available.) Lighting intensity for the altitude alerter is controlled by the cockpit instrument lighting knob. Intensity of the LCD is fixed.

Figure 4-74. Altitude Alerter

ALTITUDE ALERTER MODE

The altitude alerter system is on any time the left AC bus is powered. If MDA is annunciated, pressing the warning light push button toggles to the altitude alerter mode. When the mode is toggled in one cockpit, the other cockpit display toggles and flashes until acknowledged by pressing the warning light. Either crewmember may select an altitude by rotating the altitude knob clockwise or counter clockwise. When a new altitude is selected, the letter R appears on the display in the other cockpit. When the aircraft reaches a point

1,000 feet from the displayed altitude, an aural tone and voice alert ("altitude") will be initiated and the warning light illuminates until 200 feet above the selected altitude. If a 200-foot deviation is made above or below the displayed altitude, another tone, voice alert, and warning light will be activated.

MINIMUM DESCENT ALTITUDE (MDA) MODE

The MDA mode is selected by momentarily pressing the warning light in either cockpit. The MDA cue will appear in the bottom center of the LCD in both cockpits. The letter R will be displayed on the remote cockpit LCD along with the new altitude and the display will flash until the setting is acknowledged by pressing the light. In the MDA mode the altitude alerter will illuminate the warning light when the aircraft reaches an altitude 200 feet above the set altitude. At 100 feet above the selected altitude the warning light will extinguish and a tone and voice alert ("altitude") activate. When the selected altitude is reached, the tone and voice alert ("minimums") activate. Descent below the selected altitude causes the warning light to flash three times. Climbing 100 feet or more above the selected altitude will cause the alerter sequence to reset and reactivate at the appropriate altitudes.

STATIC AIR TEMPERATURE, CABIN ALTITUDE

The altitude alerter also provides the capability to monitor the outside air temperature (altitude or MDA alerter modes) and the cabin altitude (altitude alerter mode only). Either crewmember can access this data by pressing the warning light push button "in" for 2 seconds to toggle to these displays or remove them (declutter).

RADAR ALTIMETER

The AN/APN-194 (V) radar altimeter, as represented in Figure 4-75, is a pulsed range-tracking radar that provides the crew with accurate terrain clearance information from 0 to 5,000 feet within ±1% of the indicated altitude. The set functions normally up to 45 degrees bank and pitch angle. The set consists of two identical antennas, a receiver/ transmitter unit, a blanker unit, and two-inch height indicators mounted in each cockpit instrument panel. The indicators include an altitude scale and pointer, red MDA warning light, adjustable altitude bug, altitude set/PUSH-TO-TEST knob, and green BIT light. When a reference altitude is set on the indicator, the MDA warning light illuminates and an aural warning (intermittent tones for 2.5 seconds) sounds when the aircraft descends below the reference altitude. The MDA warning light will remain illuminated until the aircraft climbs above the reference altitude. The aural warning is reset when the aircraft climbs above the reference altitude. Each cockpit indicator may be set for a different altitude. The radar altimeter is powered by the left 115/200 VAC bus. Power is applied to the radar altimeter when either cockpit radar altimeter PUSH-TO-TEST knob is rotated clockwise. The warm-up sequence requires approximately 1 minute to complete. After power on (assuming the aircraft is on the ground), the altimeter will lock up at 0 feet, the OFF flag will pull back, and the MDA light may come on, depending on the MDA bug setting. Lighting for each radar altimeter indicator is controlled by the respective cockpit instrument knob.

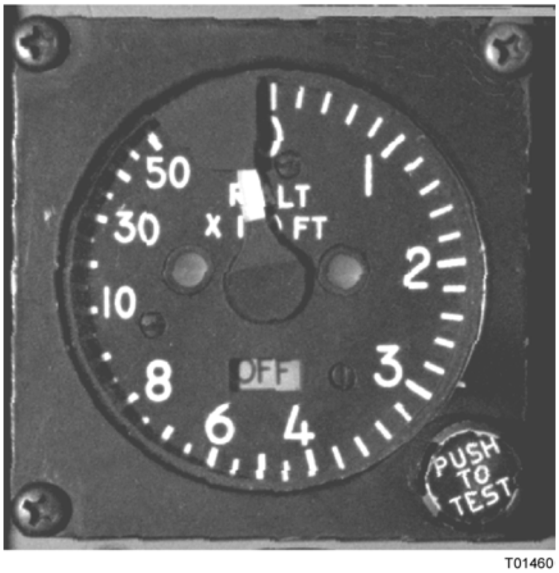

Figure 4-75. Radar Altimeter

SELF-TEST

The radar altimeter self-test can be performed from either cockpit. Set the MDA bug to 50 feet. Press and hold the PUSH-TO-TEST knob. The indicators in both cockpits will read 100 +5 feet. The green built-in-test (BIT) annunciator in the indicator will illuminate. The MDA annunciator will be off and the OFF flag will be out of view. Release the PUSH-TO-TEST knob and the indicator will return to 0 feet and the MDA annunciator will come on. The green BIT light will turn off and the OFF flag will remain out of view.

RADAR ALTIMETER OPERATION

The radar altimeter BIT may be run any time AC power is available from either cockpit. The PUSH-TO-TEST knob is rotated clockwise or counterclockwise to set the MDA bug in both cockpits. Each indicator may be set for a different altitude. As the aircraft climbs through about 5,400 feet, the altitude pointer will disappear from view and the OFF flag will appear. As the aircraft descends through 5,400 feet, the pointer will re-appear at the correct AGL altitude and the OFF flag will disappear. When the aircraft reaches the altitude corresponding to the radar altimeter bug setting, the red MDA will illuminate. The red MDA light will remain illuminated any time the aircraft is below the pilot designated altitude.

INERTIAL REFERENCE SYSTEM

The Honeywell Corporation Laseref V Micro-Inertial Reference System (IRS) provides attitude and heading data for use by various aircraft systems, including aircrew EFIS displays, FMS, flight director, and weather radar; position and velocities for the FMS; and turn rate to the EFIS. The major components of the system are the IRS and sensor assembly, and the Shadin Corporation IRS Converter. All system functionality is contained within the IRS with the exception of converting some IRS digital output data to an analog synchro form for the weather radar and flight director. The magnetic flux valve and compass control panels are not required and have been removed.

THEORY OF OPERATION

The IRS is essentially three highly-sensitive LASER accelerometers and a high-speed digital computer. During alignment the system detects accelerations caused by the earth's rotation. The system is able to break down these accelerations into components to determine heading and rough estimates of latitude and longitude. Once coordinates have been confirmed through receipt from the FMS, the system can enter the NAV mode. In NAV mode, the system computes new attitudes and rates by integrating the required components of acceleration.

SYSTEM OPERATION

Modes of operation are:

Alignment – The system is powered by 28 VDC emergency bus and begins alignment when the battery switch is turned to NORM or EMER. During normal UNS-1L FMS initialization, when the aircrew ACCEPTs the initialization data, present position data is presented to the IRS for 10 seconds for initialization and alignment. If the system is not initialized during the alignment period, the IRS will stay in ALIGN mode until the FMS is initialized. Normal alignment time in Houston will be approximately 3-1/2 minutes, and in Washington D.C., approximately 4 minutes 10 seconds. When alignment is complete (assuming it received initialization coordinates), the FMS data page for the IRS will show NAV mode, and heading becomes valid on the aircrew displays. The FMS also issues a MSG stating "IRS1 READY." If the IRS needs to be realigned, and the FMS is not re-initialized, the aircrew can force the transmission of alignment coordinates to the IRS by pressing UPDATE SENS on NAV Page 3.

Navigation – The system provides digital data to the receiving systems. Weather radar and flight director data is processed through the IRS Converter. Drift rates of less than 2 nmi/hr and close-out accuracies of approximately 2 nmi may be anticipated.

Reversionary Attitude – If the system power is lost and regained while the aircraft is in motion, it will initialize in the Reversionary Attitude mode. Stable, unaccelerated flight must be maintained for the 2 seconds required to achieve Reversionary Attitude mode. This is the best type of reversionary attitude. In turbulent air, the system will capture short periods of unaccelerated data that will be summed to give 20 seconds of valid data for an attitude alignment of lesser quality. This mode could take approximately 40 seconds. In the reversionary attitude mode, attitude operation is normal but the IRS heading must be manually updated on LSK [1R] of the IRS1 sensor page of the FMS (found on DATA page 2), and monitored occasionally for errors greater than several degrees. See Figure 4-76 (three examples of IRS status messages are shown, however, only one can be active at a time.) Due to manual heading operation, a "FHDG" legend will appear on the EFIS to remind the aircrew to initially set the heading. In this mode the system is not providing computed true heading, present position or velocities.

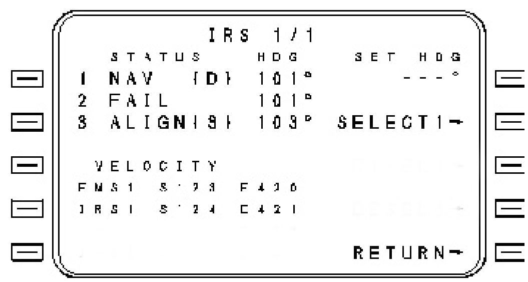

Figure 4-76. IRS Status Message Page

STANDBY ATTITUDE INDICATOR

The ARU-42/A2 attitude indicator (Figures 1-7 and 4-77) is a self-contained gyro providing a visual indication of the bank and pitch of the aircraft. It is powered from the nominal or emergency DC bus. The instrument limits are: 92 degrees climb, 78 degrees dive with full 360 degrees roll capability. The pitch trim knob is used to adjust the miniature aircraft and to cage the indicator. Rotating the knob while it is in adjusts the miniature aircraft. Pulling the knob out to the fully extended position cages (erects) the indicator. With the knob fully extended, rotating the knob fully clockwise locks the indicator in the caged position until released.

Figure 4-77. Standby Attitude Indicator

Approximately 3 minutes are required to erect to true vertical after power is applied to the system. The indicator should be uncaged (knob rotated and pushed in) and set after applying electrical power and left uncaged during flight. It should be caged prior to removing electrical power after the flight. When power is interrupted or the indicator is caged, the OFF warning flag appears on the face of the indicator. It should provide useful attitude information on the emergency bus after power failure (accurate to within ±6 degrees) but the time is dependent on the battery condition and its load.

WARNING

The indicator may precess following sustained acceleration or deceleration periods and may tumble during maneuvering flight near the vertical.

CAUTION

For solo flight, the rear cockpit gyro should be uncaged. There is a high risk of damage during flight in the caged and locked condition. Avoid snap releasing the pitch trim knob after uncaging to prevent damage to the indicator.

ATTITUDE WARNING FLAG

The attitude warning flag (OFF) will appear whenever electrical power to the system has failed or is interrupted. The flag will also appear during initial application of electrical power for approximately 1 minute. The instrument is unreliable until the flag disappears.

WARNING

There is no warning of attitude sphere malfunctions other than power failure.

The attitude warning flag will not appear with a slight electrical power reduction or failure of other components within the system. Failure of certain components can result in erroneous or complete loss of pitch and bank presentations without a visible flag. It is imperative that the attitude indicator be crosschecked with other flight instruments when under actual or simulated instrument conditions.

NOTE

During high G maneuvering the warning flag may appear without system malfunction.

ANGLE-OF-ATTACK SYSTEM

The AOA system (Figure 4-78) senses aircraft angle of attack and displays this information to both crewmembers. The AOA system consists of an AOA vane transmitter, air data computer, AOA indicator, AOA indexer, and indexer lights dimmer control in each cockpit. The system provides compensation for various wing flap and landing gear configurations. The AOA system presents the following displays in each cockpit:

1. Optimum AOA for final approach.
2. AOA when buffet and stall will occur.
3. Approximate AOA for maximum range and maximum endurance.

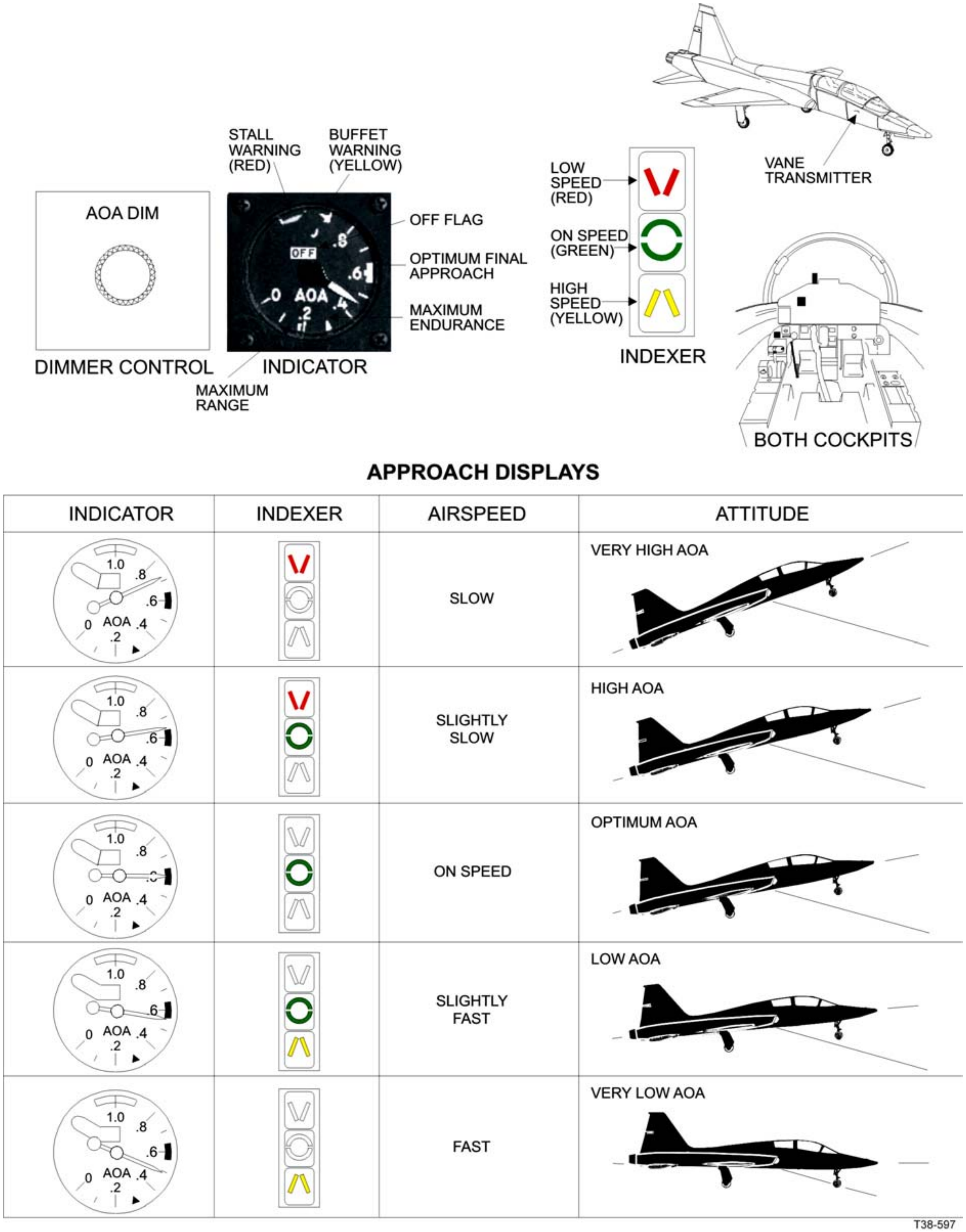

Figure 4-78. AOA System and Displays

The vane of the AOA transmitter is located on the forward right side of the fuselage. The vane is electrically heated for anti-ice and is activated when the pitot heat switch is turned on. The air data computer receives signals from the AOA vane transmitter, wing flap position synchro-transmitter, and nose gear downlock indicating system. The computer automatically calculates and sends the appropriate signals to the AOA indicator and AOA indexer in each cockpit.

AOA INDICATOR

The ARU-26/A AOA dial indicator on the instrument panel operates during all phases of flight and indicates AOA information. The indicator presents AOA as a percentage of maximum lift AOA. The dial is calibrated in units of .1 counterclockwise from 0 to 1.1. Each unit represents approximately 10 percent of aircraft lift, from 0 percent at 0 indication to 100 percent at 1.0 indication. Three preset fixed indices and two colored arcs on the dial indicate the following:

- 0.18 White Index – Maximum Range (1-G flight)
- 0.3 White Index – Maximum Endurance (1-G flight)
- 0.6 White Index – Optimum Final Approach at 3-O'clock Position (1-G flight)
- 0.9 to 1.0 Yellow Arc – Buffet Warning
- 1.0 to 1.1 Red Arc – Stall Warning

The red OFF flag will appear on the face of the dial when electrical power is removed from the AOA system or when the system has failed. The AOA indicator is powered by the left AC bus.

WARNING

The airspeed indicator should be crosschecked frequently when using AOA information; some system malfunctions may not necessarily trigger the OFF flag or be repeated in the other cockpit.

CAUTION

The AOA system is not Mach compensated. At high altitude cruise conditions, the AOA indications are artificially low. The maximum range and maximum endurance indices should not be used to establish those flight conditions.

AOA INDEXER

The ARU-27/A AOA indexer above the instrument panel is controlled by the air data computer and provides an illuminated heads-up display of the AOA information in the form of low-speed, on-speed, and high-speed indexer lights (see Figure 4-78). The three indexer lights are powered by the DC bus. The lights are operative in the landing configuration with the wing flaps up or down, or when the landing gear is up and the wing flaps are extended 5 percent or more. With the landing gear and wing flaps up, the high-speed indexer light is inoperative to eliminate continuous illumination during cruise flight conditions. See Figure 4-79 for allowable On-Speed Band for AOA indexer. AOA system failure is indicated when all three symbols of the indexer are illuminated. The three indexer lights can be tested by placing the warning test switch on the right console at TEST.

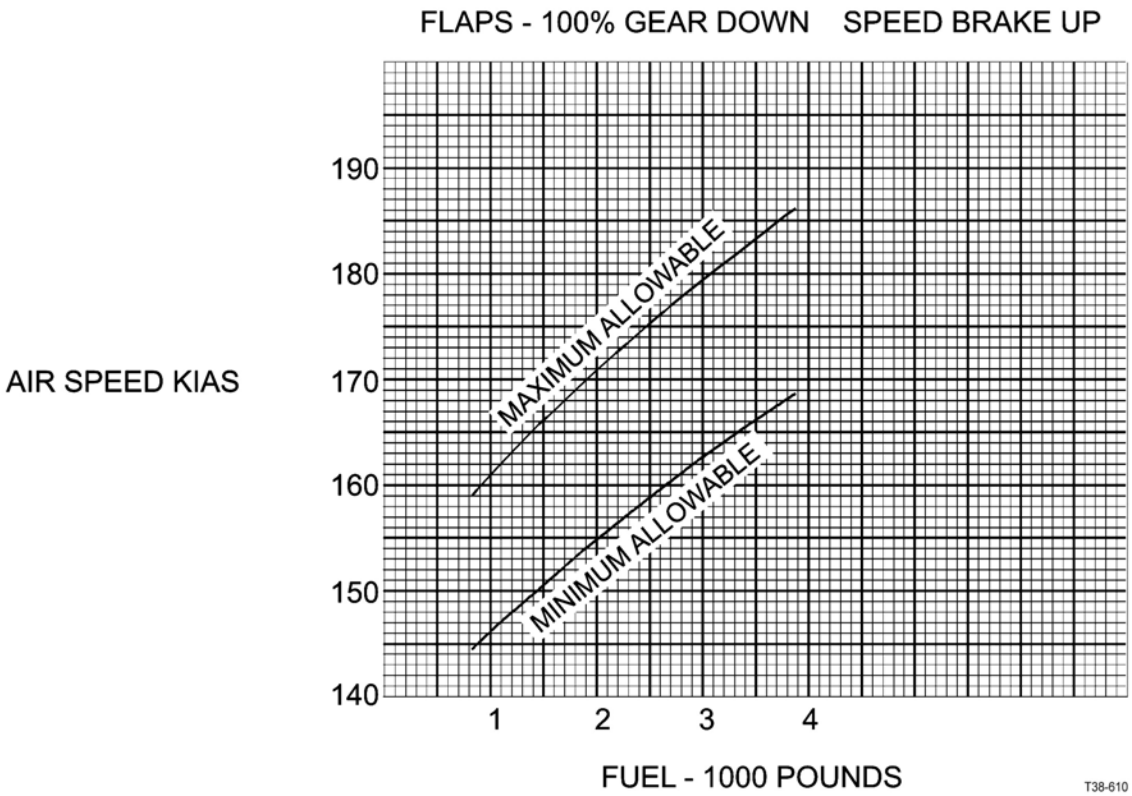

Figure 4-79. Allowable On-Speed Band for AOA Indexer

LIGHTING EQUIPMENT

AOA INDEXER LIGHTS DIMMER

The AOA indexer lights dimmer controls the brightness of the three AOA indexer lights. This control is located on the left subpanel in each cockpit.

EXTERIOR LIGHTING CONTROLS

The exterior lighting controls, consisting of switches for formation, beacon/strobe, and position lights are located on the left console aft of the throttles in the front cockpit.

Position Lights and Switch

The position lights, which operate on 6-volt AC from a transformer off the left AC bus, are individually located in each wing tip, in the vertical stabilizer, and in the lower fuselage. The position lights are controlled by a bright/dim switch (Figure 1-10) on the right console of the front cockpit.

Formation Lights and Switch

Formation lights, operating on DC bus power, are individually located on each side of the forward nose section. Formation lights are controlled by a switch (Figure 1-10) on the right console of the front cockpit.

LANDING AND TAXI LIGHTS

Two retractable landing-taxi lights are provided. For these lights to operate, the LDG TAXI LIGHT switch (Figure 1-9) on the left subpanel in the front cockpit must be set to on, the POSITION light switch must be set to either bright or dim, and the landing gear must be down and locked. While the aircraft is airborne, the lights operate in the landing mode at high brightness and with a 95-degree extension. With weight on wheels, the lights operate in the taxi mode at low brightness and with an 87-degree extension.

INTERIOR LIGHTING

The instrument lights operate on AC power. A knob (Figures 1-10 and 1-12) on the right console of each cockpit controls operation and intensity of the instrument lights. White floodlights, operating on AC, aid in illuminating the instrument panel, console panels, and the cockpit area. The floodlights are controlled by a knob (Figures 1-10 and 1-12) on the right console of each cockpit. The two floodlights over each cockpit instrument panel (Figure 1-7) automatically switch from AC to DC if the AC power supply fails, provided the floodlight control knob is not at the OFF position. These floodlights serve as an alternate lighting source under this condition and cannot be dimmed when operating on DC power. The integral console, subpanel, and pedestal lights operate on AC. Operation and intensity of these lights are controlled by rotating the console lights knob (Figures 1-10 and 1-12) on each right console.

NOTE

> If the left generator and bus transfer relay fail, instrument and console lights will not be operational. Floodlights which are powered by the right AC bus will not be automatically available, and the floodlight rheostat must be rotated out of OFF to obtain cockpit lighting.

UTILITY LIGHTS

Grimes utility lights (two in the front cockpit and one in the rear cockpit) provide additional directional cockpit lighting for the crew. The lights are shown in Figures 1-5 and 1-6.

OXYGEN SYSTEM

The aircraft uses a liquid oxygen system to supply breathing oxygen to crewmembers. The oxygen regulators (automatic diluter demand) control the flow and pressure of the oxygen and distribute it in the proper proportions to the masks. The oxygen regulator (Figures 1-10 and 1-12) on the right console of each cockpit contains a pressure gage, a blinker type flow indicator, emergency flow lever, diluter lever, and a supply lever. When the supply lever is at OFF, the flow of oxygen and cockpit air to the oxygen mask are both cut off.

OXYGEN QUANTITY INDICATOR

An oxygen quantity indicator, operating on AC power and located on the right subpanel of each cockpit (Figures 1-9 and 1-11), indicates converter liquid oxygen quantity in liters. The indicator is provided with an OFF flag, which will appear in case of electrical power failure.

OXYGEN LOW-LEVEL CAUTION LIGHT

An oxygen low-level caution light (Figures 1-10 and 1-12) on the right console of each cockpit illuminates when the oxygen indicator reads 1 liter or less of liquid oxygen. The light may blink, due to oxygen sloshing, if the system contains less than 3 liters.

OXYGEN SYSTEM PREFLIGHT CHECK (PRICE)

The acronym PRICE is often used to help remember the oxygen system checks.

P – PRESSURE

The pressure gage should read 50 to 120 psi (Figure 5-1) and should agree with the pressure gage in the other cockpit.

R – REGULATOR

Check regulator supply lever at ON. Hook up mask and perform a pressure check. Place the emergency flow lever at EMERGENCY position, take a deep breath and hold it. If mask leaks, readjust mask and check pressure. The oxygen should stop flowing if the mask is properly fitted; if the oxygen continues to flow, the regulator, the hose, or the valve is not holding pressure, and the cause of the leak should be corrected. Return the emergency lever to NORMAL. If you cannot exhale, the valve has malfunctioned and the discrepancy should be corrected.

WARNING

It is possible for the supply lever to stop in an intermediate position between OFF and ON. Care should be taken to push the supply lever full ON and visually check the flow indicator blinker for proper functioning.

I – INDICATOR

With the diluter lever in 100% OXYGEN position, check blinker for proper operation.

C – CONNECTIONS

Check connection secure at the seat. Check regulator hose for kinks, cuts, or cover fraying. Check that male part of the disconnect is not warped and rubber gasket is in place. A 12- to 20-pound pull should be required to separate the two parts. Check mask hose properly installed to connector.

E – EMERGENCY

Check emergency oxygen cylinder properly connected and a minimum pressure of 1,800 psi. (Pressure gage must be checked during parachute preflight.)

Figure 4-80 gives oxygen duration for various altitudes versus amount of liquid oxygen.

MISCELLANEOUS EQUIPMENT

The T-38N is equipped to carry the NASA unique weapons system stowage pod (WSSP) which mounts under the center section of the fuselage. The nose section of the pod is attached to a tray which slides out for loading and, when stowed, is secured in place by a metal over-center latch type strap on each side. Each latch strap is covered by a streamlined fairing which is secured by a wing nut zeus-type fastener. The pod is approximately 84 inches long, 24 inches wide, and 16 inches deep. The nose and tail sections are faired. Normal load capacity is approximately 140 pounds. The WSSP has been modified to accommodate the modified speed brake (MSB) for low L/D Space Shuttle type approaches.

Additional items provided include:

1. Instrument hood.
2. Rearview mirrors.
3. Map data case.

CREWMEMBER DURATION IN HOURS

ONE CREWMEMBER

COCKPIT ALTITUDE FEET	Diluter lever	10	9	8	7	6	5	4	3	2	1	BELOW 1
40,000 & ABOVE	100% OXYGEN	56	50	45	39	33	28	22	16	11	5.6	EMERGENCY DESCEND TO ALTITUDE NOT REQUIRING OXYGEN.
	NORMAL OXYGEN	56	50	45	39	33	28	22	16	11	5.6	
35,000	100% OXYGEN	56	50	45	39	33	28	22	16	11	5.6	
	NORMAL OXYGEN	56	50	45	39	33	28	22	16	11	5.6	
30,000	100% OXYGEN	40	36	32	28	24	20	16	12	8.1	4.0	
	NORMAL OXYGEN	41	37	32	29	25	20	16	12	8.3	4.1	
25,000	100% OXYGEN	31	28	25	21	18	15	12	9.4	6.2	3.1	
	NORMAL OXYGEN	39	35	31	27	23	19	15	11	7.8	3.9	
20,000	100% OXYGEN	23	21	19	16	14	11	9.5	7.1	4.7	2.3	
	NORMAL OXYGEN	44	40	35	31	26	22	17	13	8.9	4.4	
15,000	100% OXYGEN	19	17	15	13	11	9.5	7.6	5.7	3.8	1.9	
	NORMAL OXYGEN	54	48	43	37	32	27	21	16	10	5.4	
10,000	100% OXYGEN	15	13	12	10	9.2	7.6	6.1	4.6	3.0	1.5	
	NORMAL OXYGEN	54	48	43	37	32	27	21	16	10	5.4	

TWO CREWMEMBERS

COCKPIT ALTITUDE FEET	Diluter lever	10	9	8	7	6	5	4	3	2	1	BELOW 1
40,000 & ABOVE	100% OXYGEN	28	25	22	19	16	14	11	8.4	5.6	2.8	EMERGENCY DESCEND TO ALTITUDE NOT REQUIRING OXYGEN.
	NORMAL OXYGEN	28	25	22	19	16	14	11	8.4	5.6	2.8	
35,000	100% OXYGEN	28	25	22	19	16	14	11	8.4	5.6	2.8	
	NORMAL OXYGEN	28	25	22	19	16	14	11	8.4	5.6	2.8	
30,000	100% OXYGEN	20	18	16	14	12	10	8.1	6.1	4.0	2.0	
	NORMAL OXYGEN	20	18	16	14	12	10	8.3	6.2	4.1	2.0	
25,000	100% OXYGEN	15	14	12	11	9.4	7.8	6.2	4.7	3.1	1.5	
	NORMAL OXYGEN	19	17	15	13	11	9.8	7.8	5.9	3.9	1.9	
20,000	100% OXYGEN	11	10	9.5	8.3	7.1	5.9	4.7	3.5	2.3	1.1	
	NORMAL OXYGEN	22	20	17	15	13	11	8.9	6.6	4.4	2.2	
15,000	100% OXYGEN	9.5	8.6	7.6	6.6	5.7	4.7	3.8	2.8	1.9	0.9	
	NORMAL OXYGEN	27	24	21	18	16	13	10	8.1	5.4	2.7	
10,000	100% OXYGEN	7.6	6.9	6.1	5.3	4.6	3.8	3.0	2.3	1.5	0.7	
	NORMAL OXYGEN	27	24	21	18	16	13	10	8.1	5.4	2.7	

LIQUID CONTENTS LITERS: 10, 9, 8, 7, 6, 5, 4, 3, 2, 1, BELOW 1

· TOP FIGURES INDICATE DILUTER LEVER "100% OXYGEN"

· BOTTOM FIGURES INDICATE DILUTER LEVER "NORMAL OXYGEN"

T38-611

Figure 4-80. Oxygen Duration Hours Table

OPERATING LIMITATIONS

SECTION V

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INTRODUCTION

Cognizance must be taken of instrument markings in Figure 5-1, since they represent limitations that are not necessarily repeated in the text.

MINIMUM CREW REQUIREMENT

The minimum crew requirement for this aircraft is one pilot. Solo flights must be made with the pilot flying the aircraft from the front cockpit.

THROTTLE SETTING THRUST DEFINITIONS

NORMAL THRUST

Normal (maximum continuous) thrust is the thrust obtained at 98.5% RPM or 630ºC Exhaust Gas Temperature (EGT), whichever occurs first.

MILITARY THRUST

MIL (military) thrust is the thrust obtained at 100% RPM without afterburner operation.

MAXIMUM THRUST

MAX (maximum) thrust is the thrust obtained at 100% RPM with the afterburner operating. Afterburner range extends from minimum afterburner of approximately 5 percent augmentation above MIL thrust to maximum afterburner, which is approximately 40 percent augmentation above MIL thrust.

AIRSPEED LIMITATIONS

WING FLAPS

Do not exceed the following airspeeds for the wing flap deflections:

- 1% to 45% ....300 KIAS
- 46% to 60% ....240 KIAS
- Over 60%.................220 KIAS

WARNING

WITH EHU 31A.A INDICATORS, IT IS POSSIBLE TO EXPERIENCE AN ENGINE START OR FLAMEOUT UNRECOGNIZED BY THE PILOT. OTHER ENGINE INSTRUMENTS MUST BE REFERENCED TO CONFIRM AN ENGINE START OR FLAMEOUT.

TEMPERATURE EXHAUST GAS

EHU 31A/A

140°C	MINIMUM
140°C TO 630°C	CONTINUOUS OPERATION
645°C	MAXIMUM STEADY STATE
925°C	MAXIMUM DURING START OR ACCELERATION, MOMENTARY
630°C TO 645°C	MIL AND MAX THRUST RANGE

OIL PRESSURE

5 PSI MINIMUM (IDLE)

20 TO 55 PSI NORMAL OPERATING RANGE

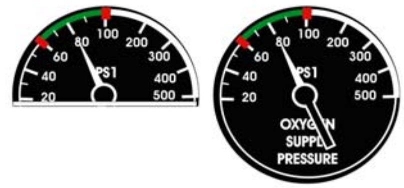
55 PSI MAXIMUM

ENGINE TACHOMETER

83 TO 98.5 RPM CONTINUOUS

104 RPM MIL AND MAX THRUST

(99.0° TO 104 RPM MIL AND MAX THRUST RANGE)



(EARLIER) (LATER)

50 TO 120 PSI NORMAL RANGE

HYDRAULIC PRESSURE

1500 PSI MINIMUM

2850 TO 3200 PSI NORMAL RANGE

3200 PSI MAXIMUM

ACCELEROMETER

– 2.3 G'S FULLY FUELED

+ 5.6 G'S FULLY FUELED

+ 7.33 G'S WITH 900 POUNDS OR LESS OF FUEL REMAINING

AIRSPEED-MACH NO. INDICATOR

220 KNOTS IAS MAXIMUM ALLOWABLE AIRSPEED WITH FLAPS EXTENDED OVER 60

W/POD MAXIMUM INDICATED AIRSPEED WITH WSSP (SEE FIGURE 5-5 FOR MORE DATA).

T38-530

Figure 5-1. Instrument Markings

Table 5-1. Engine Operating Limitations

CONDITION	EGT °C	RPM %	NOZZLE POSITION %	FUEL FLOW LB/HR	OIL PRESSURE PSI	TIME DURATION (MINUTES)
GROUND STEADY STATE						
START	925 (MAX) *845	—	—	360 (MAX)	INDICATION	—
IDLE	—	46.5 – 49.5	77 – 92	400 – 600 STD DAY	5 – 20	—
MILITARY	630 – 645	99.0 – 100.5	0 – 20	2100 – 2500	20 – 55	30
(MAX) AFTERBURNER	630 – 645	99.0 – 100.5	50 – 85	—	20 – 55	5
FLIGHT STEADY STATE						
START	925 (MAX) *845	—	—	360 (MAX)	INDICATION	—
IDLE	140 (MIN)	—	—	200 (MIN) STD DAY	5 (MIN)	—
MILITARY	630 – 645	99.0 – 104	0 – 20	—	20 – 55	30
(MAX) AFTERBURNER	630 – 645	99.0 – 104	50 – 85	—	20 – 55	15
FLUCTUATION LIMITS						
IDLE (GROUND)	—	46.5 – 49.5	NONE ALLOWED	±25	±2	—
MILITARY AND AB (GROUND)	**	99.0 – 100.5	±3	±50	±2	—
MILITARY AND AB (FLIGHT)	**	±1	±3	±50	±2	—

OTHER LIMITATIONS

EGT:

*1. ABORT START IF **EGT** REACHES **845°C** TO PRECLUDE EXCEEDING TEMPERATURE LIMITS.

2. ABORT AIRCRAFT DURING GROUND START IF **EGT** EXCEEDS **925°C** MOMENTARILY.

3. TOTAL FLUCTUATIONS IN **EGT OF 15 (±7.5°C) ARE ACCEPTABLE IF THE AVERAGE **EGT** IS BETWEEN **630°C** AND **645°C**.

4. AT LOW COMPRESSOR INLET TEMPERATURES, MILITARY AND AFTERBURNER **EGT** AND **RPM** MAY BE BELOW NORMAL OPERATING LIMITS (SEE SECTION VII).

RPM:

1. MAXIMUM ALLOWABLE TRANSIENT **RPM** IS **107%**.

NOZZLE POSITION:

1. FOLLOWING RAPID THROTTLE MOVEMENTS, NOZZLE POSITION SHOULD STABILIZE WITH PERMISSIBLE FLUCTUATION RANGE WITHIN 10 SECONDS.
2. NOZZLE POSITION MAY BE LESS THAN 50% WHEN OPERATING THE AFTERBURNER AT LESS THAN MAX AB.

OIL PRESSURE:

1. DURING COLD WEATHER STARTS, OIL PRESSURE USUALLY EXCEEDS 55 PSI. TO EXPEDITE OIL WARMUP, ENGINE MAY BE OPERATED AT MILITARY POWER OR BELOW. IF OIL PRESSURE DOES NOT RETURN TO OPERATING LIMITS WITHIN **6 MINUTES** AFTER ENGINE START, SHUT DOWN ENGINE.
2. IF A SUDDEN CHANGE OF **10 PSI** OR GREATER IN OIL PRESSURE INDICATION OCCURS AT ANY STABILIZED **RPM**, FOLLOW ENGINE OIL SYSTEM MALFUNCTION PROCEDURES IN SECTION III.

LANDING GEAR

Do not exceed 240 Knots Indicated Airspeed (KIAS) during landing gear extension/retraction or when landing gear doors are open.

CAUTION

Extension/retraction of landing gear at bank angles greater than 45 degrees or at load factors greater than 1.5 G can result in overstress failure of the main landing gear sidebrace trunnion.

Do not exceed 300 knots with the landing gear down (gear doors closed).

NOSEWHEEL STEERING

Do not exceed 65 KIAS with nosewheel steering engaged.

CANOPY

Do not exceed 50 KIAS while taxiing with a canopy open.

LOAD FACTOR LIMITATIONS

Do not exceed the following (see Figures 5-2 and 5-3).

SYMMETRICAL FLIGHT

Load Factor (G)	Weight of Fuel Remaining (Pounds)
-2.3 to +5.8	3,500
-2.5 to +6.0	3,000
-2.7 to +6.6	2,000
-2.9 to +7.2	1,000

UNSYMMETRICAL FLIGHT

Load Factor (G)	Weight of Fuel Remaining (Pounds)
0 to +4.1	3,500
0 to +4.3	3,000
0 to +4.7	2,000
0 to +5.1	1,000

SPECIAL FLIGHT LIMITATIONS

Functional check flights (FCF) and one-time ferry flight authorizations may require limitations or operation different from standard. Prior to flying an aircraft for these missions, a briefing should be received from appropriate maintenance (QC) and/or operations personnel. T.O. 1T-38A-3 contains requirements for one-time ferry flights and other special instructions. Certain conditions could exist which may allow continuous operation with restrictions. These conditions and restrictions will be noted and flight approval from the using command will be required. These aircraft will be identified by a placard on the cover of the AFTO 781 and cockpit placards.

PROHIBITED MANEUVERS

VERTICAL STALLS

Vertical stalls are prohibited.

SPINS

Intentional spins are prohibited. Refer to Section VI for spin recovery procedure in case an inadvertent spin is experienced.

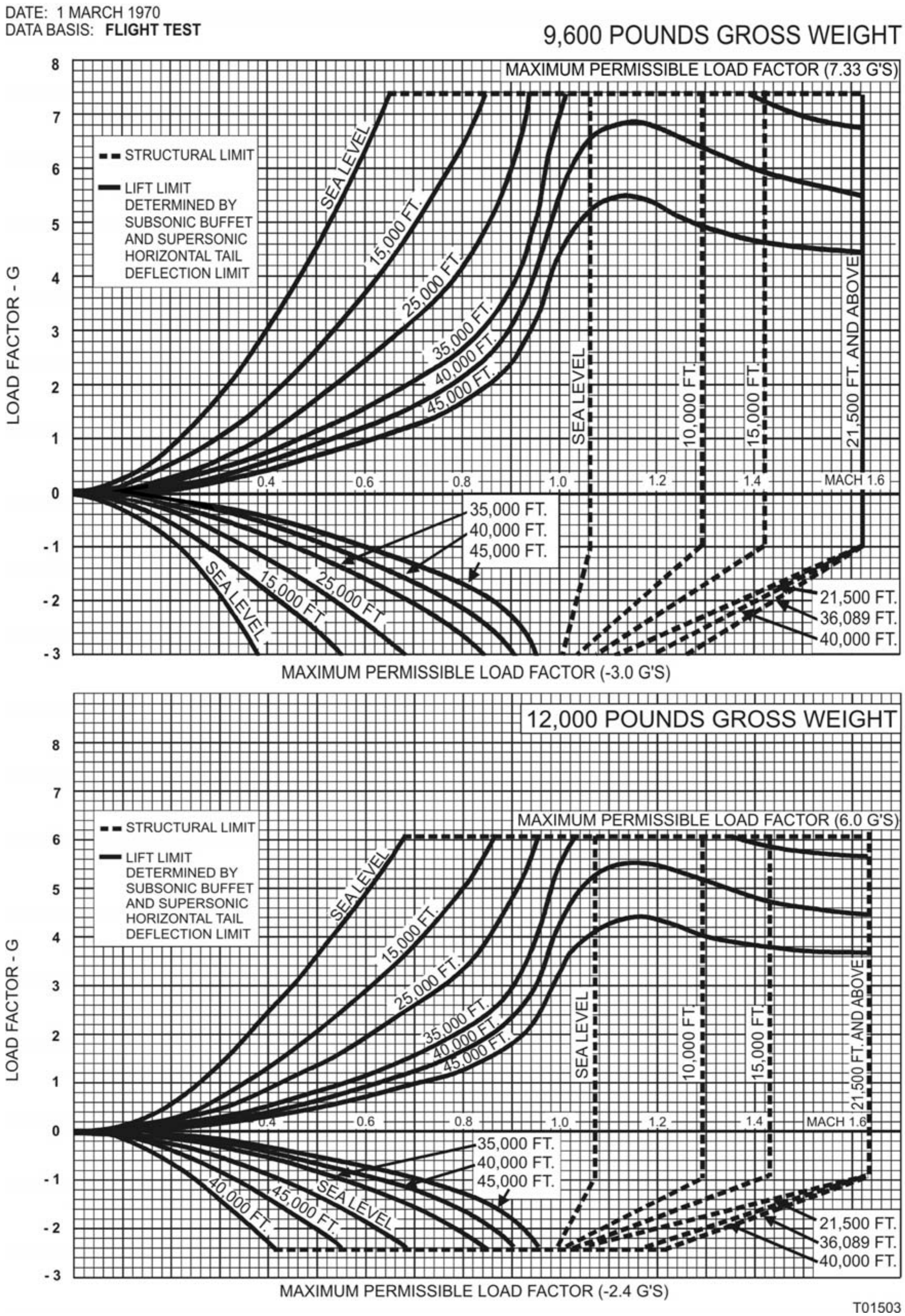


Figure 5-2. Operating Flight Strength – Symmetrical Flight

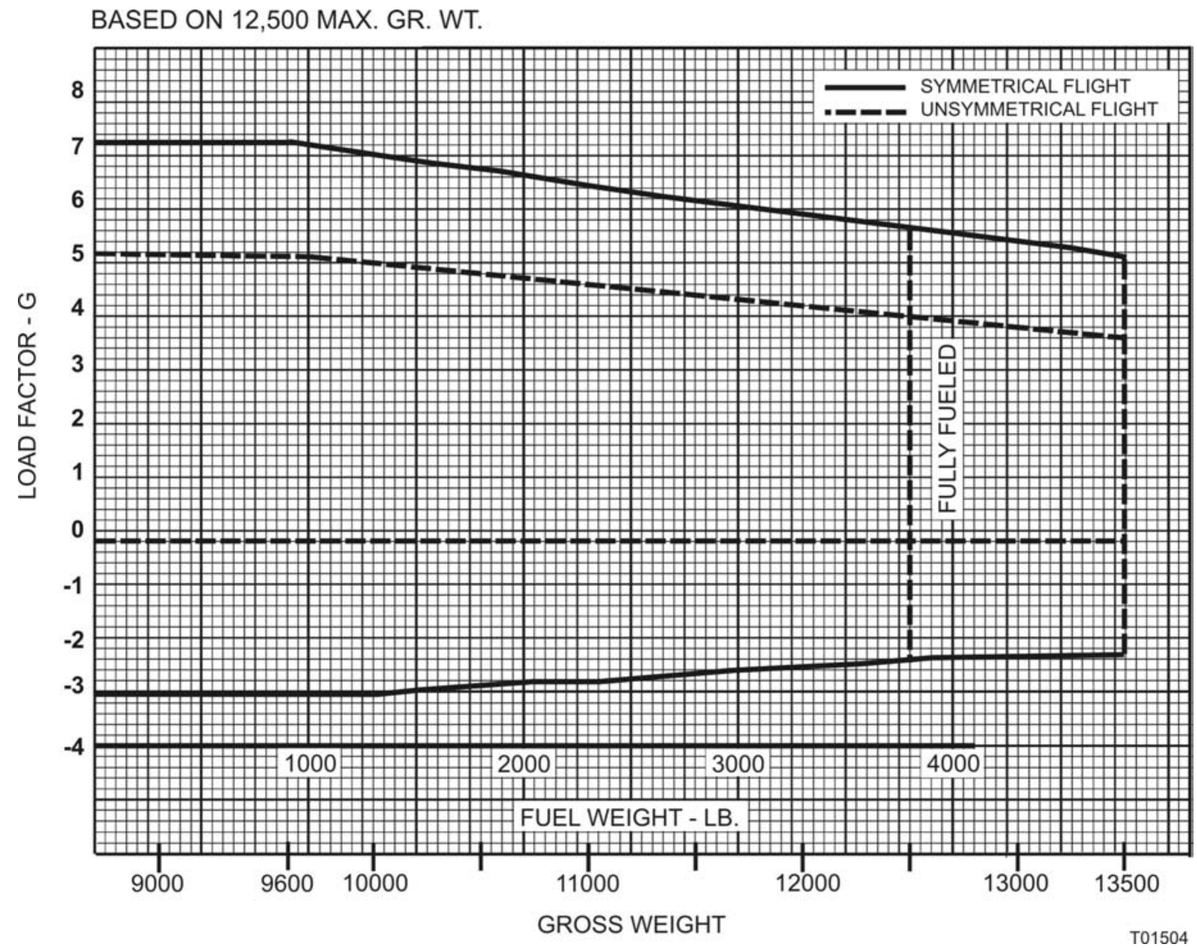


Figure 5-3. Maximum Permissible Load Factor

ROLLS

Continuous aileron rolls (more than one complete roll) will be accomplished only at 1.0 G and three-quarter or less stick deflection. Single aileron rolls may be accomplished at any load factor or stick deflection if asymmetric G limits are observed.

MISCELLANEOUS LIMITATIONS

FUEL SYSTEM

To prevent fuel starvation and subsequent engine flameout, do not exceed the following:

1. Maximum thrust dives with less than 650 pounds of fuel in either fuel supply system.
2. Maximum thrust power in zero G flight or at negative load factors exceeding 10 seconds at 10,000 feet or 30 seconds at 30,000 feet. With less than 650 pounds of fuel in either supply system, time for successful engine operation is further reduced.

NOTE

Lower power settings will result in proportionally longer operating times; however, do not exceed engine oil system supply limitations.

If fuel without icing inhibitor (FSII) is used, the potential exists for fuel freezing during extended flight at altitude. To preclude these problems, the following guidelines should be followed:

Initial Fuel Temperature	Minimum Static Air Temperature at Cruise Altitude
Greater than 50°F	Unrestricted
40°F to 50°F	-40°C
Less than 40°F	Flight Not Recommended

ENGINE OIL SYSTEM

Due to engine oil supply and pressure requirements, zero-G flight is restricted to 10 seconds and negative-G flight (any attitude) to 60 seconds. A momentary drop or loss of oil pressure may be experienced during negative-G or inverted flight. Engine oil venting overboard and/or low oil pressure may occur until positive-G loads are applied.

CAUTION

If oil pressure does not recover within approximately 10 seconds, return to normal flight conditions.

WHEEL BRAKES AND TIRES

If the following minimum time intervals between full stop landings cannot be complied with, brakes, wheels, and tires should be allowed to cool with the aircraft parked in an uncongested area and the condition reported in Form 781.

Minimum Time Interval
Between Full Stop Landings

Gear retracted in flight..............45 minutes
Gear extended in flight..............15 minutes

LANDING RATE OF DESCENT

Landing should be made with as low a sink rate as practicable. Do not exceed the following sink rates at touchdown:

590 feet per minute normal landing
(395 feet per minute crab landing)
with less than 1,700 pounds of fuel.

340 feet per minute normal landing
(200 feet per minute crab landing)
with full fuel.

LANDING GEAR MAXIMUM GROUND SPEEDS

The nose tire is rated to 174 knots ground speed.
The main wheel tire is rated to 195 knots ground speed.

NOTE

The nosewheel tire has been tested to 120% of rated speed without catastrophic failure.

WEIGHT AND CENTER OF GRAVITY LIMITATIONS

The weight and balance limitations cannot be exceeded by normal operating or loading conditions; however, it is possible to attain an aft center of gravity when the right fuel system contains more fuel than the left fuel system. To avoid exceeding the aft center of gravity limit during solo flight, do not allow the right (aft) fuel system quantity to equal more than twice the left (forward) fuel system quantity. If this should occur, longitudinal static stability is reduced and caution should be exercised to prevent over controlling during high speed subsonic flight or landings.

HYDRAULIC PRESSURE

Hydraulic pressure readings outside the normal range with no demand on the respective system are indicative of a malfunction within the system. High pressures pose the greater danger because of possible fluid overtemperatures.

However, operating hydraulically powered equipment (e.g., making rapid flight control movements) will cause pressure fluctuations well outside the static limit. These fluctuations are not considered a malfunction.

Table 5-2. Aircraft Limitations With External Stores

STORE	AIRSPEED LIMITATIONS	ACCELERATION – G CARRIAGE		STORES CONFIGURATION WEIGHT LB.	TOTAL DRAG INDEX	REMARKS
	CARRIAGE	SYM	UNSYM			
PYLON	600 1.2	BAL	BAL	29	5	
WSSP	400*	+4.0 0.0	+3.0 0.0	E110 F250	25**	NORMAL LOAD CAPACITY 140 LB.

* 350 KIAS IN SEVERE TURBULENCE OR SPEED BRAKES OPEN. AVOID ABRUPT CONTROL MOVEMENTS OVER 240 KIAS.

** STORE DRAG INCLUDES PYLON.

NOTE

For flight above FL 300 and 0.92 Mach, with a WSSP installed, the aircraft can experience a slight reduction in lateral directional stability. Turbulent air makes this condition more apparent. If this condition is encountered, reduce airspeed to below 0.92 Mach and use small rudder inputs as required.

FLIGHT CHARACTERISTICS

SECTION VI

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WAKE TURBULENCE

Avoid wake turbulence. The aircraft, because of the short wingspan, is particularly susceptible to wake turbulence upset. The vortex-produced rolling moment can exceed aileron authority in the takeoff and/or landing configuration. The rapid changes in lift can result in a stall without sufficient altitude to recover.

STALLS

The stall is characterized by airframe buffet and a high sink rate rather than by a clean nose-down pitch motion. As angle of attack is increased, there is a corresponding increase in buffet intensity. The buffet is most severe with flaps fully extended. The stall condition is immediately preceded by heavy low-speed buffet and moderate wing rock. The wing rock can be controlled with rudder. The actual stall is normally not accompanied by any abrupt aircraft motion, but is indicated only by the very high sink rate.

WARNING

> If the stall condition is aggravated by abrupt control inputs, unusual aircraft attitudes may result.

STALL RECOVERIES

Stalls can be terminated by relaxing back stick pressure, rolling wings level, and moving throttles to MAX simultaneously. If in the landing configuration, raise gear and speed brake, allowing flaps to remain extended until stall recovery has been accomplished. While it is normally not necessary to allow the nose to pitch down, relaxation of back pressure is critical in breaking the stall and allowing the aircraft to accelerate, reducing the buffet, eliminating wing rock, and maintaining adequate aileron control. Reducing the bank angle will lower the stall speed and decrease the sink rate (see Figures 6-1, 6-2, and the Effect of Bank Angle on Vertical Velocity charts in Part 7 of Appendix A). Since timely identification of an actual stall is difficult, stall recovery should be initiated at the first indication of increasing buffet or rate of sink. Recovery from a stalled condition can be accomplished with a minimum loss of altitude using the above stall recovery technique.

WARNING

If a high sink rate condition is allowed to develop, excessive altitude loss will occur and recovery may not be possible at traffic altitudes.

NOTE

See Section VII for engine operating instructions during stall.

SUBSONIC ACCELERATED STALLS

Accelerated stalls are similar to 1-G stalls.

POST STALL GYRATIONS

Gyrations can be experienced during 1-G stalls, inverted stalls (negative G, negative angle of attack, and stick held forward), accelerated stalls, and cross control stalls. These gyrations will not result in a spin (abrupt full aft stick movement at near maximum rate is required for spin entry). The corrective procedure for all unrecognizable gyrations is to smoothly neutralize controls until the aircraft settles into a recognizable maneuver or recovers. Expect a short period of erratic motion and/or negative load factors after controls are neutralized.

EFFECT OF BANK ANGLE ON VERTICAL VELOCITY

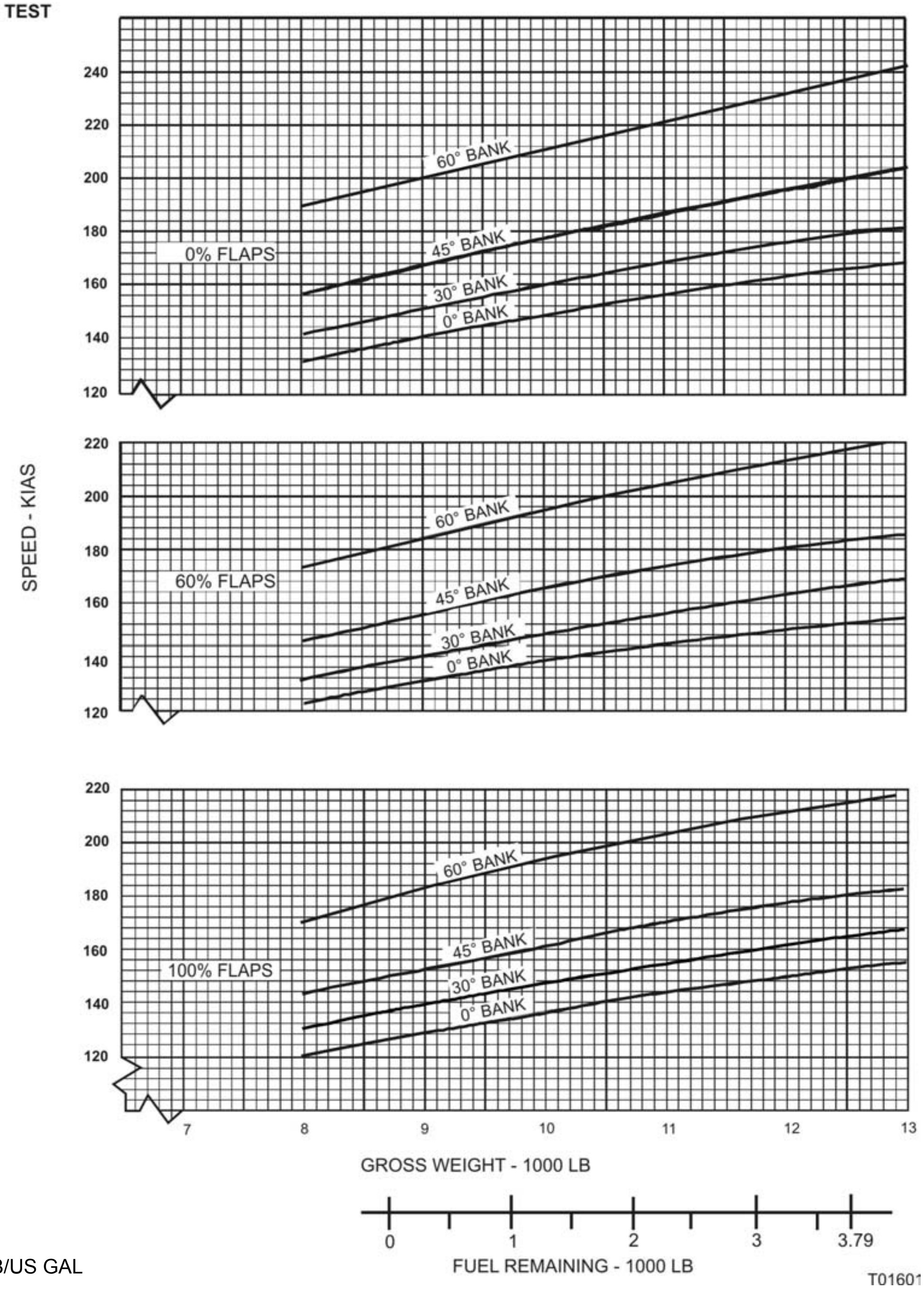
Steep bank angles during turn to final approach can cause a very rapid descent rate from which it may be impossible to recover. This is especially true for single-engine approaches to landing. Figure 6-2 shows the effects of bank angle on velocity for sea level standard day conditions for light and heavy aircraft gross weights at the recommended final turn speed. Single-engine landing patterns should be planned so that steep bank angles are not required. A complete set of charts showing the effects of bank angle on vertical velocity for various conditions can be found in Part 7 of Appendix A.

SPINS

The aircraft exhibits a high degree of resistance to spin entry; abrupt application of aft stick at close to maximum possible rates within the envelope shown in Figure 6-3 is required to enter a spin. Entry will occur without use of rudder. Normal flight maneuvers, if properly flown, will not cause a spin. During unusual maneuvers (e.g., collision avoidance), the pilot must be aware of his airspeed and control inputs relative to those required for a spin entry.

LANDING GEAR UP OR DOWN SEA LEVEL TO 5,000 FT.

MODEL: T-38A
DATE: 1 AUGUST 1965
DATA BASIS: **FLIGHT TEST**



ENGINE: (2) J85-GE-5
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/US GAL

Figure 6-1. Stall Speed Chart
Power – Off (Idle Thrust)

DATE: 1 APRIL 1969
DATA BASIS: **FLIGHT TEST**

60% FLAPS AND GEAR DOWN

NOTE

Chart valid only for recommended approach turn speed.

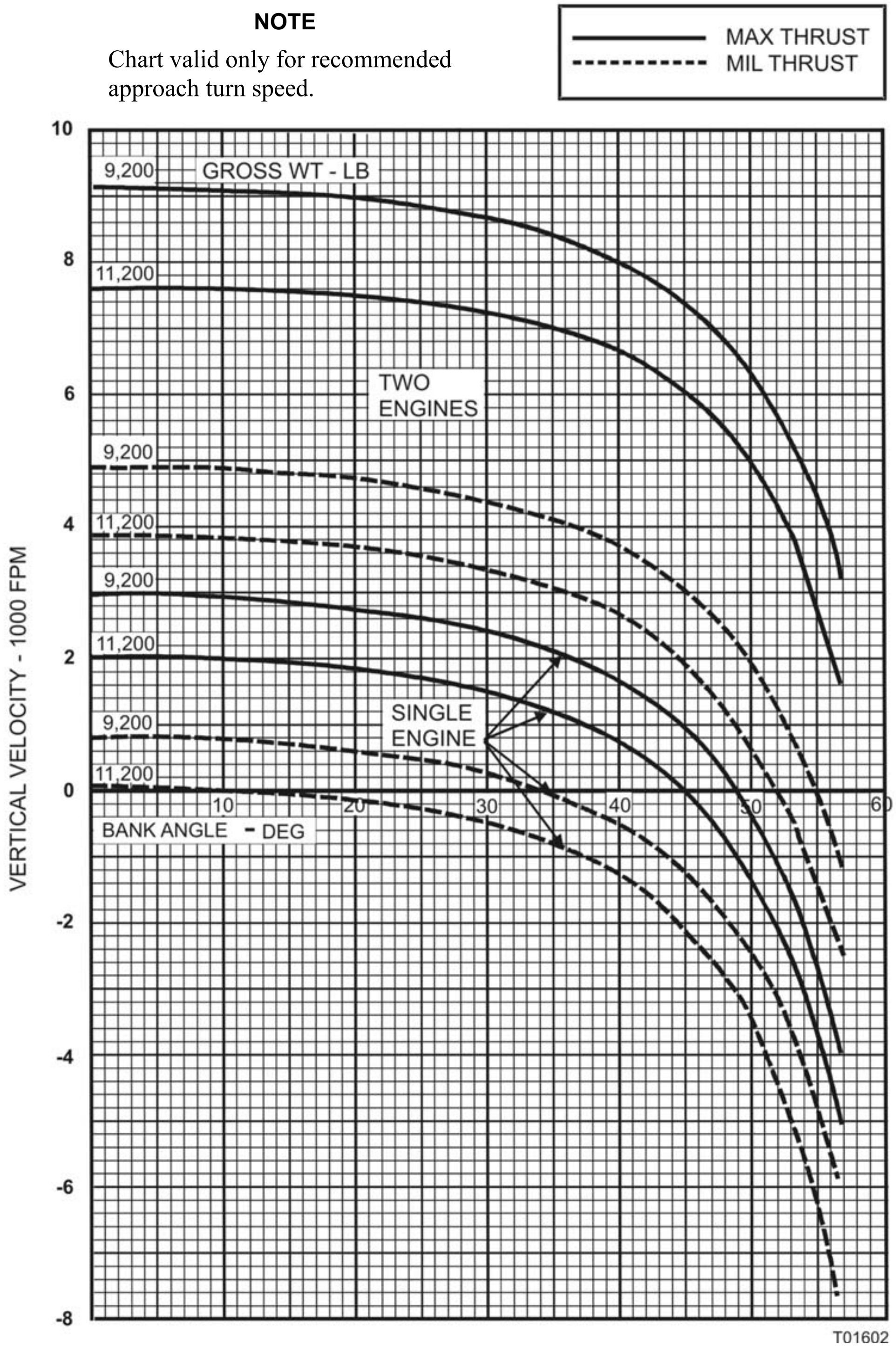


Figure 6-2. Effect of Bank Angle on Vertical Velocity Sea Level Standard Day

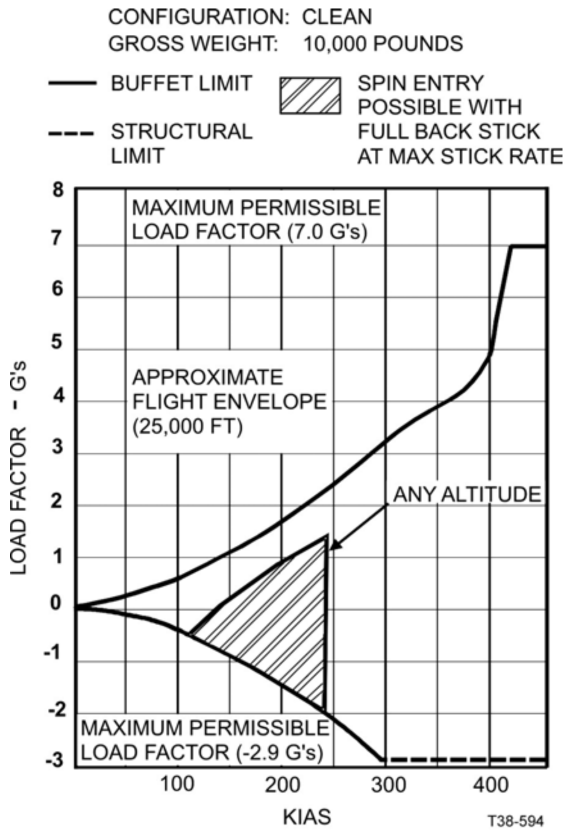


Figure 6-3. Area of Possible Spin Entry

WARNING

Abruptly applying spin recovery controls when the aircraft is not in an actual spin may cause a spin or extremely disorientating aircraft gyrations. Do not apply spin recovery controls unless a spin has been definitely diagnosed.

ERECT SPIN

Once an erect spin has developed, the spin will be flat and may be either oscillatory or very smooth. The aircraft may oscillate about all three axes, and the pilot will experience transverse G-loads. Flameout of one or both engines can be expected.

Erect Spin Recovery

The primary anti-spin control is the aileron, and it is imperative that full aileron deflection be held during recovery.

WARNING

If full aileron deflection in the direction of the spin is not maintained throughout the recovery, spin recovery may be prolonged or prevented.

1. Control stick – Full aileron, using both hands, in direction of spin (turn needle) and as much aft stick as possible without sacrificing aileron.
2. Rudder – Full opposite (opposite turn needle).
3. Do not change gear, flaps, and speed brake positions during recovery.
4. Neutralize controls after recovery.

NOTE

Recovery from the spin is normally abrupt and may be followed by some spiraling during the resultant dive.

INVERTED SPIN

An inverted spin is very oscillatory about all axes and is easily recoverable.

Inverted Spin Recovery

Immediately upon experiencing an inverted spin, use the following procedure:

1. All flight controls – Neutralize.

WARNING

- Maintain controls in a neutral position throughout the inverted spin recovery. Any aileron or rudder deflection can induce a transition to an erect spin.
- Ejection from either an erect or inverted spin is to be accomplished if a spin recovery is not completed by 15,000 feet above the terrain, or if transverse G loads preclude maintaining antispin controls, whichever occurs first.

FLIGHT CONTROLS

STABILITY AUGMENTATION

The stability augmenter system positions the rudder control surfaces to automatically damp out yaw short period oscillations. The aircraft may be flown safely throughout the flight envelope (see Figure 6-4) without the stability augmenter system engaged.

G-OVERSHOOT

The horizontal tail control system incorporates a bob-weight to increase stick forces under G-loads. Since the pilot does not feel the effect of the bob-weight until the aircraft responds to the stick movement, G-overshoots may occur if the stick is deflected too abruptly.

LATERAL CONTROL

Aileron deflection does not increase proportionally with stick travel. The first 4-1/2 inches of stick travel provide one-half aileron deflection, while the remaining 1-1/2 inches of stick travel provide full aileron deflection.

MANEUVERING FLIGHT

NOTE

Maneuvering and handling qualities are degraded at lower airspeeds; therefore, a minimum of 300 Knots Indicated Airspeed (KIAS) should be maintained except for instrument approaches, maximum range descents, landings and tactical maneuvering. The objective for establishing a minimum airspeed is to maintain a satisfactory energy state (i.e., “G” available that will provide desired recovery response if an undesirable flight parameter is encountered below 15,000 feet Above Ground Level [AGL]).

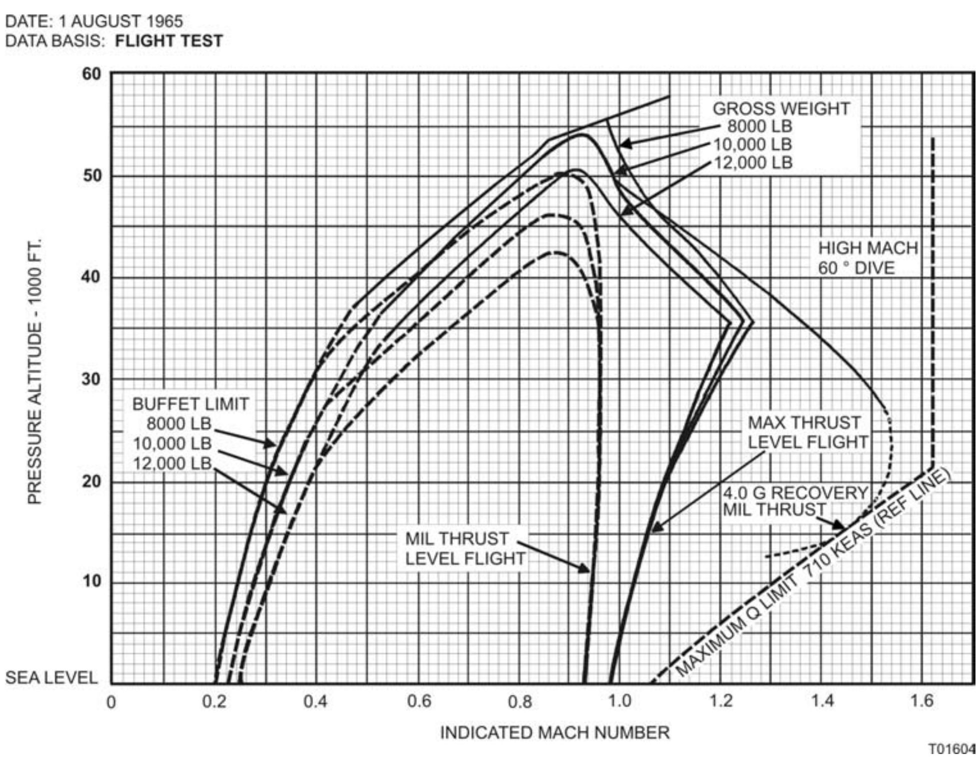


Figure 6-4. Flight Envelope – Standard Day

STICK FORCES

Minimum stick forces per G occur at approximately mach 0.9. Be careful not to overcontrol when maneuvering near this airspeed so that the allowable load factor is not exceeded.

PILOT INDUCED OSCILLATIONS

The relationship between pilot response and aircraft pitch response in high subsonic-low altitude flight is such that overcontrolling may lead to severe pilot induced oscillations. This oscillation is characterized by a sudden and violent divergence in pitch attitude resulting in very large positive and negative load factors, which are actually made larger by the pilot attempting to control the oscillation. Because the basic aircraft is stable, the pilot should immediately release the stick so that the aircraft can damp itself or if at very low altitude or close to another aircraft, the pilot should attempt to apply and rigidly hold backpressure on the stick. In addition to the above, a reduction in airspeed will aid in recovery. It should be noted that if the pilot is not securely strapped into the seat, the above recovery procedures may be difficult to accomplish.

ROLLS

Roll rates obtainable in this aircraft with full aileron deflection are extremely high and could cause the pilot to become disoriented. Caution should be exercised when using rudder in conjunction with aileron application during rapid roll or turn entry. Rapid input of both rudder and half (or more) aileron, can cause large load factor excursions during the maneuver.

UNSYMMETRICAL-G

Unsymmetrical-G forces occur any time the aircraft has a roll rate. A phenomenon known as roll coupling can also superimpose an additional G increment during rolling maneuvers. In steady state banked coordinated flight (roll rate = 0), G forces are symmetrical. When evaluating G-limit overshoots as a result of a wing tip vortex or wake turbulence encounter, the unsymmetrical acceleration limit applies.

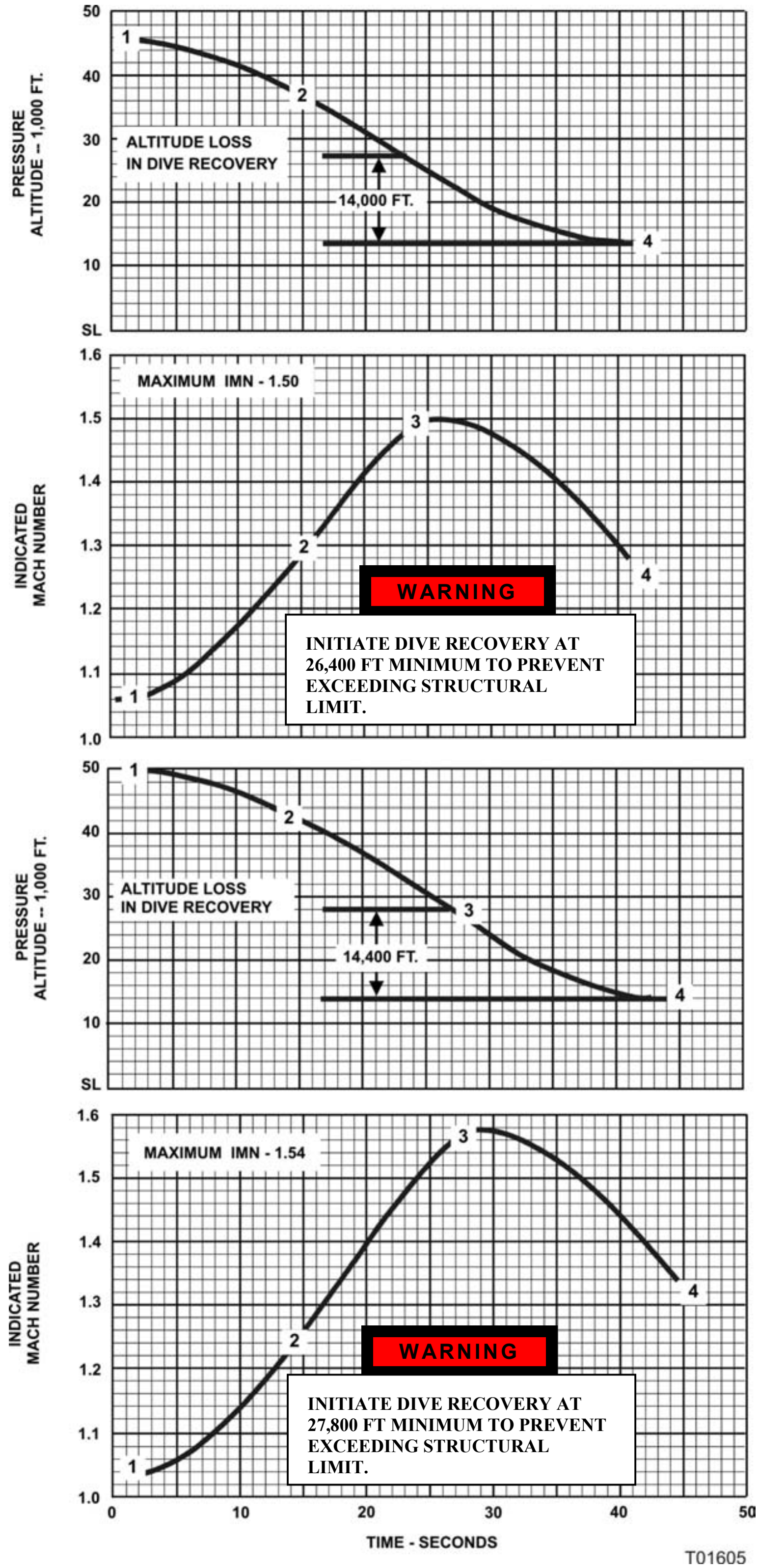
HIGH SPEED DIVE RECOVERY

To recover from a high speed dive, simultaneously retard throttles to IDLE, open the speed brake, level the wings, and pull out with sufficient G-forces for a safe recovery.

STANDARD DAY GROSS WEIGHT 10,000 LB

DATE: 15 January 1965
DATA BASIS: FLIGHT TEST

1. BEGIN 1.5 Gs MAX THRUST ENTRY.
2. ATTAIN 60° DIVE ANGLE.
3. REDUCE THRUST TO MIL AND BEGIN 4-G DIVE RECOVERY. AT 26,400 FT. FOR ENTRY AT 45,000 FT. AT 27,800 FT. FOR ENTRY AT 50,000 FT.
4. END DIVE RECOVERY AT LEVEL FLIGHT ATTITUDE.



NOTE

Altitude loss shown includes a 4-second time allowance for load factor to build up to 4 Gs.

Figure 6-5. High Mach 60° Dive

NOTE

If aircraft configuration or power settings are such as to cause deceleration during dive recovery. The altitude lost will be less than that shown on the charts.

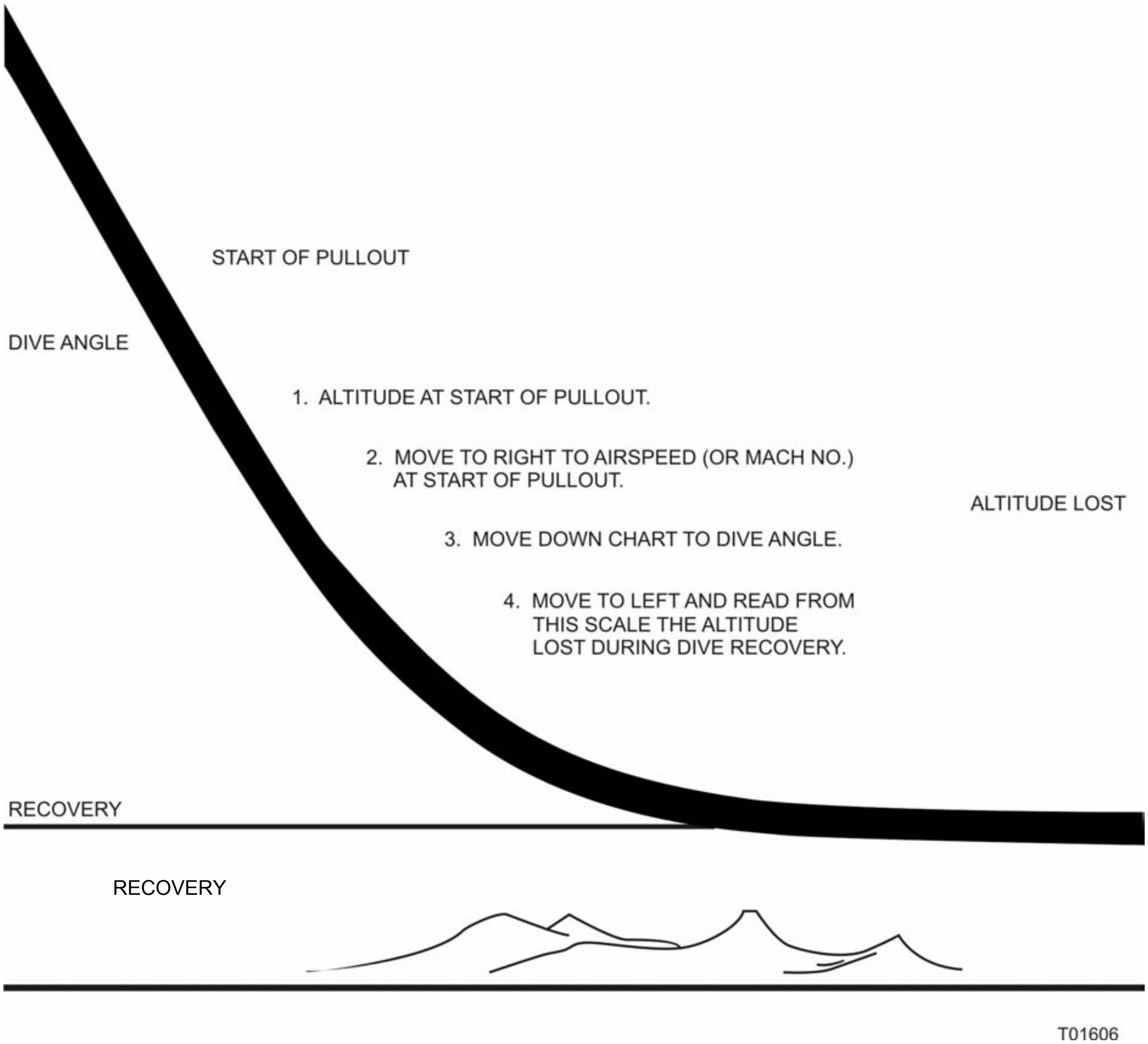


Figure 6-6. How to Read Dive Recovery Charts

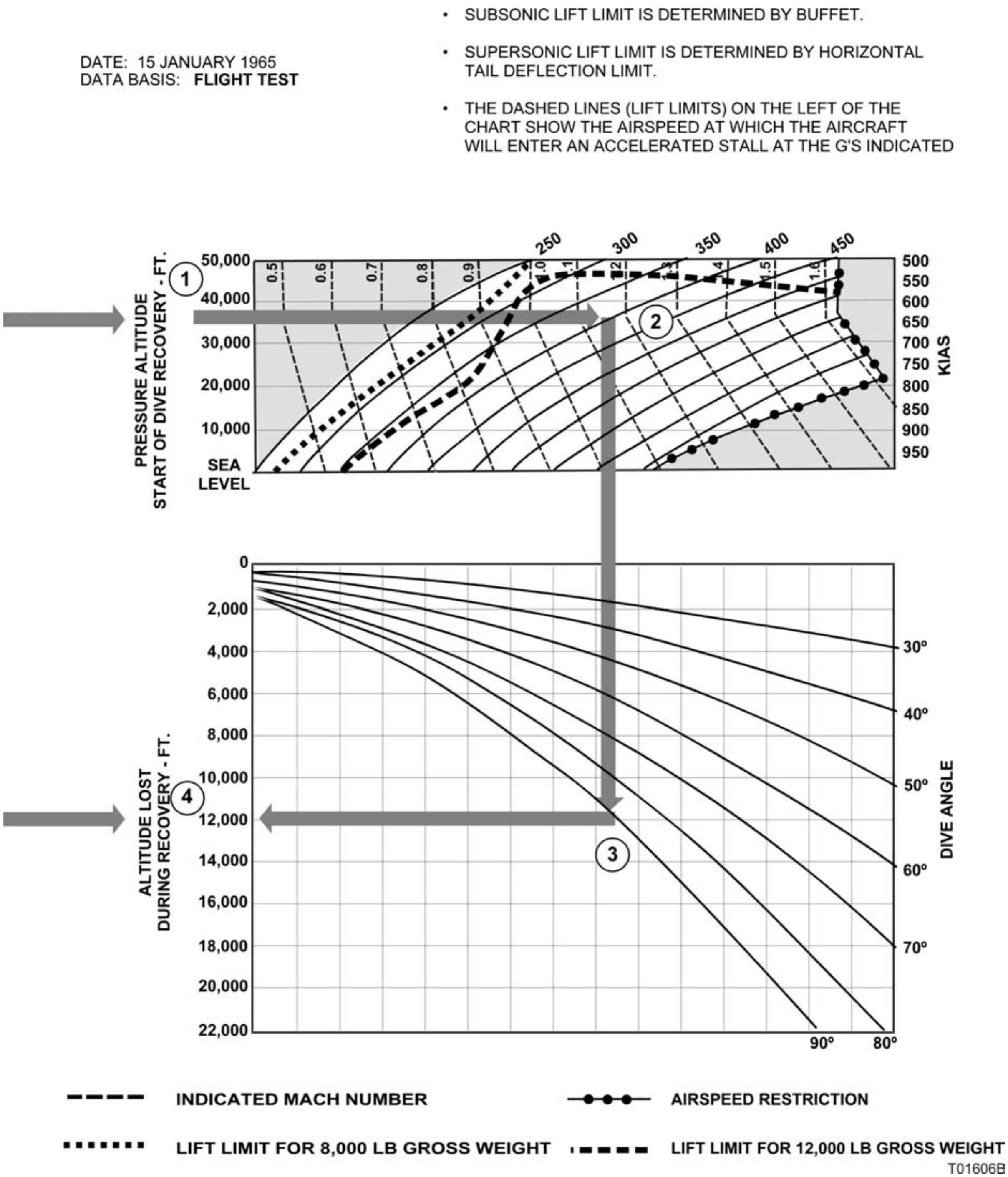


Figure 6-7. Altitude Lost During Dive Recovery Constant 4.0 G Acceleration

DATE: 15 JANUARY 1965
DATA BASIS: **FLIGHT TEST**

- SUBSONIC LIFT LIMIT IS DETERMINED BY BUFFET.
- SUPERSONIC LIFT LIMIT IS DETERMINED BY HORIZONTAL TAIL DEFLECTION LIMIT.
- THE DASHED LINES (LIFT LIMITS) ON THE LEFT OF THE CHART SHOW THE AIRSPEED AT WHICH THE AIRCRAFT WILL ENTER AN ACCELERATED STALL AT THE Gs INDICATED.

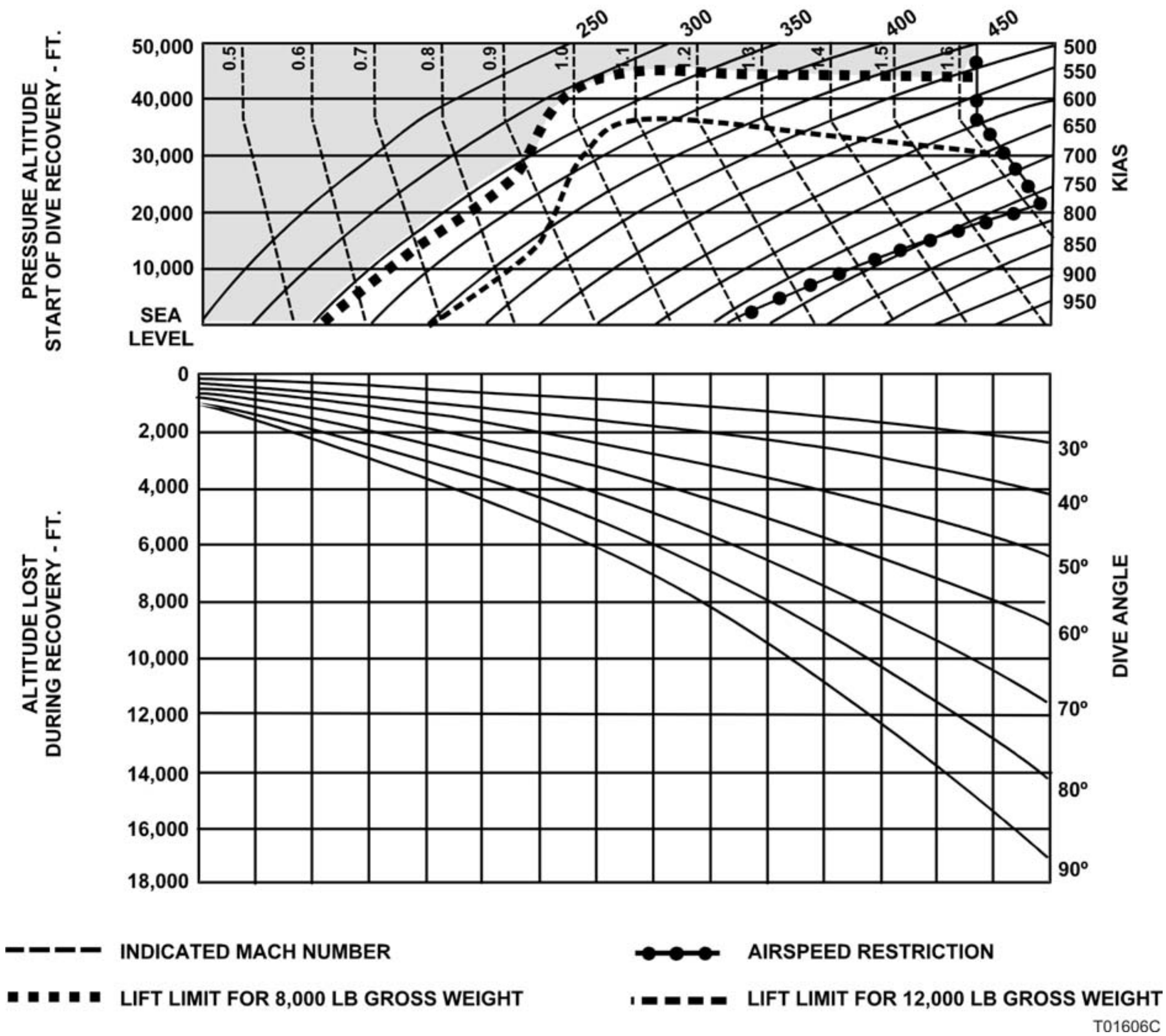


**Figure 6-8. Altitude Lost During Dive Recovery
Constant 6.0 G Acceleration**

DATE: 15 JANUARY 1965
DATA BASIS: **FLIGHT TEST**

- SUBSONIC LIFT LIMIT IS DETERMINED BY BUFFET.
- SUPERSONIC LIFT LIMIT IS DETERMINED BY HORIZONTAL TAIL DEFLECTION LIMIT.
- THE DASHED LINES (LIFT LIMITS) ON THE LEFT OF THE CHART SHOW THE AIRSPEED AT WHICH THE AIRCRAFT WILL ENTER AN ACCELERATED STALL AT THE Gs INDICATED.

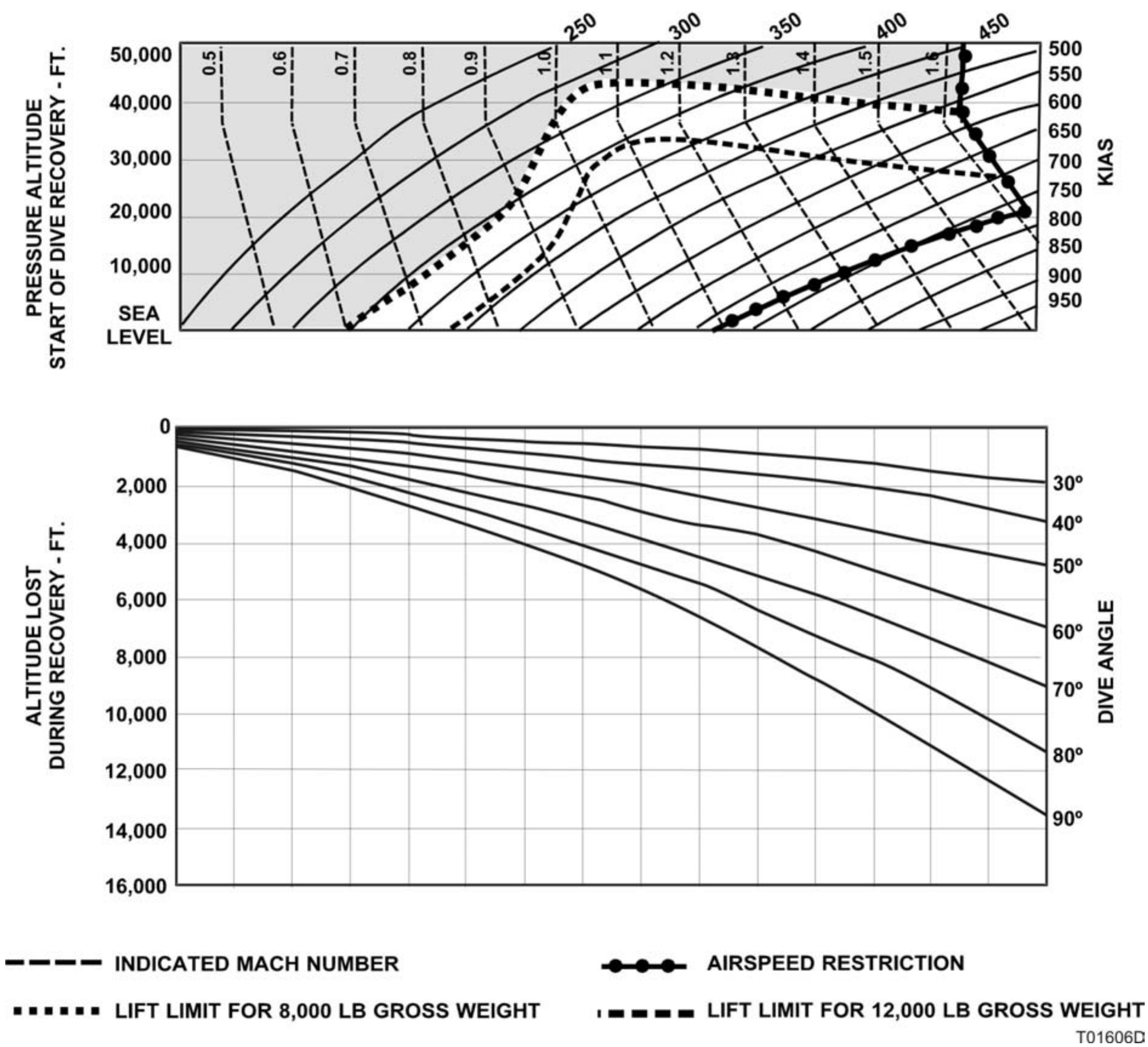


**Figure 6-9. Altitude Lost During Dive Recovery
Constant 7.33 G Acceleration**

SYSTEMS OPERATION

SECTION VII

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FUEL MANAGEMENT

The fuel systems function automatically to supply fuel to the engines once the throttles have been moved from the OFF position and the fuel boost pumps turned on. The fuel quantity indicators should be monitored to maintain the two systems within 200 pounds of each other to ensure the aircraft center-of gravity (CG) is maintained within limits. Maintaining the two systems within the 200 pound parameter is accomplished by using the fuel balancing (crossfeed) procedures in this section. Crossfeeding is not recommended during low fuel conditions or while at low altitudes. Instead use differential power settings to obtain proper balance. With the fuel low caution light illuminated, a slightly nose up flight attitude should be maintained to assure maximum usable fuel from both systems. Maintaining this attitude is necessary to preclude uncovering the fuel boost pump inlets, allowing air to enter the fuel supply lines, causing engine flameout.

NOTE

During low fuel state descents, do not maintain a nose down attitude for extended periods. Occasionally transition to a positive pitch attitude to refill the boost pump sump.

FUEL BALANCING (CROSSFEED)

Crossfeeding is recommended when fuel differential exceeds 200 pounds. Attempt to enter traffic pattern in a fuel-balanced condition. Differential power settings should be used to balance fuel to avoid use of crossfeed operation during low fuel conditions.

1. Fuel Quantity Gauge – TEST.

If a malfunctioning fuel gage is indicated, do not crossfeed.

2. Crossfeed Switch – ON.
3. Boost Pump Switch (on side of lower fuel quantity) – OFF.

WARNING

- With the crossfeed switch ON and either both boost pumps ON – or both boost pumps OFF – a rapid fuel imbalance can occur.
- If crossfeed operation is continued until the active system runs dry, dual engine flameout will occur.

4. Boost Pump Switches – Both ON When Quantities are Equal.
5. Crossfeed Switch – OFF.

LOW FUEL OPERATION

If an internal system has less than 650 pounds of fuel, the surface of the fuel falls below the fuel boost pump upper-inlet and the boost pump output is reduced approximately 40 percent. During crossfeed operation, if the engines are operated at high power settings, the low pressure light may come on and engine RPM fluctuations may occur because of insufficient fuel pressure. With a low fuel state (approximately 250 pounds in either system) do not attempt to ensure fuel flow to both engines by selecting crossfeed operation with both fuel boost pumps operating. If the fuel supply in one system is depleted or is pulled away from the boost pump by G-forces and the boost pump in the other system fails, air may be supplied to the engines causing dual engine flameout. In this situation, there is no cockpit indication of boost pump failure.

LOW FUEL OPERATION SINGLE ENGINE

When 250 pounds of fuel remains in either system, place both boost pumps ON and crossfeed switch ON to allow the engine to be fed from both systems simultaneously.

COMPRESSOR STALL

A compressor stall is an aerodynamic interruption of airflow through the compressor section. Factors that can increase the stall sensitivity and decrease the compressor stall margin are: Foreign object damage (FOD), high aircraft angles of attack at low airspeeds, low compressor inlet temperatures (CIT), maneuvering flights, unusual flight attitudes, atmospheric variations, jet wash, temperature and pressure distortion, ice formation on inlet ducts and engine inlet guide vanes, or a combination of the above. Compressor stalls can be caused by various other factors such as: Engine component malfunction, incorrect engine rigging, incorrect RPM and fuel flow trim, throttle burst to military or maximum power at high altitude and low airspeed, and by hot gas ingestion. The stall is recognized by a "pop" or "bang" followed by an audible "buzzing" sound and vibration, accompanied by a rapid RPM drop and high Exhaust Gas Temperature (EGT). The stall should be cleared as soon as possible to prevent engine damage by overtemperature. This type of compressor stall can normally be recovered by rapidly retarding throttle to IDLE. Compressor stalls may lead to a flameout.

FLAMEOUT

Flameouts may result from the same conditions that cause compressor stalls. During a flameout, the aerodynamic disruption causes combustion to cease (the fire goes out) and the engine will rapidly wind down to windmilling RPM. The flameout is recognized by an audible sound similar to a compressor stall, however, both RPM and EGT will rapidly decrease. Immediately pulling the throttle to idle and pushing the start button will provide a restart attempt during the wind down and may recover the engine to idle.

VARIABLE INLET GUIDE VANES

Variable inlet guide vanes and air bleed valves have been incorporated in the J-85 engine to reduce the possibility of a compressor stall throughout the normal operating range of the engine. The vanes function automatically to direct the flow of air to the compressor blades at the proper angle. The bleed valves open and close automatically to provide proper control of compressor pressure. Prior to start, the bleed valves may be partly open or completely closed. This is due to residual servo hydropressure unbalance in the bleed valve actuator system and main fuel control after engine shutdown. The valves will open during normal engine start.

ENGINE COMPRESSOR STALL/ FLAMEOUT SUSCEPTIBILITY AREA (FIGURE 7-1)

Figure 7-1 depicts the stall/flameout prone areas for the installed J-85-5 engine. The chart is presented in terms of pressure altitude versus indicated mach number for standard day conditions with considerations for temperature deviation of 10ºC from standard. The chart illustrates the operating airspace at higher altitudes where colder temperatures and less dense air may cause the engine to stall or flameout. This operating restriction is further expanded as temperatures colder than standard are encountered. Conversely, the opposite is true as temperatures warmer than standard are encountered. These regions of flight require operator attention and have been portrayed on the chart as the black striped and shaded areas. Flight is not prohibited in these areas but merely requires the operator to acknowledge the engine susceptibility as indicated on the chart.

THROTTLE MOVEMENT

The engine stall margin and operating parameters decrease with increasing altitude where the air is less dense and colder. As a result, throttle movement must be more carefully controlled in the black striped and shaded areas shown in Figure 7-1. Abrupt throttle movements, which are acceptable to the engine at low altitude, are not recommended in these areas and can result in a stall or flameout.

AFTERBURNER INITIATION (HIGH ALTITUDE)

Afterburner initiation attempts in the black striped area as indicated in Figure 7-1 are not recommended. Afterburner light-off is not guaranteed and, even if successful, may drive the engine RPM down (rollback) and possibly cause engine flameout.

NOTE

> To increase the probability of afterburner light-off if required (in the black striped area), increase airspeed as much as practical before initiating afterburner.

MANEUVERING

Maximum performance maneuvering involves high Angle-of-Attack (AOA); low airspeed; unusual attitudes; high yaw, roll, and pitch rates; and throttle manipulation, which increase the engine susceptibility to compressor stall and flameout. Maneuvering above approximately 28,000 ft and below 0.6 Indicated Mach Number (IMN) (Figure 7-1, shaded area) has proven to increase susceptibility to stall/flameout due to reduced/distorted ram air flow to the engine, caused by lower air density coupled with reduced effective intake duct area. Throttle manipulation demanding more engine air increases the possibility of stall/flameout. The area below approximately 30,000 ft and above 0.6 IMN has not been a stall/flameout prone area because ram air in the higher speed range is sufficient to satisfy engine requirements. However, excessive heavy maneuvering and throttle movements broaden the susceptible area indicated on the chart.

HIGH MACH DIVE

CAUTION

Avoid afterburner operation as indicated in the solid black area of Figure 7-1. Engine stall or damage to the variable exhaust nozzles may occur.

EFFECT OF COMPRESSOR INLET TEMPERATURE (T^2 CUTBACK)

The T^2 sensor in the main fuel control automatically reduces the physical RPM and EGT (T^2 cutback) to prevent over-pressurization and high corrected speed conditions of the compressor at low CIT. At any normal operating condition, CIT is higher than the outside air temperature (OAT) and varies with airspeed for a given OAT. Increasing airspeed will increase CIT. At low indicated airspeeds and low OAT conditions, the engine RPM and EGT indications may be below the normal operating limits at MIL and MAX power. When the aircraft is flown in the black striped area of the engine envelope, Figure 7-1, T^2 cutback may be observed. In maneuvering flight, the CIT of each engine will vary depending on flight attitude. As a result, the engine sensing the lower CIT will have a decreased stall margin and increased probability of compressor stall if a throttle transient is made. If T^2 cutback is observed, the airspeed should be increased by exchanging altitude for airspeed to increase CIT prior to making a throttle movement.

CAUTION

Rapid altitude changes near the engine compressor stall/flameout susceptibility area (black-striped region) may result in flameouts without throttle movement due to lag in the T^2 cutout sensor.

EGT DROOP AT HIGH-Q/MIL POWER

At low altitude and high airspeed (500 KIAS), EGT droop may occur with engine at military power when accompanied by three percent or less nozzle indication.

EFFECT OF HIGH ALTITUDE AND LOW AIRSPEED ON ENGINE RPM

During 1.0 G stalls at or above 20,000 feet, with throttles at IDLE detent and airspeed 200 KIAS or below, the in-flight idle RPM can decay to less than normal ground idle speed (46.5% to 49.5% RPM) and the generator caution lights will illuminate. Under these flight conditions, an engine on which RPM has dropped below normal idle speed will not accelerate when the throttle is advanced. To avoid this condition, maintain engine RPM at 80 percent or above when airspeeds of less than 200 KIAS above 20,000 feet are anticipated. Corrective action for idle decay is to retard the throttle of the affected engine(s) to idle and increase airspeed to above 200 KIAS by lowering the nose of the aircraft. As airspeed increases, throttle advances may be attempted; however, the throttle should be returned to IDLE detent if the engine does not accelerate.

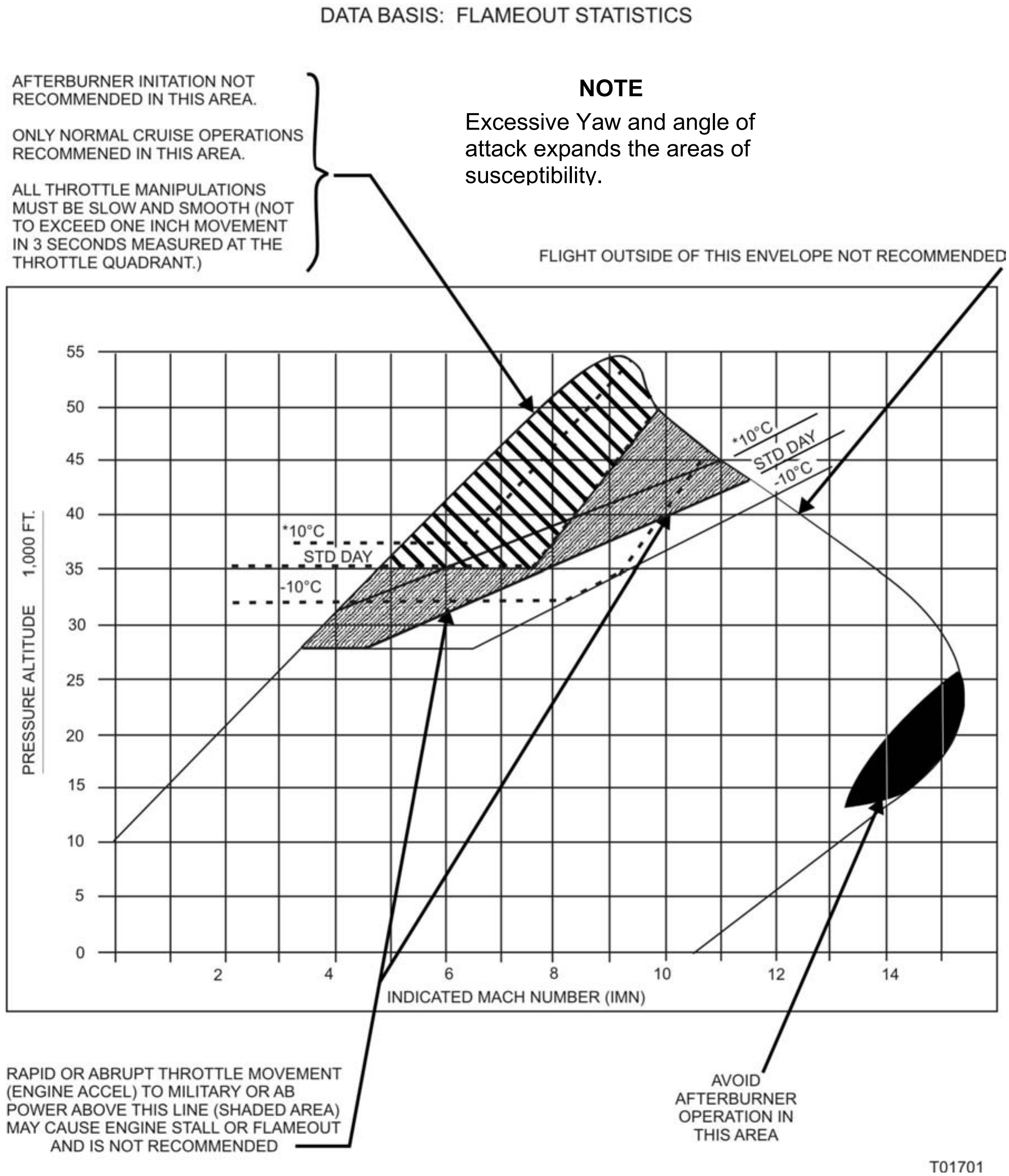

Figure 7-1. Engine Compressor Stall/Flameout Susceptibility Areas 1G Level Flight

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CREW DUTIES

SECTION VIII

(NOT APPLICABLE)

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ALL-WEATHER OPERATION

SECTION IX

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INSTRUMENT FLIGHT PROCEDURES

INSTRUMENT TAKEOFF

For an instrument takeoff, perform all normal pre-takeoff checks and turn on pitot heat and engine anti-ice system if necessary. Allow for increased takeoff roll if engine anti-ice is used. Verify Attitude Director Indicator (ADI) and Horizontal Situation Indicator (HSI) for proper heading. On level surface with proper strut inflation, ADI gives approximately 3-degree nose-low indication. It will give an approximate level-flight indication for intermediate altitude level-offs during departures and under normal cruise conditions. Adjust standby attitude gyro to 3-degree nose-low indication. Manual bank steering may be used to aid in maintaining heading, but steering bar indications should be cross-checked with ADI heading. Whenever visibility permits, runway features and lights should be used as aids to maintain proper heading. Adjust back stick pressure to attain takeoff attitude and allow aircraft to fly off runway. When vertical velocity indicator and altimeter indicate definite climb, retract landing gear. Raise wing flaps immediately after landing gear lever has been placed at LG UP.

INSTRUMENT CLIMB

Approaching 300 Knots Indicated Airspeed (KIAS) in a 5-degree climb indication, retard throttles to MIL thrust. Maintain a 2- to 5-degree climb indication and at least a 1,000-fpm climb until reaching recommended climb schedule. A slow airspeed and/or low rate of climb may be required to comply with departure procedures. For this type climb, reduce power below MIL as required. Power settings between 90% and 95% RPM will provide comfortable climb rates at 300 KIAS for intermediate altitude level-offs. MAX thrust instrument climbs require extremely high pitch angles and are not normally used for instrument departures.

If conditions require a MAX thrust climb, maintain a 2- to 5-degree climb indication until approaching recommended climb mach, then rotate to approximately a 20- to 25-degree initial climb indication.

HOLDING PATTERNS

Hold at 250 to 265 KIAS at all altitudes. To descend in holding patterns, reduce power and maintain holding airspeed in descent. The speed brake may be used for holding pattern descents, but higher descent rates must be anticipated.

PENETRATION DESCENTS

Prior to penetration descent, the canopy defog system should be operated at the highest flow possible (consistent with crewmembers' comfort) during high altitude flight to prevent the formation of frost or fog during descent. To enter a penetration descent, reduce power and lower the nose approximately 10 degrees on the ADI. Open speed brake (if required) at 300 KIAS and maintain by adjusting pitch as required. Set level-off altitude into the altitude alerter. Initiate the level off from a penetration descent 1,000 feet or more above the desired altitude by decreasing the pitch attitude by approximately one half. Use normal lead point for level-off at the desired altitude. The speed brake may be left open or closed as required to obtain the desired airspeed at the final approach fix.

NOTE

> For engine anti-ice operation, 80% RPM or above is recommended.

INSTRUMENT APPROACHES

Figure 9-1 shows a typical Tactical Air Command and Navigation (TACAN) System penetration and approach. Normally, a maximum of 300 KIAS will be maintained during approach maneuvering prior to extending the gear. Recommended final approach airspeed will depend upon the type of approach being made. Angle-of-Attack (AOA) indexer will show a fast indication during final approach maneuvering and on speed indication after final approach fix. For a straight-in approach, maintain 155 KIAS plus fuel minimum (AOA indexer on speed). Full flaps should be used for landing.

NOTE

> Increase final approach and touchdown speeds by half the gust factor.

CIRCLING APPROACHES

A circling approach is a visual maneuver flown at a lower altitude than a normal Visual Flight Rules (VFR) overhead traffic pattern. The pilot's shallower look angle to the runway causes a tendency to fly a downwind and/or a base leg that is too close to the runway, thus increasing the possibility of an overshoot or steeper than normal final approach. Ensure sufficient downwind and/or base leg displacement prior to initiating the turn to final approach. As the circling maneuver may initially be a level turn, aircraft configuration will require higher power settings than those used in an overhead traffic pattern. Bank angles in excess of 45 degrees may make a level turn impossible under some conditions of heavy gross weights, high temperatures, and pressure altitudes. Maintain 175 KIAS plus fuel minimum and 60% flaps until transitioning to a normal final. AOA indications will vary depending on airspeed, bank angle, and back pressure applied during the circling maneuver. Refer to AFM 51-37 for illustrations of circling approach maneuvers.

INSTRUMENT LANDING SYSTEM (ILS)

Refer to Figures 9-5 and 9-6 for aircraft configuration.

Refer to Section IV for Electronic Flight Instrumentation System (EFIS) procedures.

MISSED APPROACH PROCEDURE

To accomplish a missed approach, advance throttles to MIL, close speed brake (if open) as power is applied, and rotate the aircraft to normal instrument takeoff attitude. Retract landing gear and flaps as in an instrument takeoff and accelerate to 240-300 KIAS. Climb at 240-300 KIAS to missed approach altitude. Power may be reduced to 90% to 95% to provide a more controlled rate of climb.

SINGLE-ENGINE APPROACHES

Refer to Figures 9-2, 9-4, and 9-6 for recommended airspeed and configuration for single engine TACAN, radar, or ILS approach. Delay lowering landing gear until just prior to glide slope if heavy fuel loads, engine anti-ice operation, turbulence, or other conditions cause single-engine MIL thrust to be inadequate for gear down level flight at recommended airspeeds. MAX thrust should be used on single-engine approaches, if necessary.

Single-Engine Missed Approach

Refer to Figures 9-2, 9-4, and 9-6 for single-engine instrument approach power settings and configurations. If a single-engine missed approach is necessary, use the procedure for single-engine go-around.

ICE AND RAIN

TAKEOFF

Monitor engine performance closely during takeoff on runways with large amounts of puddled water. Engine flameouts have occurred as a result of water thrown up by the nosewheel. In the event of dual engine flameout, loss of horizontal slab authority and nosewheel steering may effect abort distance and directional control.

WEATHER RADAR

The aircraft is equipped with color weather radar that will detect and display rain and wet hail. It is less effective with low reflectance targets such as dry snow, dry hail, or small raindrops. It will not display clouds or fog. When weather is anticipated after takeoff, ensure the radiation hazard zone depicted in Section IV of this manual is clear then turn the radar power knob to the ON position and select WX (weather) or WXA (weather alert). Select the weather radar mode for the HSI navigation display in use and adjust the antenna up as required to minimize ground return and detect weather along the departure route. Significant weather displayed on the HSI should be verified visually if possible and with the Air Traffic Control (ATC) controller. Fly to avoid adverse weather. Detailed weather radar operation data is available in Section IV of this manual.

ICING

Anti-icing equipment for the wings, empennage, and inlet ducts is not provided. The aircraft is provided with engine anti-ice, pitot heat, AOA vane heat, Static Air Temperature (SAT) probe heat, and canopy defog heat, which also provides windshield heat for adverse weather operation. An ice detection light makes it possible for the front seat pilot to detect ice forming at the base of the windscreen at night. Icing conditions which may be encountered are trace, light, moderate, and severe. Moderate and severe icing, particularly, can cause rapid buildup of ice on the aircraft surfaces and greatly affect performance.

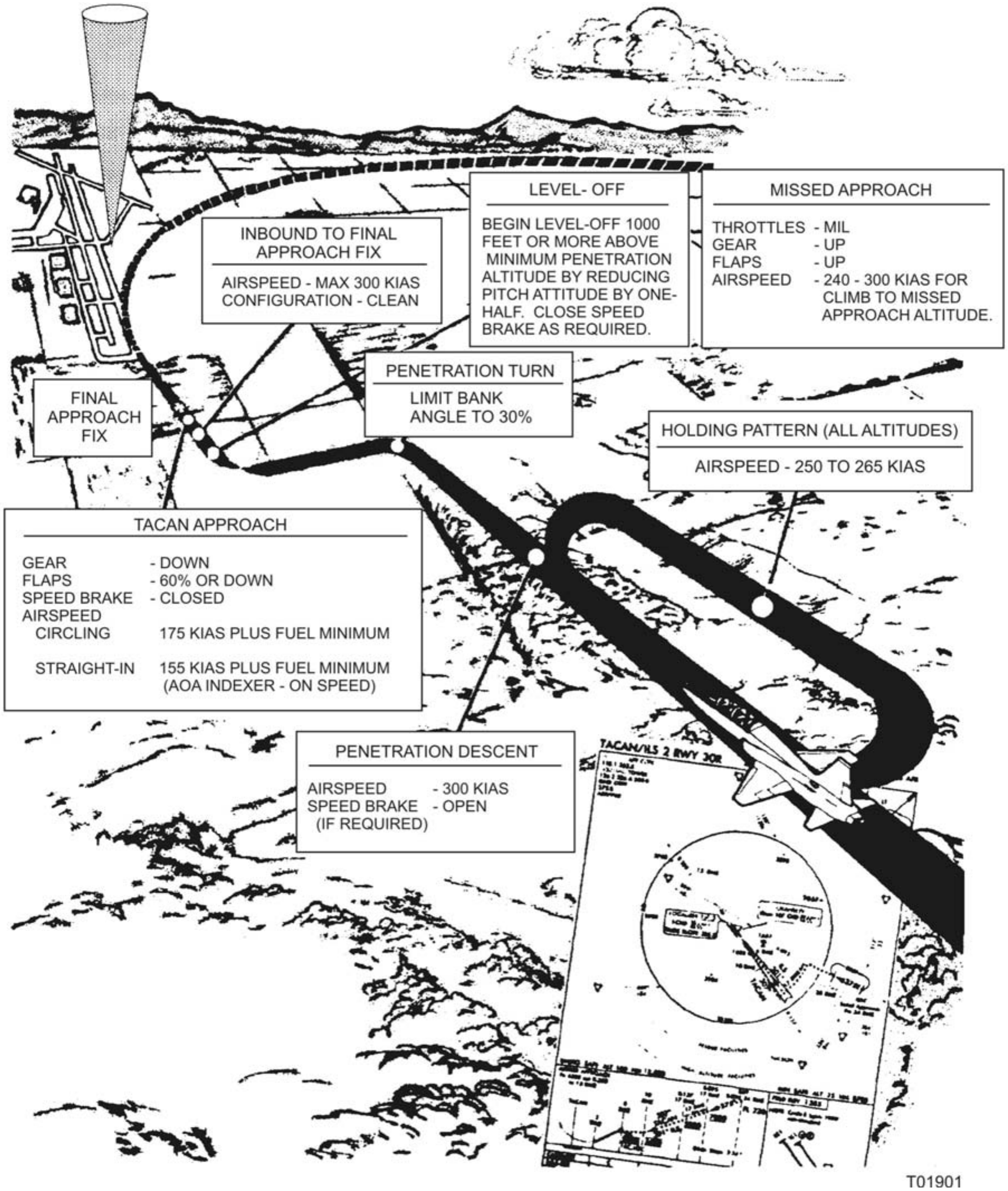


Figure 9-1. Tacan Holding, Penetration, and Approach

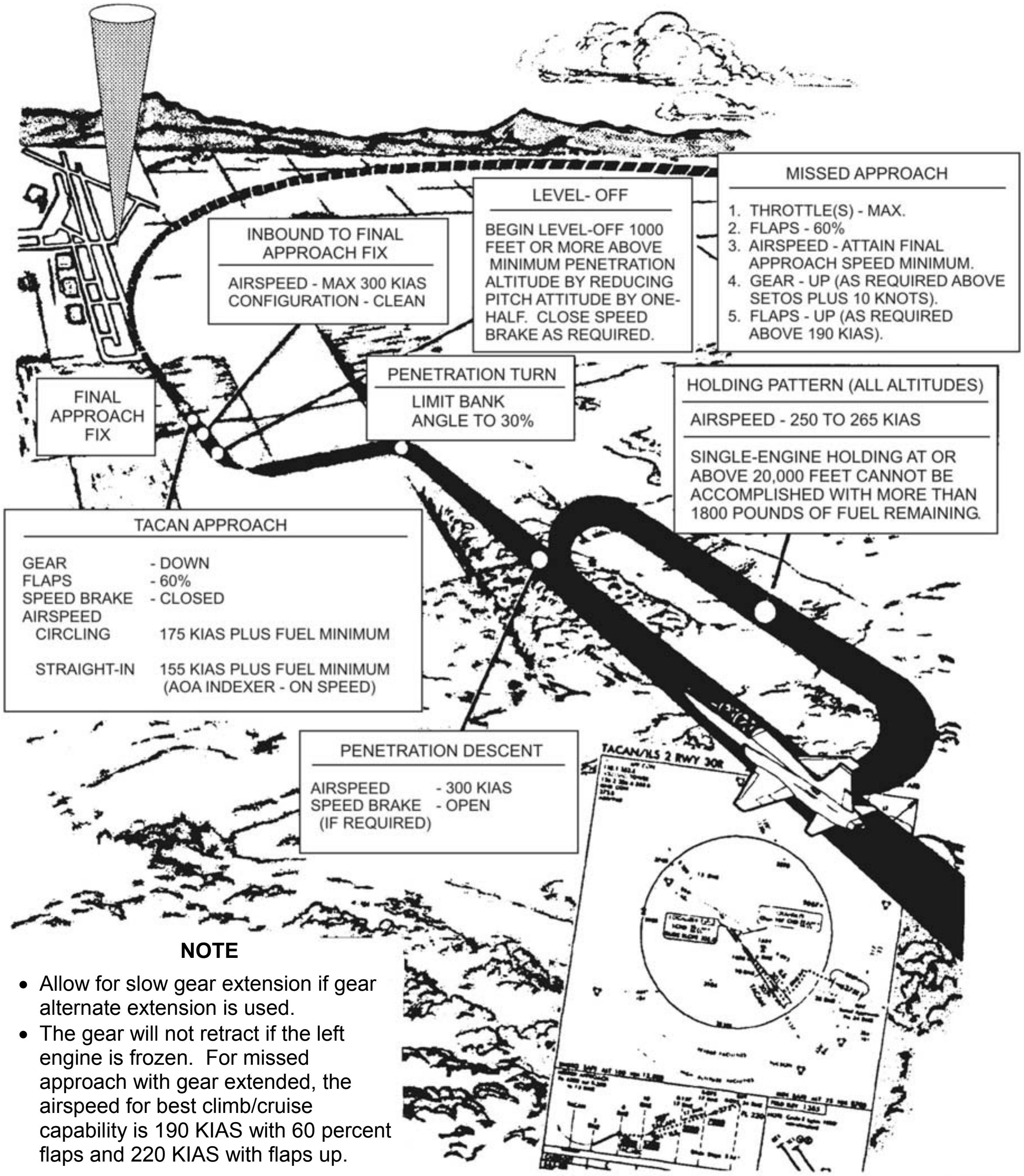


Figure 9-2. Tacan Holding, Penetration, and Approach Single-Engine

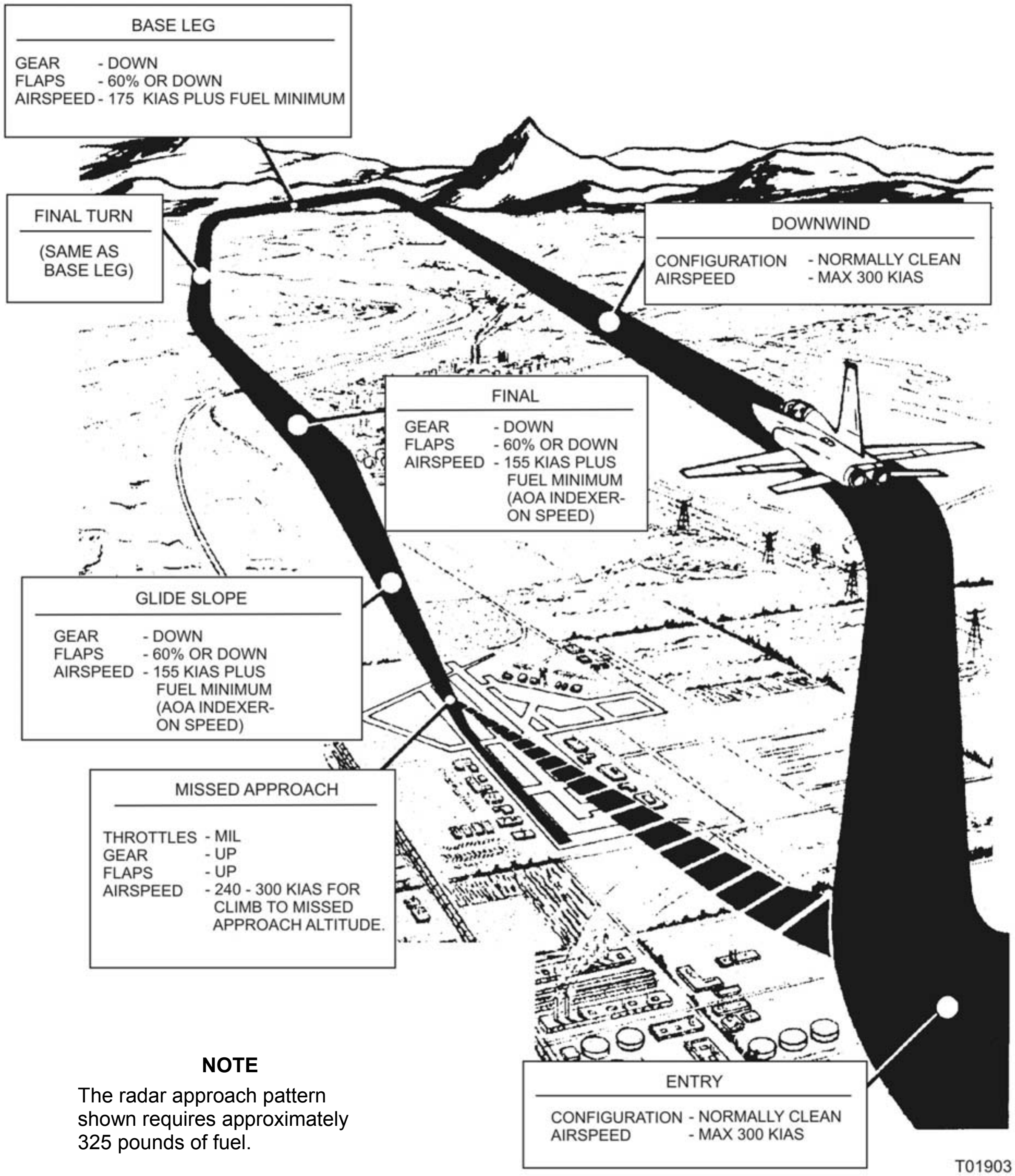
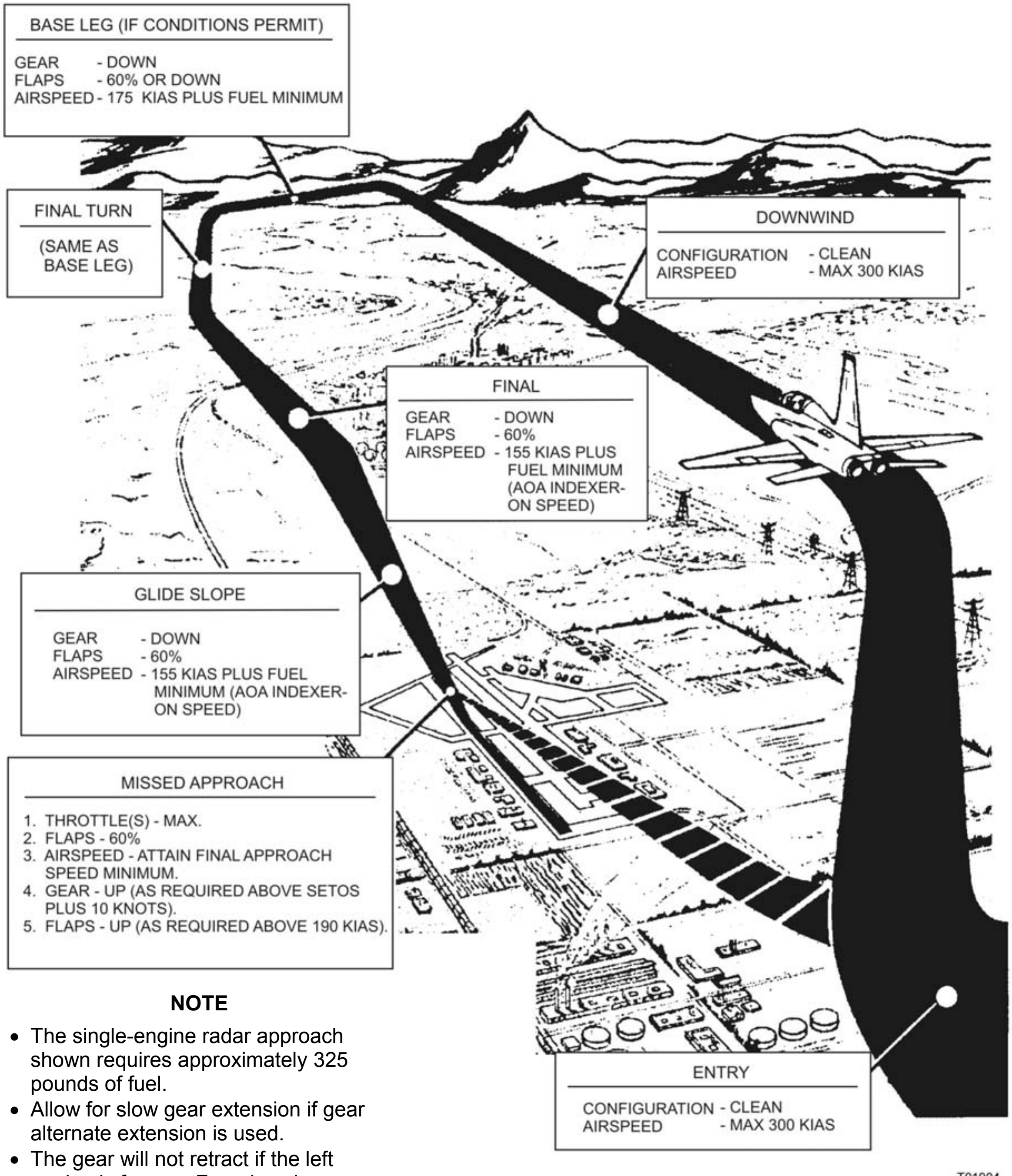


Figure 9-3. Radar Approach



NOTE

- The single-engine radar approach shown requires approximately 325 pounds of fuel.
- Allow for slow gear extension if gear alternate extension is used.
- The gear will not retract if the left engine is frozen. For missed approach with gear extended, the airspeed for best climb/cruise capability is 190 KIAS with 60% flaps and 220 KIAS with flaps up.

Figure 9-4. Radar Approach Single-Engine

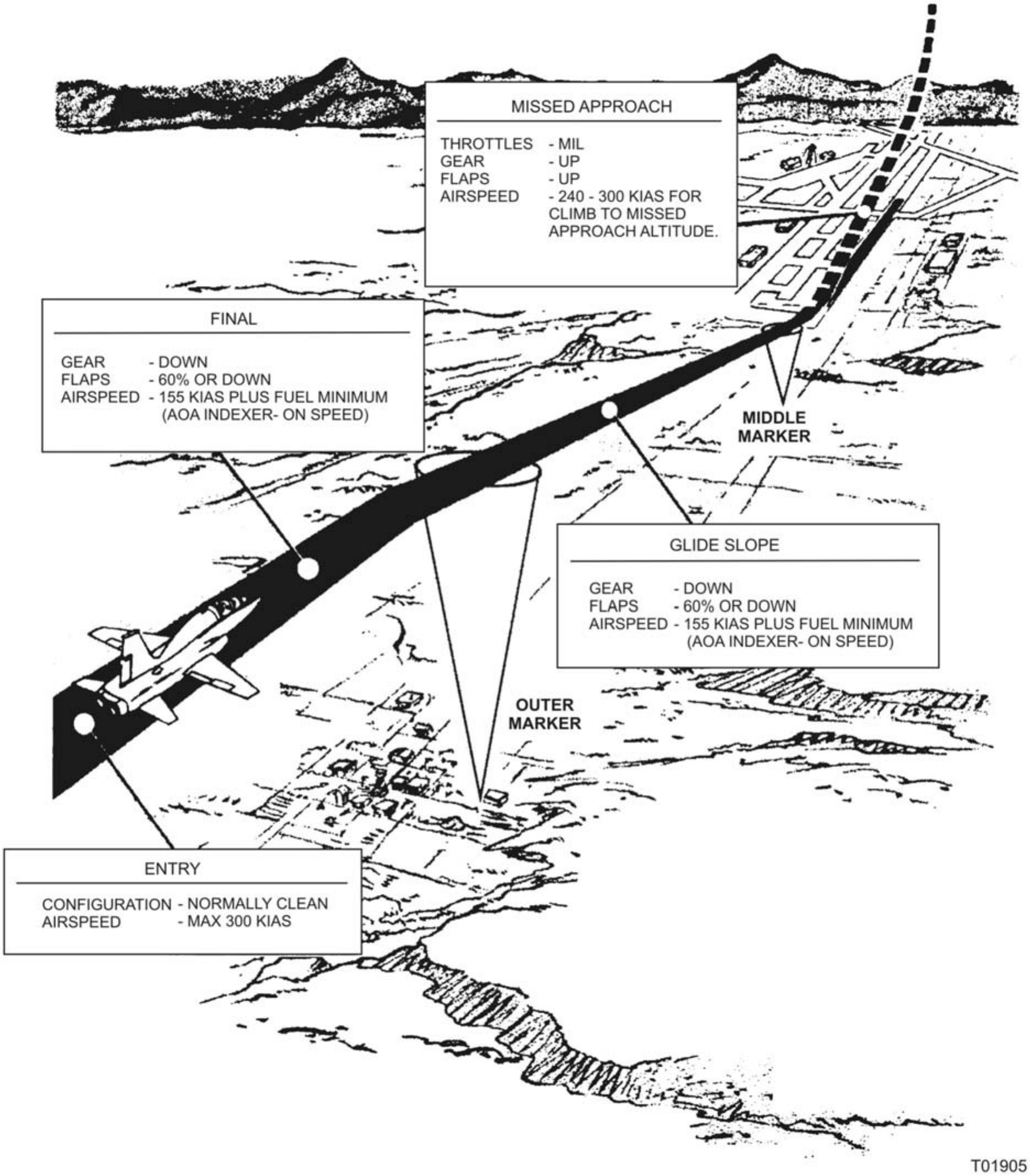
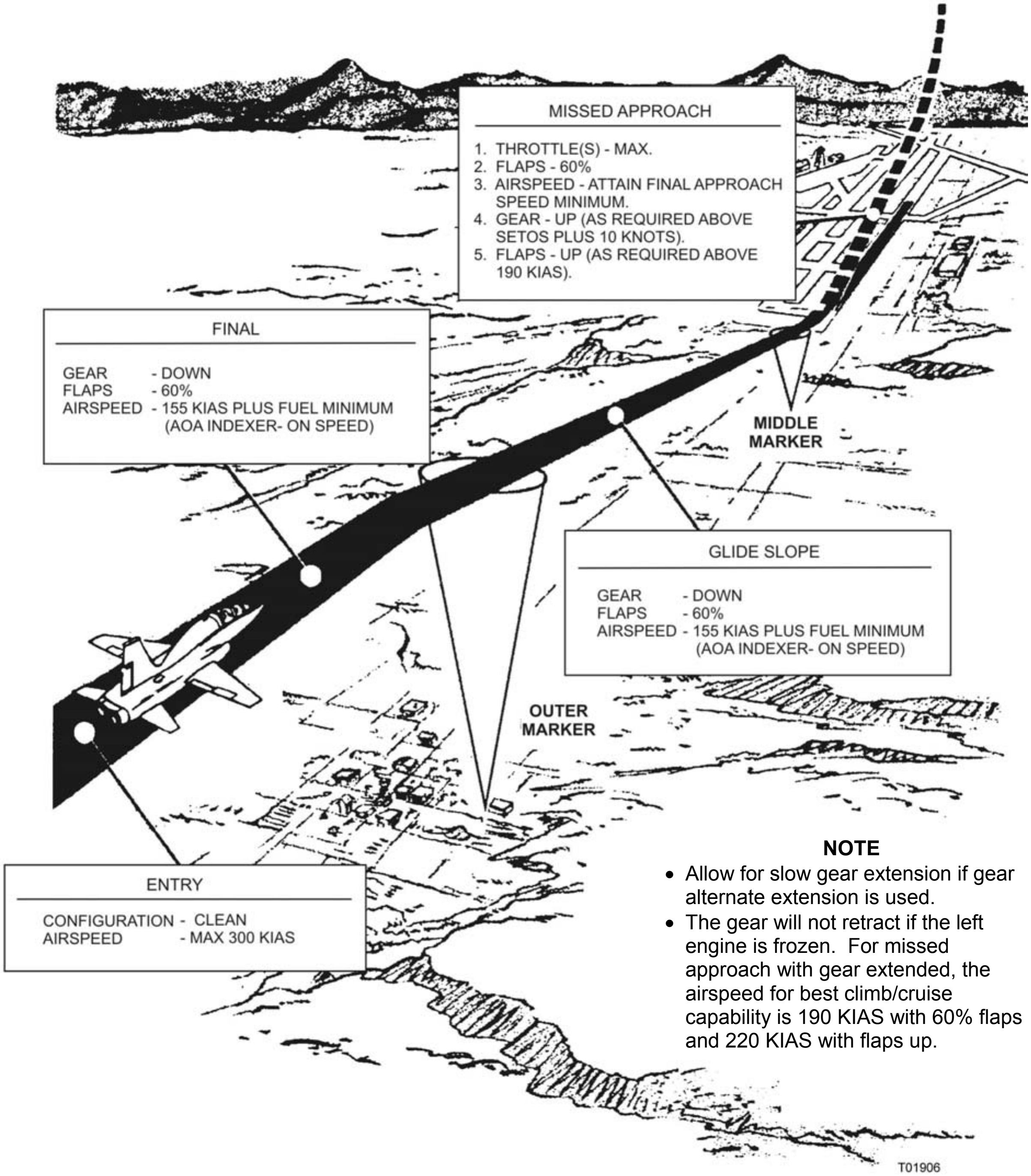


Figure 9-5. ILS Approach



NOTE

- Allow for slow gear extension if gear alternate extension is used.
- The gear will not retract if the left engine is frozen. For missed approach with gear extended, the airspeed for best climb/cruise capability is 190 KIAS with 60% flaps and 220 KIAS with flaps up.

Figure 9-6. ILS Approach Single-Engine

WARNING

The aircraft should not be flown into known icing conditions. If icing is inadvertently encountered, leave the area of icing conditions as soon as possible.

When icing conditions are unavoidable, the pitot heat switch should be placed at PITOT HEAT and the canopy defog knob turned to full increase. The aircraft is not equipped with a windshield anti-icing or rain removal equipment. Instrument approaches in heavy rain are possible, but forward visibility through the windshield may be marginal. Forward visibility in icing conditions is further reduced and may be completely obscured through the windshield.

ICE INGESTION

Engine damage may occur if as little as 1/4 inch of ice accumulates on engine inlet duct lips. Ingestion of accumulated ice into an engine may be evidenced by a jar or noise in the engine and may result in damage to inlet guide vanes and first stage compressor blades. Engine instrument indications may remain normal, even though engine damage from ice ingestion has been experienced.

CAUTION

- After ice ingestion, the affected engine should be operated at the lowest possible RPM necessary to make a safe landing, avoiding abrupt or rapid throttle movements.
- If inflight icing conditions result in ice accumulations on the aircraft, enter this information on JSC Form 111, as the engines must be inspected for ice ingestion damage when this occurs.

ENGINE ICING

Engine inlet duct and/or guide vane icing may occur when the ambient temperature is at or slightly above freezing and either the humidity is high or when operating in visible moisture. Under these conditions, and when icing conditions are unavoidable, the engine anti-ice switch should immediately be placed at MAN ON, ensuring continuous anti-icing action.

NOTE

To ensure effective anti-icing, maintain a minimum of 80% RPM when the engine anti-icing system is turned ON.

RAIN

CAUTION

Flight in moderate precipitation may damage the nose cone or vertical stabilizer. Nose cone damage may result in inflight engine FOD. If flight in moderate precipitation is unavoidable, slow to the minimum practical airspeed to negate or lessen damage.

TURBULENCE AND THUNDERSTORMS

WEATHER RADAR

The weather radar installed in the T-38N is not designed to detect turbulence or thunderstorms directly. It will detect the precipitation that is associated with them. With the radar power knob in the ON position and WX or WXA selected, choose the weather radar mode for the HSI navigation display in use and adjust the range and antenna elevation as appropriate for the route of flight. Do not fly into the narrow corridor between significant weather returns without verifying the weather conditions at the end of the corridor. Significant weather displayed on the HSI should be verified visually if possible and with the ATC controller. Fly to avoid adverse weather.

WARNING

- Intentional flight into thunderstorms should be avoided.
- The recommended best penetration airspeed if turbulence and thunderstorms are experienced is 280 KIAS.

NIGHT FLYING

When flying away from concentrations of ground lights, caution should be exercised to prevent spatial disorientation.

COLD WEATHER OPERATION

Most cold weather operating difficulties are encountered on the ground. The following instructions are to be used in conjunction with the normal procedures given in Section II when cold weather aircraft operation is necessary.

BEFORE ENTERING AIRCRAFT

Remove all protective covers and duct plugs; check to see that all surfaces, ducts, struts, drains, canopy rails, and vents are free of snow, ice, and frost. Brush off light snow and frost. Remove ice and encrusted snow either by a direct flow of air from a portable ground heater or by using de-icing fluid.

WARNING

- All ice, snow, and frost must be removed from the aircraft before flight is attempted. Takeoff distance and climb-out performance can be adversely affected by ice and snow accumulations. The roughness and distribution of these accumulations can vary stall speeds and alter flight characteristics to a degree extremely hazardous to safe flight.
- Ensure that water does not accumulate in control hinge areas or other critical areas where refreezing may cause damage or binding.

CAUTION

To avoid damage to aircraft surfaces, do not permit ice to be chipped or scraped away.

Check the fuel system vents on the vertical stabilizer for freedom from ice. Remove all dirt and ice from landing gear shock struts, actuating cylinder pistons, and limit switches. Wipe exposed parts of shock struts and pistons with a rag soaked in hydraulic fluid. Inspect aircraft carefully for fuel and hydraulic leaks caused by contraction of fittings or by shrinkage of packings. Inspect area behind aircraft to ensure that water or snow will not be blown onto personnel and equipment during engine start.

ON ENTERING AIRCRAFT

Use external power for starting to conserve the battery. No preheat or special starting procedures are required; however, at temperatures below -30ºF (-34ºC), allow the engines to idle 2 minutes before accelerating. Turn on cockpit heat and canopy defog system, as required, immediately after engine start. Check flight controls, speed brake, and aileron trim for proper operation. Cycle flight controls four to six times. Check hydraulic pressure and control reaction, and operation of all instruments.

ENGINE OIL PRESSURE INDICATIONS

Oil pressure indications above 55 psi will be observed after engine start. As the oil warms up, pressure should reduce to within operating limits. To reduce time for the oil pressure to return to normal, the engine may be operated above idle, up to military power, until oil pressure is within limits. If oil pressure does not return to within operating limits within 6 minutes, shut down engine and determine cause.

ENGINE IDLE RPM

Low engine idle RPM can be expected after engine start when the engines are cold and the ground ambient temperature is below -16ºF (-26ºC). Monitor EGT and increase engine RPM as necessary to cut in the AC generators. If engine RPM will not increase when the throttle is advanced, shut down engine and determine cause. Engine idle RPM should be within operating limits after the engine has warmed up and the oil pressure has decreased to the normal operating range.

TAXIING

Nosewheel steering effectiveness is reduced when taxiing on ice and hard packed snow. A combination of nosewheel steering and wheel braking should be used for directional control. The nosewheel will skid sideways easily, increasing the possibility of tire damage. Reduce taxi speeds and exercise caution at all times while operating on these surfaces. Increase the normal interval between aircraft both to ensure a safe stopping distance and to prevent icing of the aircraft from melted snow and ice caused by the jet blast of the preceding aircraft. Minimize taxi time to conserve fuel and reduce the amount of ice fog generated by the engines. If bare spots exist through the snow, skidding onto them should be avoided. Check for sluggish instruments while taxiing.

TAKEOFF

Do not advance throttles into MAX range until the aircraft is rolling straight down the runway.

WARNING

Do not take off on slush covered runway; the nosewheel may sling slush into the inlet ducts, causing engine flameout and/or damage.

LANDING

Use landing techniques given in Section II. When landing on runways that have patches of dry surface, avoid locking the wheels. If the aircraft starts to skid, release brakes until recovery from skid is accomplished.

ENGINE SHUTDOWN

Use normal engine shutdown procedure.

HOT WEATHER AND DESERT OPERATION

Operation of the aircraft in hot weather and in the desert requires that precautions be taken to protect the aircraft from damage caused by high temperatures, dust, and sand. Care must be taken to prevent the entrance of sand into aircraft parts and systems such as the engines, fuel system, pitot static system, etc. All filters should be checked more frequently than under normal conditions. Plastic and rubber segments of the aircraft should be protected both from high temperatures and blowing sand. Canopy covers should be left off to prevent sand from accumulating between the cover and the canopy and acting as an abrasive on the plastic canopy. With a canopy closed, cockpit damage may result when ambient temperature is in excess of 110ºF. Temperatures in the avionics bay may also exceed that value. Unless needed for weather avoidance on departure, the radar may be left in STBY until airborne. Desert and hot weather operations require that in addition to normal procedures, the following precautions be observed.

TAKEOFF

1. Monitor pitch attitude closely to ensure a positive rate of climb during gear and flap retraction and to prevent an excessive angle of attack.
2. Be alert for gusts and wind shifts near the ground.

APPROACH AND LANDING

1. Monitor airspeed closely to ensure that recommended approach and touchdown airspeeds are maintained; high ambient temperatures cause speed relative to the ground to be higher than normal.
2. Anticipate a long landing roll due to higher ground speed at touchdown.
3. Utilize effective aerodynamic braking and all available runway for stopping the aircraft without overheating the wheel brakes.

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APPENDIX A
PERFORMANCE DATA

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INTRODUCTION

PART 1

TABLE OF CONTENTS

INTRODUCTION

The flight performance charts provide the pilot with flight test data for basic flight planning purposes. All charts are based on standard day conditions except when necessary, as in the takeoff and landing charts, to include temperature corrections for nonstandard days. These corrections are based on maintaining the recommended indicated mach number or indicated airspeed. Instrument error is assumed to be zero in all performance charts of this appendix.

TAKEOFF FACTOR

The takeoff factor is used to simplify the takeoff charts. The factor is based on atmospheric condition and the desired takeoff power setting. This factor reduces the time and effort required in takeoff planning.

DESCRIPTION OF DRAG INDEX SYSTEM

The Drag Index System permits the presentation of performance for a number of external store loadings on one chart and greatly reduces the number of charts required in flight planning work. In the drag index system, each item of the external store configuration, such as a pylon, is assigned a drag number whose value depends on the size and shape of the item and its location on the aircraft. These numbers are not drag coefficients. The summation of the store drag numbers for a particular loading defines a drag index for that configuration. This drag index, when used in the performance charts, determines the aircraft performance for that external store configuration. The T-38N, with no external store, has a drag index of zero.

ALTIMETER AND AIRSPEED INSTALLATION ERROR CORRECTION

Static pressure, which affects both airspeed and altimeter indications, is not always accurately measured because of the location of the static ports. This pressure error is a function of both airspeed and altitude. Knots Calibrated Airspeed (KCAS) is obtained from Knots Indicated Airspeed (KIAS) by correcting for the installation error in static pressure (airspeed installation error). Knowing indicated airspeed and pressure altitude, both airspeed and altimeter installation corrections may be read from Figure A1-1.

USE OF ALTIMETER CORRECTION CHART

Consider the aircraft flying at 300 KIAS at FL300. Read up the 300 KIAS line to intersect the 30,000-foot correction curve, and from this point, draw a horizontal line to the left margin of the chart. Read the correction, which is -440 feet. Since indicated altitude is pressure altitude plus correction, the corrected altitude is 29,560 feet.

MACH NUMBER CORRECTION

To convert true mach number to indicated mach number, use mach number correction chart, Figure A1-2.

COMPRESSIBILITY CORRECTION TO CALIBRATED AIRSPEED

Figure A1-3, Compression Correction to Calibrated Airspeed, provides the necessary airspeed correction to convert KCAS to Knots Equivalent Airspeed (KEAS) (KEAS = KCAS — $_D V_c$).

AIRSPEED CONVERSION

The Standard Altitude Table, Figure A1-4, is used to convert between KCAS, true mach number, and Knots True Airspeed (KTAS). If KCAS is known, enter the chart at that value and move upward to the known pressure altitude. At that point, true mach number is read on the left-hand scale and KTAS for standard atmosphere conditions is interpolated between the sloping speed lines whose scale is located at the sea level pressure altitude line. To correct KTAS for nonstandard temperatures, move horizontally from the intersection of KCAS and the known altitude to the sea level pressure altitude line, then vertically downward to the known ambient air temperature, and read the corrected KTAS on the scale at the right.

STANDARD ALTITUDE TABLE

Significant properties of the International Civil Aircraft Organization (ICAO) standard atmosphere are tabulated at 1,000-foot increments between -2,000 and 65,000 feet altitude in Figure A1-5. Sea level values of the properties are listed in the top of the chart for use with the ratios shown in the table. As an example of the use of the table, find the equivalent airspeed in knots in standard atmosphere corresponding to 0.85 mach number at 30,000 feet pressure altitude. In Figure A1-5, at 30,000 feet read $a/a_o = 0.8909$, read $1/\sqrt{}_s$, = 1.6349, and at the top of the table read $a_o = 661.7$ knots.

Then: $a = a_o \text{ X } a/a_o = 661.7 \text{ X } 0.8909 =$ 589.5 knots.

KTAS = Mach X a = 0.85 X 589.5 = 501.1 knots.

KEAS = KTAS ¸ $1/\sqrt{}_s$ = 501.1 ¸ 1.6349 = 306.5 knots.

DENSITY ALTITUDE

Figure A1-6 presents the variation of density altitude with ambient temperature for constant values of pressure altitude.

Values of $1/\sqrt{s}$ are tabulated at the right of the chart as a function of the density altitude scale on the left side. ICAO standard atmosphere conditions are defined by the line that slopes to the left and upward through the chart. As an example in using the chart, find the value of $1/\sqrt{s}$ at 8,000 feet pressure altitude and 19ºC temperature. Move vertically up to the 8,000 feet pressure altitude line, then move horizontally right to the scale and read $1/\sqrt{\sigma} = 1.16$. The equivalent density altitude, if required, is 10,000 feet. Note that these conditions do not correspond to those of the standard atmosphere, since the true temperature at 8,000 feet pressure altitude in standard atmosphere is approximately 0º and $1/\sqrt{\sigma} = 1.12$.

STANDARD CONVERSION TABLE

Linear scales for converting units of temperature, distance, and speed from one measurement system to another are provided in Figure A1-7. Additional conversion factors for volume, pressure, and weight are listed at the bottom of the table.

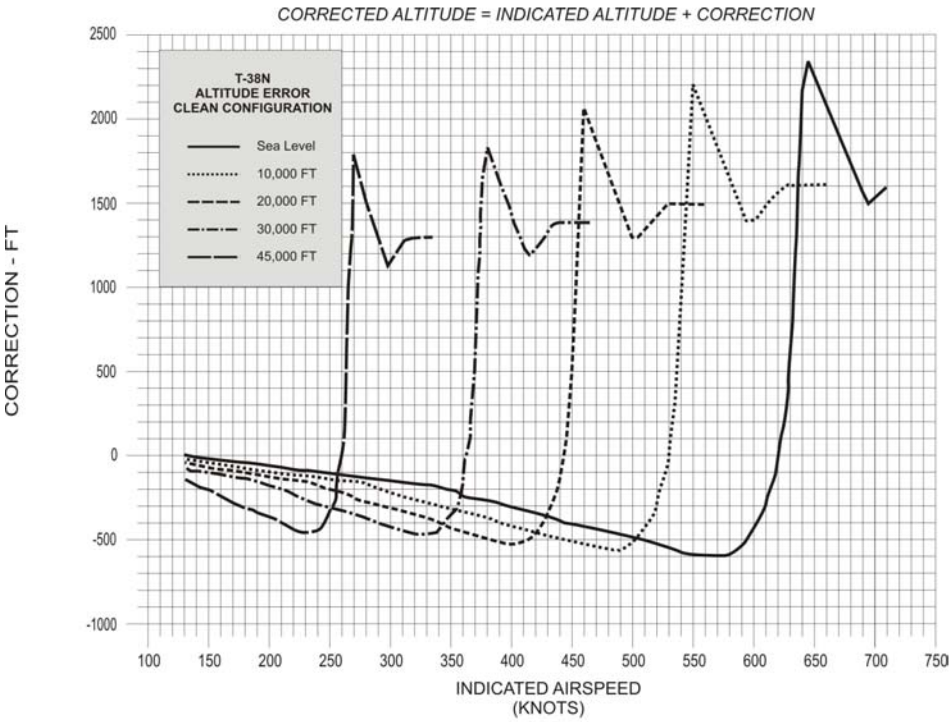
Figure A1-1

ALTIMETER AND AIRSPEED INSTALLATION ERROR CORRECTIONS

CLEAN CONFIGURATION

MODEL: T-38N
DATA BASIS: 1995 FLIGHT TEST

ENGINE: (2) J85-GE-5
FUEL: JET A
FUEL DENSITY: 6.7 LB/US GAL



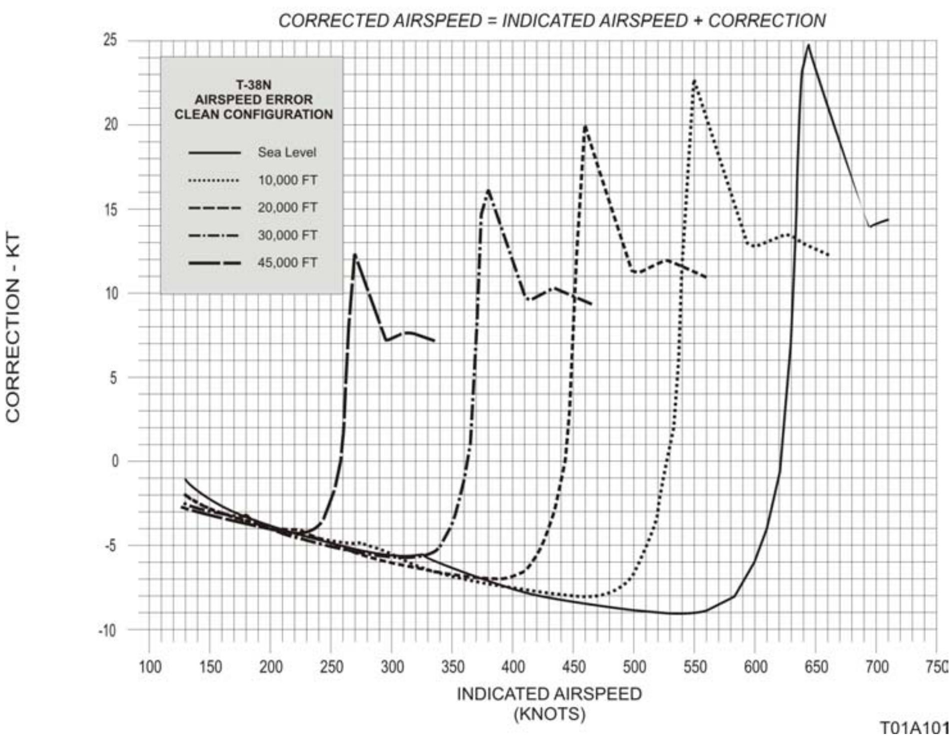


Figure A1-2

MACH NUMBER

MODEL: T-38N
DATA BASIS: 1995 FLIGHT TEST

ENGINE: (2) J85-GE-5
FUEL: JET A
FUEL DENSITY: 6.7 LB/US GAL

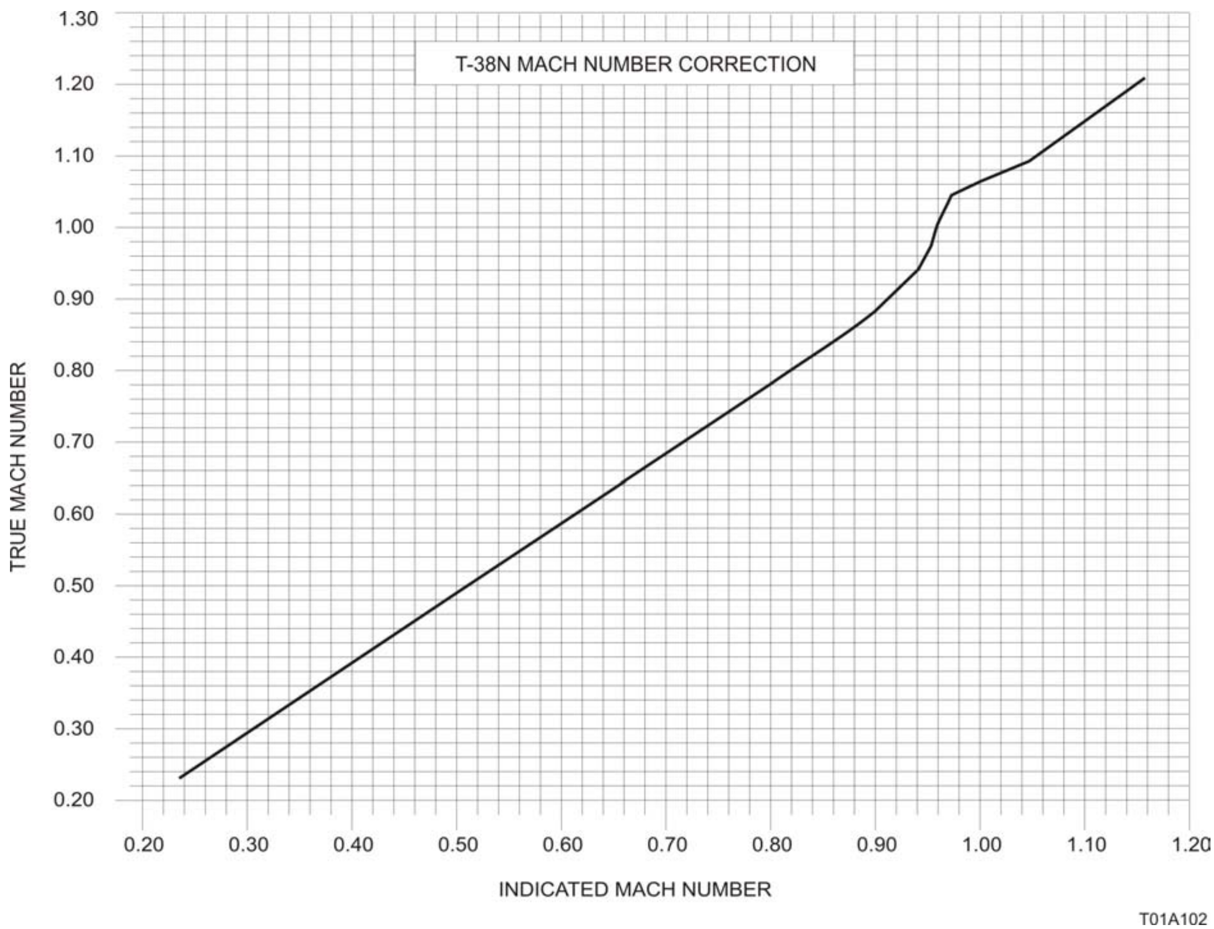
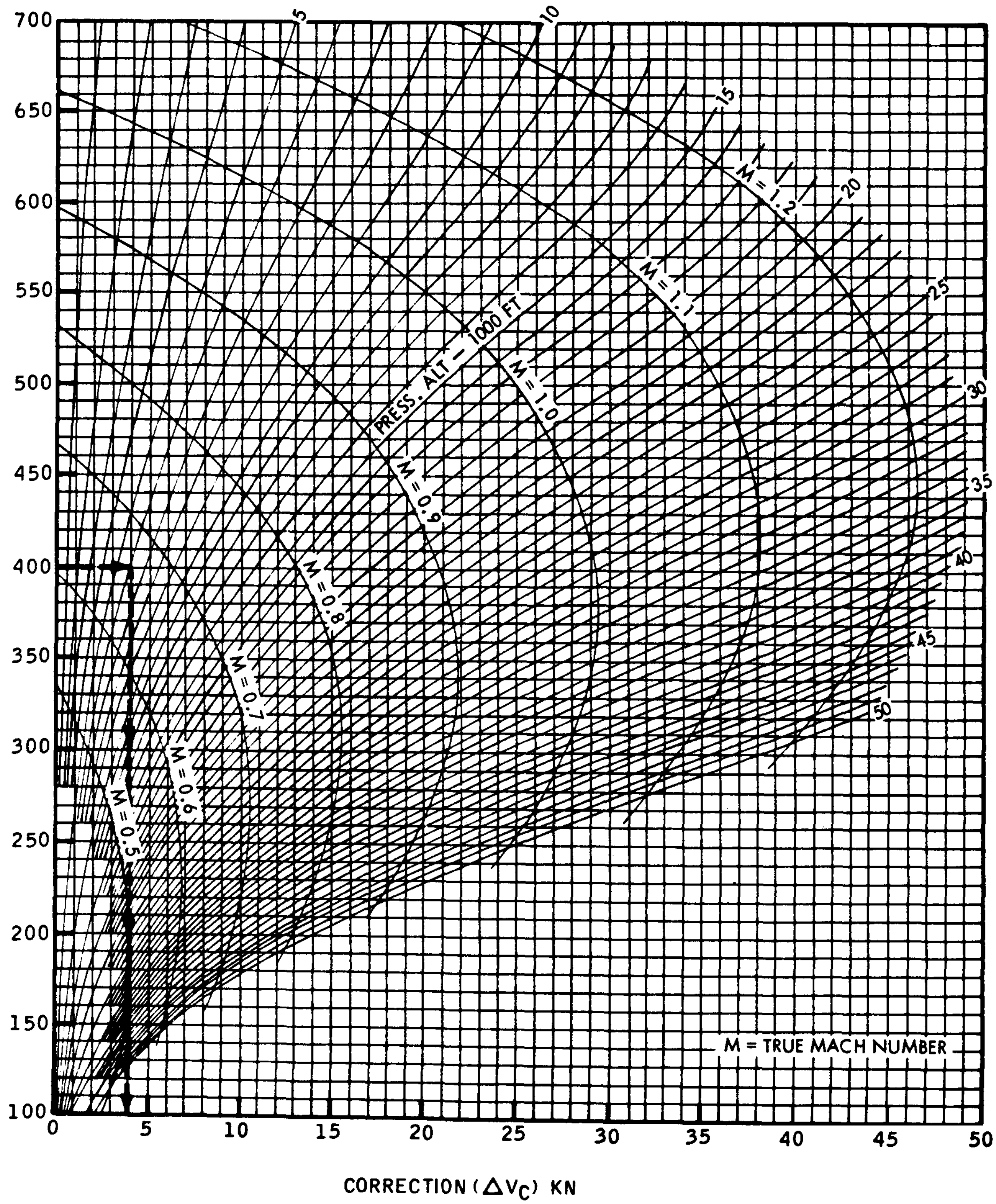


Figure A1-3

COMPRESSIBILITY CORRECTION TO CALIBRATED AIRSPEED



T-38A 1-302 D

T01A103

Figure A1-4

AIRSPEED CONVERSION

EXAMPLE:
KCAS = 440
PRESS. ALT = 15,000 FT
TMN = 0.85
KTAS (STD DAY) = 530
KTAS (AT 20°C) = 565

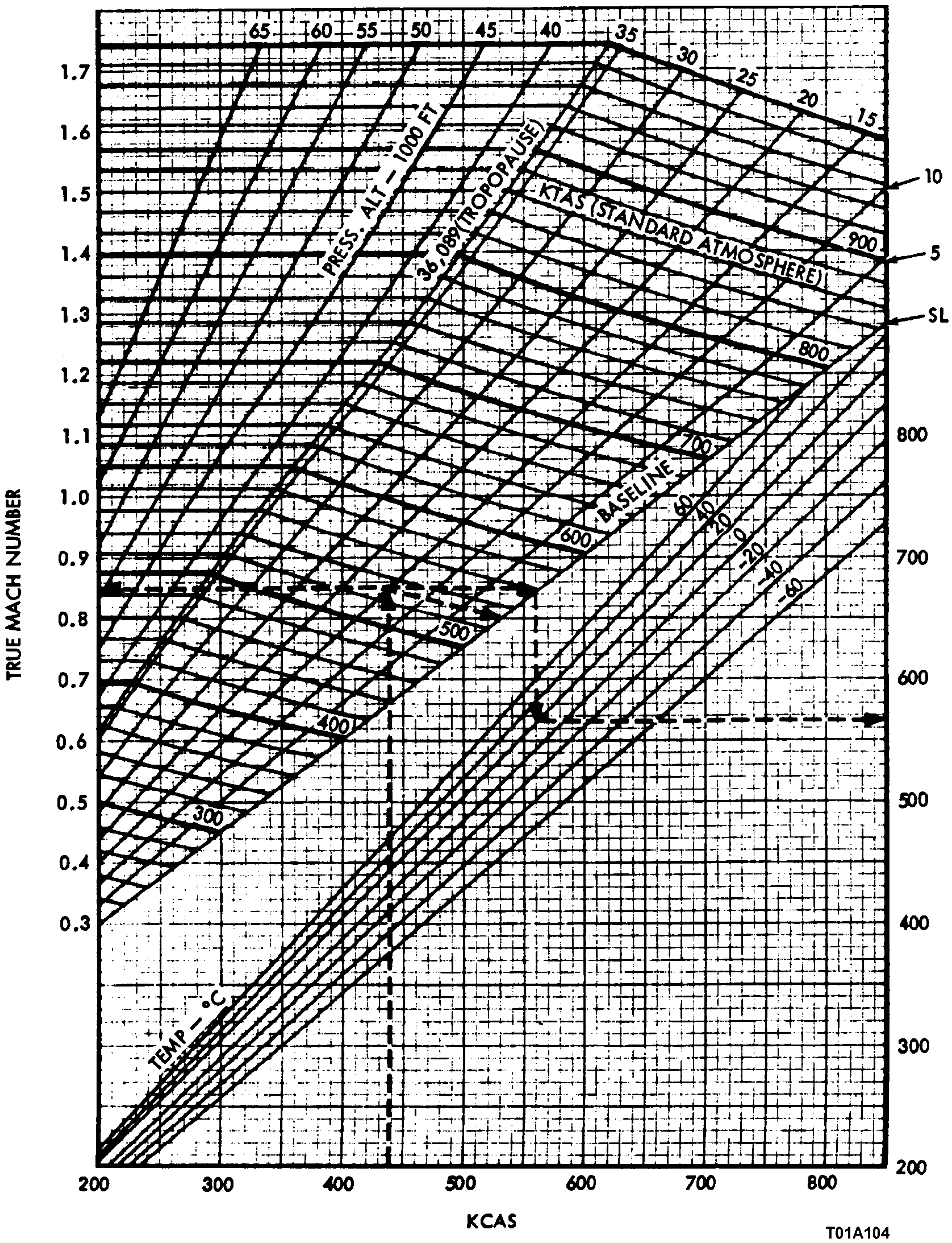


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Figure A1-5

STANDARD ALTITUDE TABLE

STANDARD SEA LEVEL AIR: W = 0.076475 LB/CU FT ρ_o = 0.0023769 SLUGS/CU FT
T = 59°F (15°C) STANDARD ATMOSPHERE 1" OF HG = 70.732 LB/SQ FT = 0.4912 LB/SQ IN.
P = 29.921 IN. OF HG (NACA TECHNICAL REPORT NO. 1235) α_o = 1116.89 FT/SEC = 661.7 KN

ALTITUDE FEET	DENSITY RATIO $\rho/\rho_o = \sigma$	$1/\sqrt{\sigma}$	TEMPERATURE		SPEED OF SOUND RATIO α/α_o	PRESSURE	
			DEG. F	DEG. C		IN. OF HG	RATIO $P/P_o = \delta$
-2,000	1.0598	0.9714	66.132	18.962	1.0064	32.15	1.0294
-1,000	1.0296	0.9855	62.566	16.981	1.0030	31.02	1.0147
0	1.0000	1.0000	59.000	15.000	1.0000	29.92	1.0000
1,000	0.9711	1.0148	55.434	13.019	0.9966	28.86	0.9644
2,000	0.9428	1.0299	51.868	11.038	0.9931	27.82	0.9298
3,000	0.9151	1.0454	48.302	9.057	0.9896	26.82	0.8962
4,000	0.8881	1.0611	44.735	7.075	0.9862	25.84	0.8637
5,000	0.8617	1.0773	41.169	5.094	0.9827	24.90	0.8320
6,000	0.8359	1.0938	37.603	3.113	0.9792	23.98	0.8014
7,000	0.8106	1.1107	34.037	1.132	0.9756	23.09	0.7716
8,000	0.7860	1.1279	30.471	-0.849	0.9721	22.22	0.7428
9,000	0.7620	1.1456	26.905	-2.831	0.9686	21.39	0.7148
10,000	0.7385	1.1637	23.338	-4.812	0.9650	20.58	0.6877
11,000	0.7156	1.1822	19.772	-6.793	0.9614	19.79	0.6614
12,000	0.6932	1.2011	16.206	-8.774	0.9579	19.03	0.6360
13,000	0.6713	1.2205	12.640	-10.756	0.9543	18.29	0.6113
14,000	0.6500	1.2403	9.074	-12.737	0.9507	17.58	0.5875
15,000	0.6292	1.2606	5.508	-14.718	0.9470	16.89	0.5643
16,000	0.6090	1.2815	1.941	-16.699	0.9434	16.22	0.5420
17,000	0.5892	1.3028	-1.625	-18.681	0.9397	15.57	0.5203
18,000	0.5699	1.3246	-5.191	-20.662	0.9361	14.94	0.4994
19,000	0.5511	1.3470	-8.757	-22.643	0.9324	14.34	0.4791
20,000	0.5328	1.3700	-12.323	-24.624	0.9287	13.75	0.4595
21,000	0.5150	1.3935	-15.889	-26.605	0.9250	13.18	0.4406
22,000	0.4976	1.4176	-19.456	-28.587	0.9213	12.64	0.4223
23,000	0.4807	1.4424	-23.022	-30.568	0.9175	12.11	0.4046
24,000	0.4642	1.4678	-26.588	-32.549	0.9138	11.60	0.3876
25,000	0.4481	1.4938	-30.154	-34.530	0.9100	11.10	0.3711
26,000	0.4325	1.5206	-33.720	-36.511	0.9062	10.63	0.3552
27,000	0.4173	1.5480	-37.286	-38.492	0.9024	10.17	0.3398
28,000	0.4025	1.5762	-40.852	-40.473	0.8986	9.725	0.3250
29,000	0.3881	1.6052	-44.419	-42.455	0.8948	9.297	0.3107
30,000	0.3741	1.6349	-47.985	-44.436	0.8909	8.885	0.2970
31,000	0.3605	1.6654	-51.551	-46.417	0.8871	8.488	0.2837
32,000	0.3473	1.6968	-55.117	-48.398	0.8832	8.106	0.2709
33,000	0.3345	1.7291	-58.683	-50.379	0.8793	7.737	0.2586
34,000	0.3220	1.7623	-62.249	-52.361	0.8754	7.382	0.2467
35,000	0.3099	1.7964	-65.816	-54.342	0.8714	7.041	0.2353
36,000	0.2981	1.8315	-69.382	-56.323	0.8675	6.712	0.2243
37,000	0.2844	1.8753	-69.700	-56.500	0.8671	6.397	0.2138
38,000	0.2710	1.9209	-69.700	-56.500	0.8671	6.097	0.2038
39,000	0.2583	1.9677	-69.700	-56.500	0.8671	5.811	0.1942
40,000	0.2462	2.0155	-69.700	-56.500	0.8671	5.538	0.1851
41,000	0.2346	2.0645	-69.700	-56.500	0.8671	5.278	0.1764
42,000	0.2236	2.1148	-69.700	-56.500	0.8671	5.030	0.1681
43,000	0.2131	2.1662	-69.700	-56.500	0.8671	4.794	0.1602
44,000	0.2031	2.2189	-69.700	-56.500	0.8671	4.569	0.1527
45,000	0.1936	2.2728	-69.700	-56.500	0.8671	4.355	0.1455
46,000	0.1845	2.3281	-69.700	-56.500	0.8671	4.151	0.1387
47,000	0.1758	2.3848	-69.700	-56.500	0.8671	3.956	0.1322
48,000	0.1676	2.4428	-69.700	-56.500	0.8671	3.770	0.1260
49,000	0.1597	2.5022	-69.700	-56.500	0.8671	3.593	0.1201
50,000	0.1522	2.5630	-69.700	-56.500	0.8671	3.425	0.1145
51,000	0.1451	2.6254	-69.700	-56.500	0.8671	3.264	0.1091
52,000	0.1383	2.6892	-69.700	-56.500	0.8671	3.111	0.1040
53,000	0.1318	2.7546	-69.700	-56.500	0.8671	2.965	0.09909
54,000	0.1256	2.8216	-69.700	-56.500	0.8671	2.826	0.09444
55,000	0.1197	2.8903	-69.700	-56.500	0.8671	2.693	0.09001
56,000	0.1141	2.9606	-69.700	-56.500	0.8671	2.567	0.08578
57,000	0.1087	3.0326	-69.700	-56.500	0.8671	2.446	0.08176
58,000	0.1036	3.1063	-69.700	-56.500	0.8671	2.331	0.07792
59,000	0.09877	3.1819	-69.700	-56.500	0.8671	2.222	0.07426
60,000	0.09414	3.2593	-69.700	-56.500	0.8671	2.118	0.07078
61,000	0.08972	3.3386	-69.700	-56.500	0.8671	2.018	0.06746
62,000	0.08551	3.4198	-69.700	-56.500	0.8671	1.924	0.06429
63,000	0.08150	3.5029	-69.700	-56.500	0.8671	1.833	0.06127
64,000	0.07767	3.5881	-69.700	-56.500	0.8671	1.747	0.05840
65,000	0.07403	3.6754	-69.700	-56.500	0.8671	1.665	0.05566

Figure A1-6

DENSITY ALTITUDE

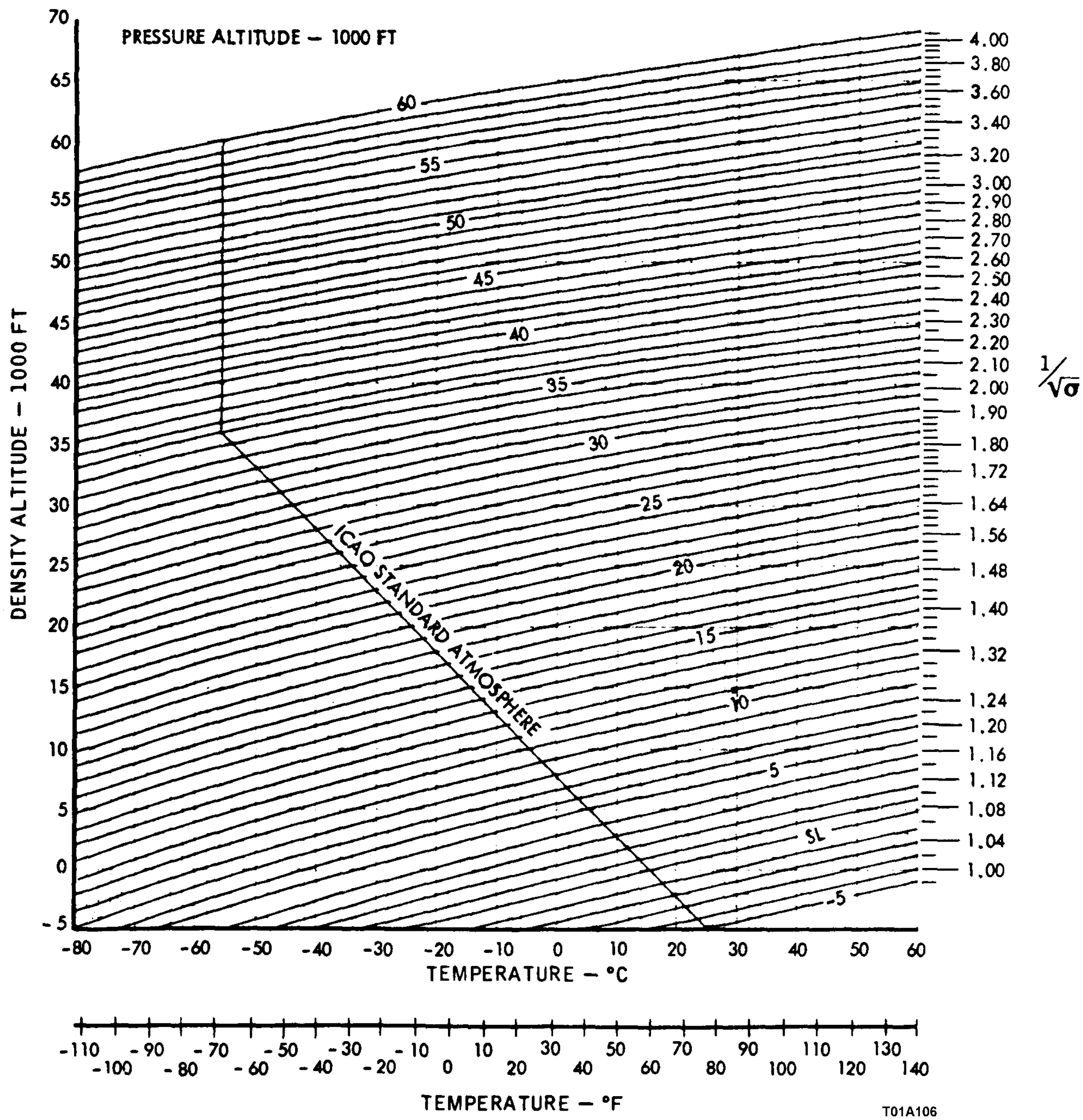
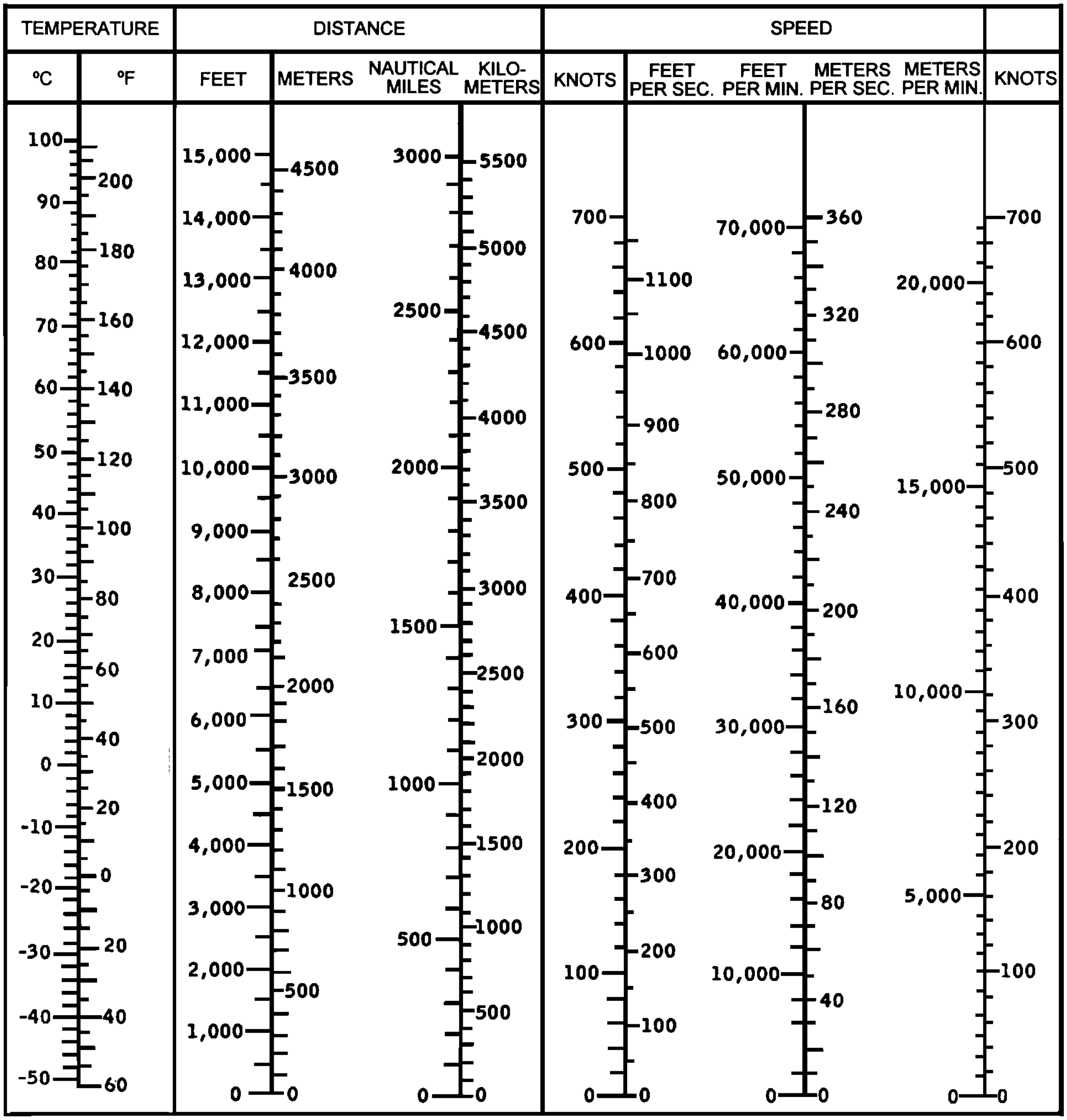


Figure A1-7

STANDARD CONVERSION TABLE



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TAKEOFF

PART 2

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WIND COMPONENTS

A takeoff and landing wind components chart (Figure A2-1) is provided to enable the pilot to convert surface winds to headwind and crosswind components. The headwind component is used to compute takeoff and landing data. The crosswind component is used to determine the feasibility of operations. Maximum recommended 90 degree crosswind components for dry runways is 30 knots, for wet runways 20 knots, and for icy runways and those containing standing water (SW) 10 knots. These limits are depicted on the wind components chart (Figure A2-1).

USE OF WIND COMPONENTS CHART

The chase-thru lines (Figure A2-1) show a 35-degree right crosswind of 42 knots. The headwind component is 34 knots, and the crosswind component is 24 knots.

TAKEOFF FACTOR

The takeoff factor is a number which is common to all takeoff charts for a given thrust rating and atmospheric condition. The takeoff factor chart (Figure A2-2) shows the takeoff factor as a function of pressure altitude, runway air temperature, and thrust rating, including the effect of the anti-ice system operation.

USE OF TAKEOFF FACTOR CHART

The chase-thru lines on Figure A2-2 show a runway air temperature of 15ºC and a pressure altitude of 4,000 feet that give takeoff factors of 3.45 and 5.25 for MAX and MIL thrust respectively.

TAKEOFF SPEED

Takeoff speed is the speed at which the main gear lifts off the runway. The takeoff speed chart (Figure A2-3) enables the pilot to determine normal takeoff speed and the climb speed to be attained to clear a 50-foot obstacle.

USE OF TAKEOFF SPEED CHART

The chase-thru lines on Figure A2-3 show the normal takeoff speed for an aircraft with a gross weight of 11,800 pounds is 154 KIAS.

TAKEOFF DISTANCE

Takeoff distance is ground run distance in feet to liftoff. Takeoff distance to clear a 50-foot obstacle is ground run distance in feet to liftoff plus the air distance to clear a 50-foot obstacle. The takeoff distance charts (Figure A2-4 and Figure A2-5), show ground run distance and total distance to clear a 50-foot obstacle as a function of takeoff factor, gross weight, wind velocity and runway slope, for takeoff on a dry, hard surface runway. The charts show data for normal takeoffs at MAX or MIL thrust, using the normal takeoff procedures given in Section II. For large takeoff factors and heavy gross weights that occur with MIL thrust, the normal takeoff speed is increased by $_{\Delta}$VM to assure 100 ft/min rate of climb with two engines operating.

NOTE

> Drag associated with the WSSP does not significantly increase ground run distance.

USE OF TAKEOFF DISTANCE CHARTS

The chase-thru lines on Figure A2-4 show a maximum thrust takeoff for a gross weight of 11,800 pounds, headwind of 10 knots, and a takeoff factor of 3.45. The resulting normal ground run distance is 3,050 feet. The corresponding total distance to clear a 50-foot obstacle is 4,600 feet (Figure A2-5).

EFFECT OF RUNWAY CONDITION READING

Runway Condition Reading (RCR) is a number that indicates the degree of braking friction on the runway surface. RCR 5 is icy, RCR 12 is wet, and RCR 23 and above is dry. On slippery runways, the critical field length is increased, which may cause an increase in the minimum acceleration speed check. The refusal speed and critical engine failure speeds are decreased (when compared to dry, hard surfaced runways).

CRITICAL FIELD LENGTH

Critical field length is the total runway length required to accelerate with both engines operating to the critical engine failure speed, experience an engine failure, then either continue to takeoff or stop in the same distance. The critical field length is shown for MAX thrust on Figure A2-6. For single-engine takeoff at large takeoff factors and heavy gross weights, the normal takeoff speed is increased by $_{\Delta}V_{SE}$ to assure 100 feet per minute rate of climb.

USE OF CRITICAL FIELD LENGTH CHART

The chase-thru lines on Figure A2-6 show that at a takeoff factor of 3.45 and a gross weight of 11,800 pounds, $_{\Delta}V_{SE}$ is 9 knots. The chase-thru lines further show that with a 10-knot headwind, the Critical Field Length for an RCR of 23 is 5,800 feet and is increased to 6,500 feet for an RCR of 12. The Single Engine Takeoff Speed is normal takeoff speed plus $_{\Delta}V_{SE}$; 154 + 9 = 163 KIAS.

REFUSAL SPEED

Refusal speed is the maximum speed to which the aircraft can accelerate and then stop in the remaining runway length. Stopping distance data in the refusal speed charts (Figure A2-7 and Figure A2-8) are for two engines at MAX or MIL thrust on a dry hard surface runway. At refusal speed, a 3-second delay is allowed to recognize engine failure during which time acceleration continues. At the end of this period, throttles are pulled to idle and optimum braking is applied in a three-point attitude. While braking, one engine is windmilling and one engine is at idle thrust.

CRITICAL ENGINE FAILURE SPEED

Critical engine failure speed is the speed to which the aircraft will accelerate with both engines, experience an engine failure, and permit either acceleration to takeoff or deceleration to a stop in the same distance. Data for critical engine failure speed is presented in Figure A2-7. If a critical engine failure speed computes to less than 110 KIAS, use 110 KIAS as the critical engine failure speed. When an RCR factor is present, use the full computed critical engine failure speed corrected for RCR.

USE OF REFUSAL SPEED CHARTS OR CRITICAL ENGINE FAILURE SPEED CHARTS

The chase-thru lines on Figure A2-7 show a refusal speed of 133 KIAS for a takeoff factor of 3.45 at gross weight of 11,800 pounds on a 7,000-foot runway for an RCR of 23. Correcting for an RCR of 12 reduces the refusal speed to 106 KIAS. A 10-knot headwind increases the refusal speed to 143 KIAS for an RCR of 23 and 116 KIAS for an RCR of 12. For a takeoff factor of 3.45 at gross weight 11,800 pounds and a critical field length of 5,800 feet, the critical engine failure speed is 122 KIAS for an RCR of 23. An RCR of 12 results in a critical engine failure speed of 102 KIAS. Adding the 10-knot headwind increases these speeds to 132 KIAS for an RCR of 23 and 112 KIAS for an RCR of 12. If critical engine failure speed computes to less than 110 KIAS, use 110 KIAS as critical engine failure speed. (Exception: If an RCR factor is present, use the actual computed speed as critical engine failure speed.)

TAKEOFF ABORT CHARTS (GENERAL)

The takeoff abort charts contained in Figure A2-6 through Figure A2-10 provide the means of planning for a GO-NO-GO decision should an engine fail during takeoff. A discussion is provided to illustrate the factors that influence the decision to stop or go. A detailed description of each abort chart is provided in the preceding paragraphs. The principal factor affecting aborted takeoff is the relationship of actual runway length to critical field length. This relationship falls into three categories as follows:

CATEGORY I. Runway Length Greater than Critical Field Length. (Refusal speed exceeds critical engine failure speed.)

a. If engine failure occurs below critical engine failure speed: Aircraft should be stopped, as runway length will be sufficient for stopping. Takeoff distance increases as engine failure speed decreases and may exceed the runway length under certain conditions.

b. If engine failure occurs between critical engine failure speed and refusal speed: Takeoff should normally be continued; however, aircraft can take off or stop within remaining distance.

c. If engine failure occurs above refusal speed: Aircraft must continue takeoff as it would overrun runway in stopping. Sufficient runway for takeoff will be available.

CATEGORY II. Runway Length Same as Critical Field Length. Refusal speed and critical engine failure speed coincide; therefore, aircraft must be stopped if below critical engine failure speed and should continue takeoff if above the coincidence speed. Runway will be adequate for either condition.

CATEGORY III. Runway Length Less than Critical Field Length. (Refusal speed less than critical engine failure speed.) This is the most critical category. If flight operations are to be conducted under these conditions, decision speed (Figure A2-9) must be used as the Go-No-Go factor. If engine failure occurs between refusal speed and decision speed, the takeoff must be aborted, even though barrier engagement can be expected. If engine failure occurs after decision speed, sufficient runway for takeoff should be available, and takeoff should be continued.

DECISION SPEED

Decision speed is the minimum speed at which the aircraft can experience an engine failure and still accelerate to single-engine takeoff speed in the remaining runway. If the decision speed is greater than the dual engine takeoff speed, then the decision speed is equivalent to the takeoff speed. The decision speed is found on Figure A2-9.

USE OF DECISION SPEED CHART

The chase-thru line on Figure A2-9 shows a decision speed of 102 KIAS for a takeoff factor of 3.45 at a gross weight of 11,800 pounds on a 7,000-foot runway with a 10-knot headwind, and $_{\Delta}V_{SE}$ = 9 knots (Figure A2-6).

VELOCITY DURING TAKEOFF GROUND RUN

The velocity during takeoff ground run chart shows the relationship between KIAS and distance traveled during ground run on a dry, hard surface runway. The two-engine velocity during takeoff ground run chart (Figure A2-10), is used to check acceleration performance. Compute the minimum acceleration check speed for a point 2,000 feet from brake release. If the takeoff run is less than 3,000 feet, compute minimum acceleration check speed for a point 1,000 feet from brake release. Under certain slippery runway conditions, the minimum acceleration check speed may be above the corrected critical engine failure speed. When this occurs, adjust the acceleration check distance to any usable value up to 2,000 feet from brake release that will result in a minimum acceleration check speed equal to or less than the critical engine failure speed corrected for RCR. The forecast speed at this point is the normal acceleration check speed. Minimum acceleration check speed (MACS, Figure A2-10) is the minimum acceptable speed at the check distance with which takeoff should be continued. The single-engine velocity during ground run (Figure A2-11) is used to evaluate single-engine takeoff acceleration performance.

USE OF TWO-ENGINE VELOCITY DURING TAKEOFF GROUND RUN CHART

Assume a takeoff weight of 11,800 pounds, a runway temperature of 15ºC, RCR of 12, a pressure altitude of 4,000 feet, and a 10-knot headwind. Enter the chart at the takeoff speed 155 KIAS (Figure A2-3) and ground run distance of

3,000 feet (Figure A2-4). From the point of intersection of these lines, draw a line parallel to the guideline. Enter Figure A2-10 at ground run distance of 2,000 feet. Proceed vertically to intersection with constructed airspeed guideline and read airspeed of 129 knots from the left side of the chart. This is the velocity at a point 2,000 feet from brake release. Since this acceleration check speed is above the corrected critical engine failure speed of 112 KIAS (Figure A2-7), reenter chart at ground run distance of 1,500 feet. Proceed vertically to intersection with constructed airspeed guideline and read airspeed of 110 knots from the left side of the chart. This is the velocity at 1,500 feet from brake release.

USE OF SINGLE-ENGINE VELOCITY DURING TAKEOFF GROUND RUN CHART

Assume a takeoff weight of 11,800 pounds, a runway air temperature of 15ºC, a pressure altitude of 4,000 feet, and a 10-knot headwind. Enter Figure A2-11 at the runway temperature 15ºC, right horizontally to the pressure altitude of 4,000 feet, down vertically to the aircraft gross weight 11,800 pounds, left horizontal to the baseline. Draw a line that parallels the guideline. Assume an engine failure at 120 KIAS and it is desired to find the distance necessary to accelerate to 160 KIAS. Enter the chart at the no-wind groundspeed of 110 knots (120 minus 10 knots headwind) and 150 knots (160 minus 10 knots headwind). Read the distances for 110 knots no wind (3,600) and 150 knots no wind (7,400). The difference between the noted distances (7,400 minus 3,600) is 3,800 feet and is the distance necessary to accelerate to 160 KIAS.

Figure A2-1

TAKEOFF AND LANDING WIND COMPONENTS

MODEL: T-38A
DATA: 1 AUGUST 1965
DATA BASIS: **FLIGHT TEST**

20 & 10 KNOT CROSSWIND COMPONENTS ARE CALCULATED

ENGINE: (2) J85-GE-5
FUEL: JP-4
FUEL DENSITY: 6.5 LB/US GAL

NOTE

Enter chart with steady wind to determine headwind component and with maximum gust velocity to determine crosswind component.

MAXIMUM RECOMMENDED CROSSWIND COMPONENT —·—·—·—·—·

SW – STANDING WATER

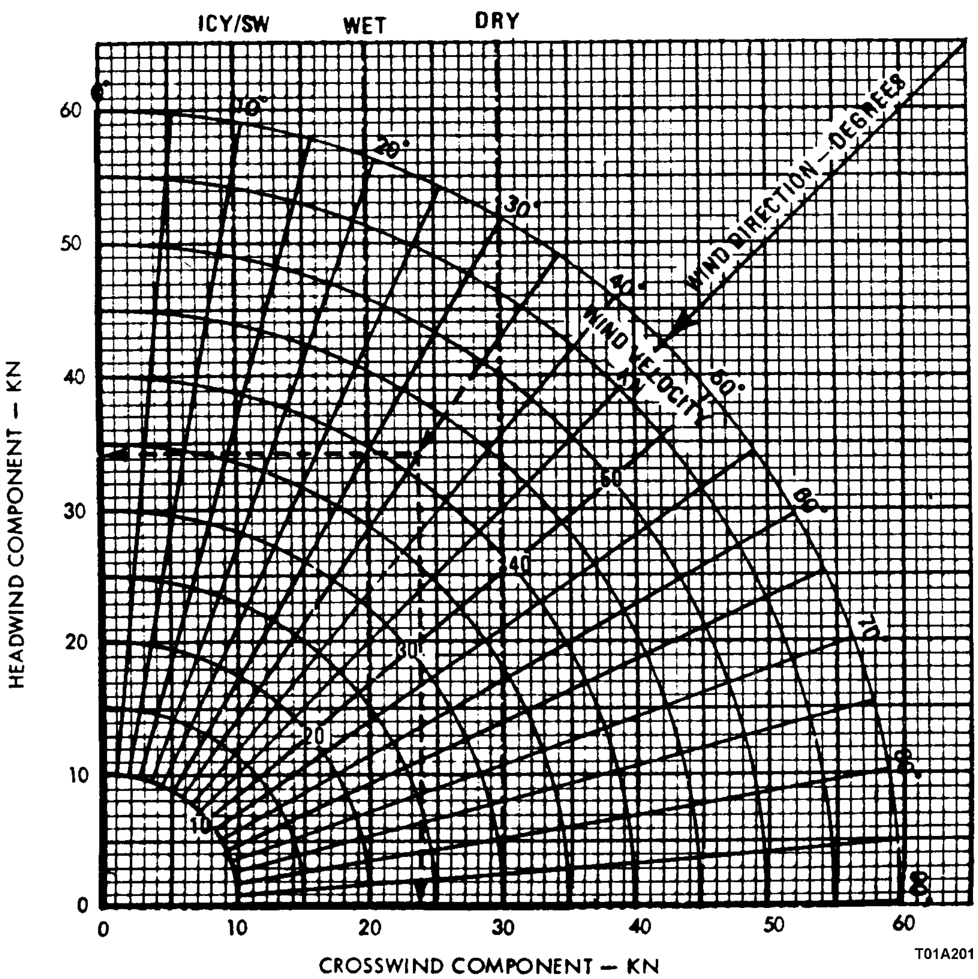

Figure A2-2

TAKEOFF FACTOR

MODEL: T-38A
DATA: 1 AUGUST 1965
DATA BASIS: **FLIGHT TEST**

ENGINE: (2) J85-GE-5
FUEL: JP-4
FUEL DENSITY: 6.5 LB/US GAL

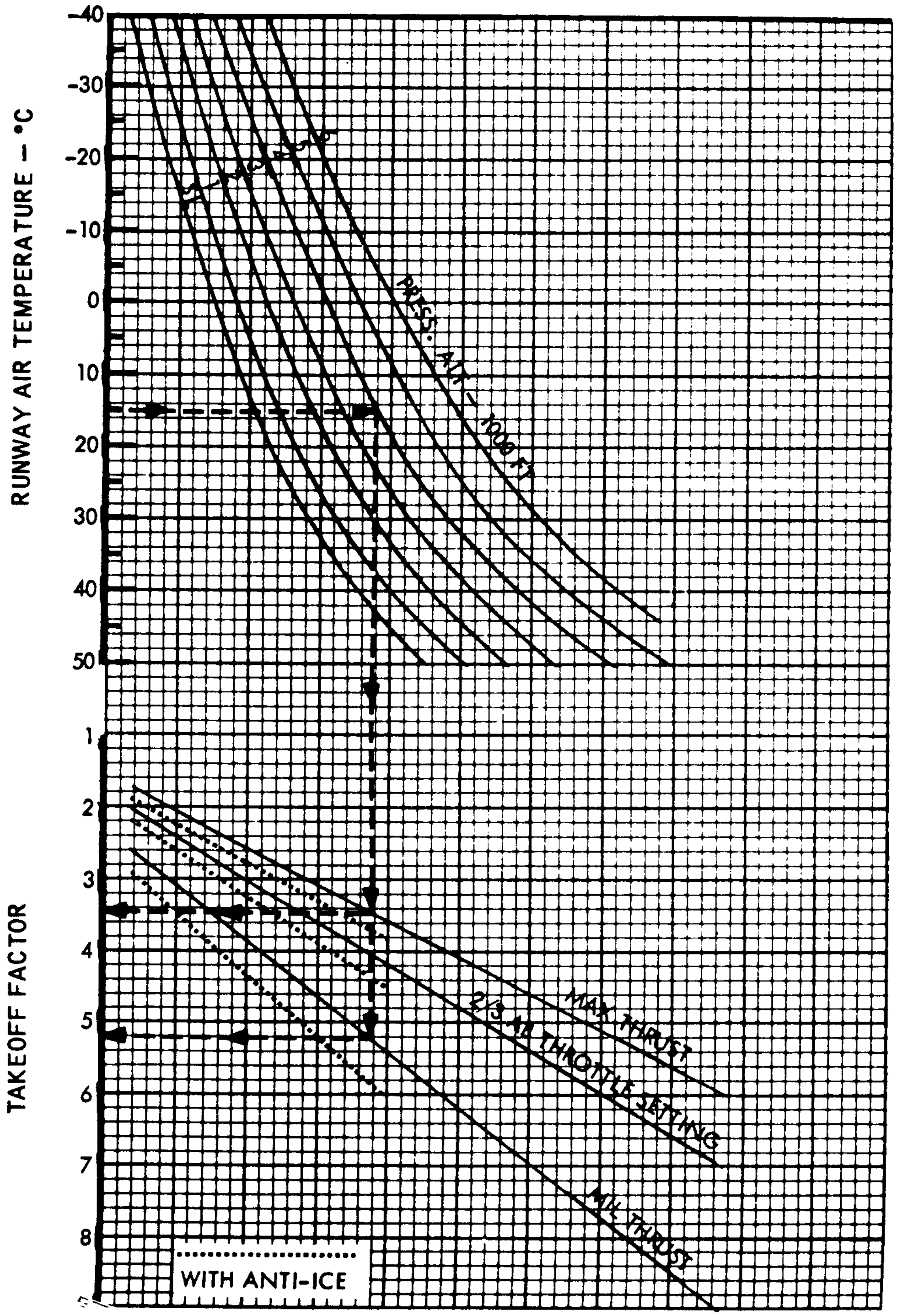

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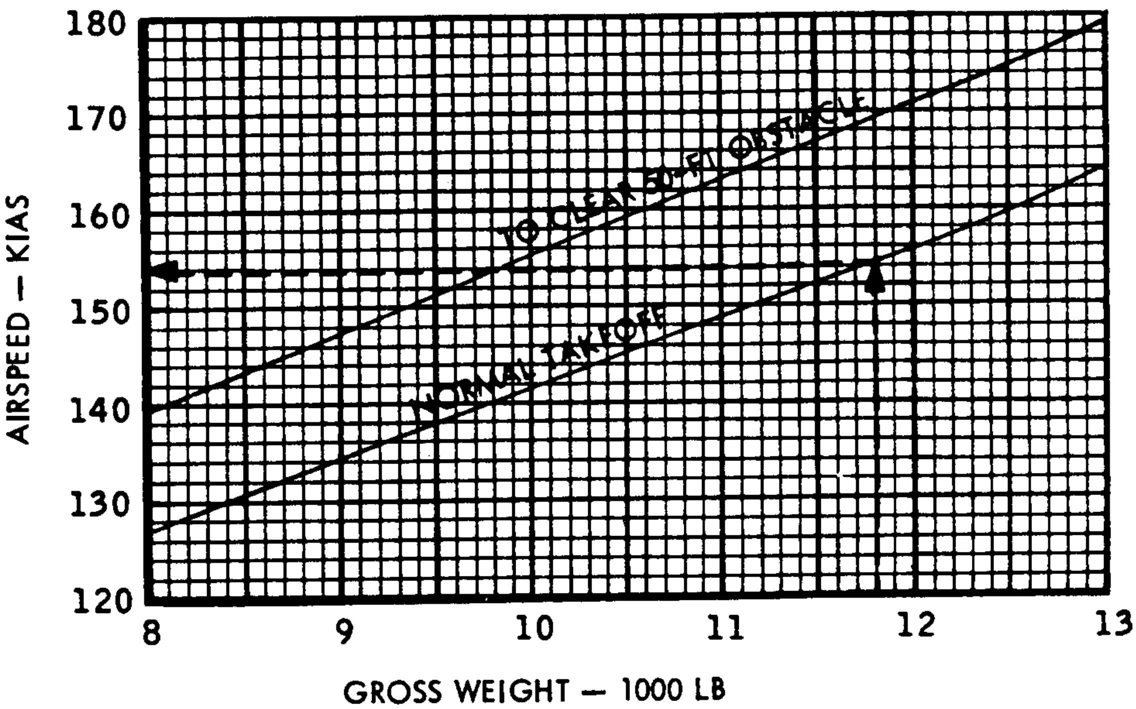
Figure A2-3

TAKEOFF SPEED

FLAPS – 60%

MODEL: T-38A
DATA: 1 OCTOBER 1976
DATA BASIS: **ESTIMATED DATA**

ENGINE: (2) J85-GE-5
FUEL: JP-4
FUEL DENSITY: 6.5 LB/US GAL



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NOTE

- For MIL thrust takeoff, add ΔV_M from Takeoff Distance Chart (Figure A2-4) to takeoff speed.
- For single-engine takeoff, add ΔV_{SE} from Critical Field Length Chart (Figure A2-6) to takeoff speed.

Figure A2-4

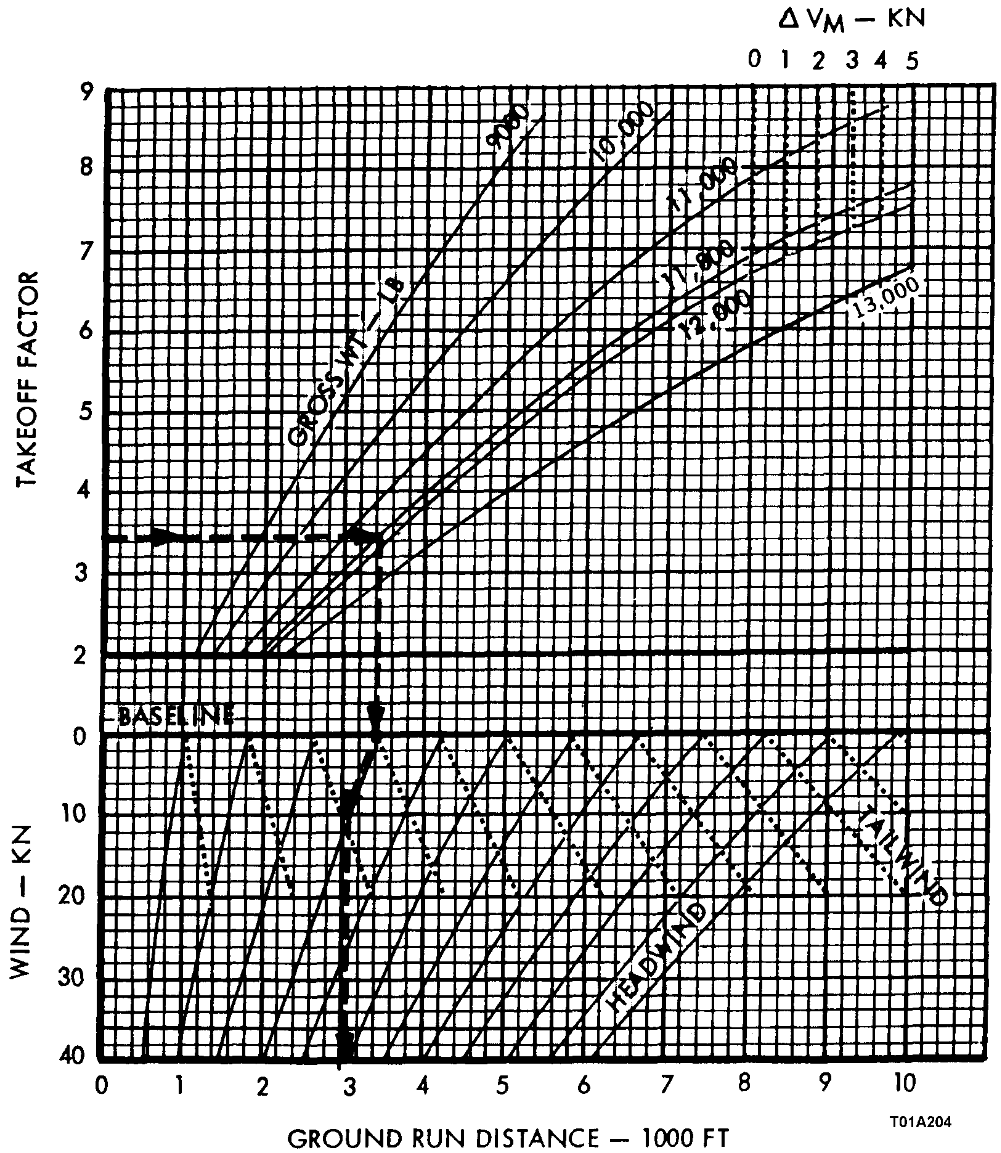
TAKEOFF DISTANCE

DRY, HARD-SURFACED RUNWAY

FLAPS – 60%

MODEL: T-38A
DATA: 1 OCTOBER 1976
DATA BASIS: **ESTIMATED DATA**

ENGINE: (2) J85-GE-5
FUEL: JP-4
FUEL DENSITY: 6.5 LB/US GAL



NOTE

- Add ΔV_M to takeoff speed (Figure A2-3).
- Increase ground run distance 5 percent for each percent of uphill runway slope.
- With the WSSP/MXU-648/SUU-11 installed, add 6 percent to the computed ground run distance.
- With the SUU-20 installed, add 10 percent to the computed ground run distance.

Figure A2-5

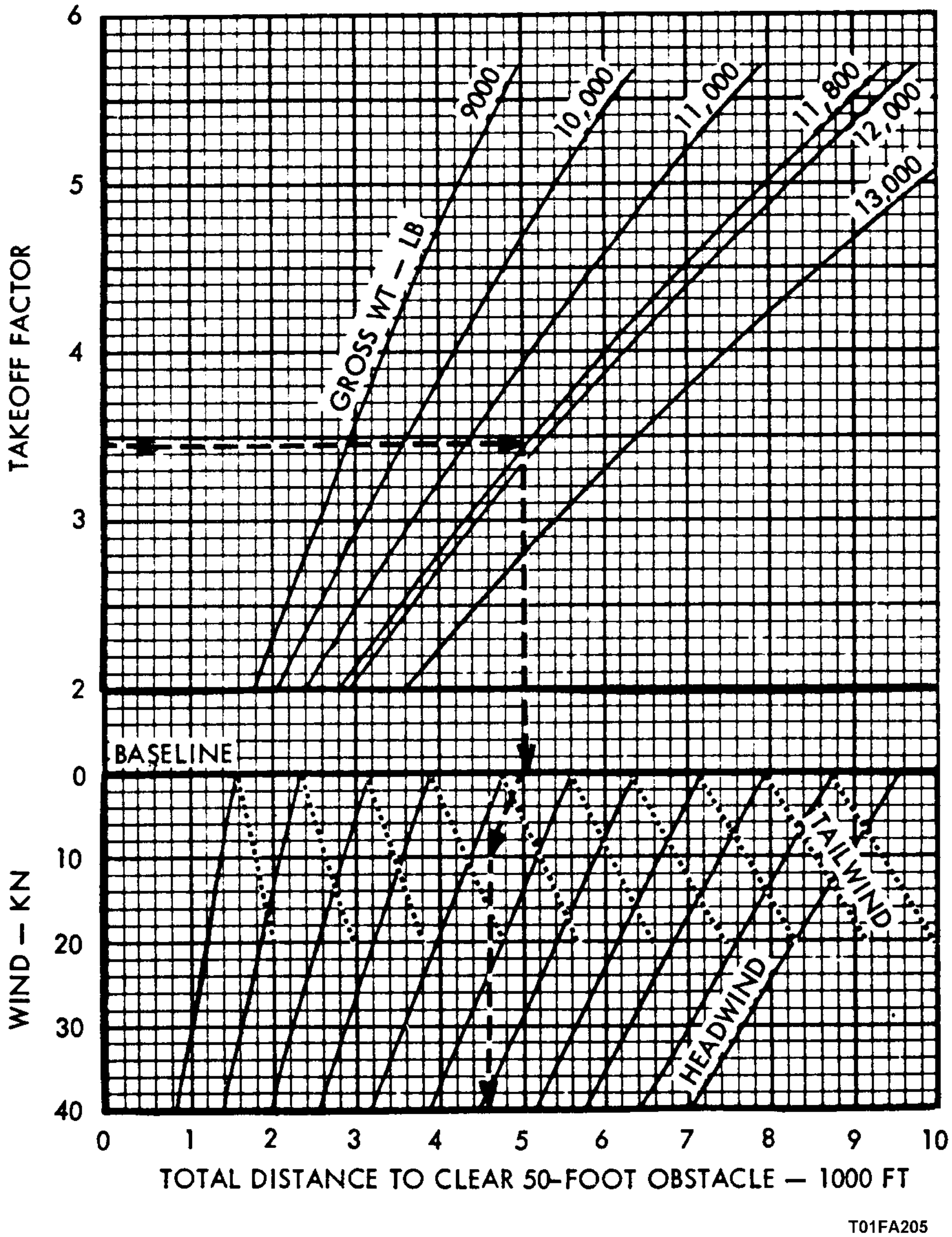
TAKEOFF DISTANCE TO CLEAR 50-FOOT OBSTACLE

DRY, HARD-SURFACED RUNWAY

FLAPS – 60%

MODEL: T-38A
DATA: 1 AUGUST 1965
DATA BASIS: **FLIGHT TEST**

ENGINE: (2) J85-GE-5
FUEL: JP-4
FUEL DENSITY: 6.5 LB/US GAL



NOTE

Increase total distance 5 percent for each percent of uphill runway slope.

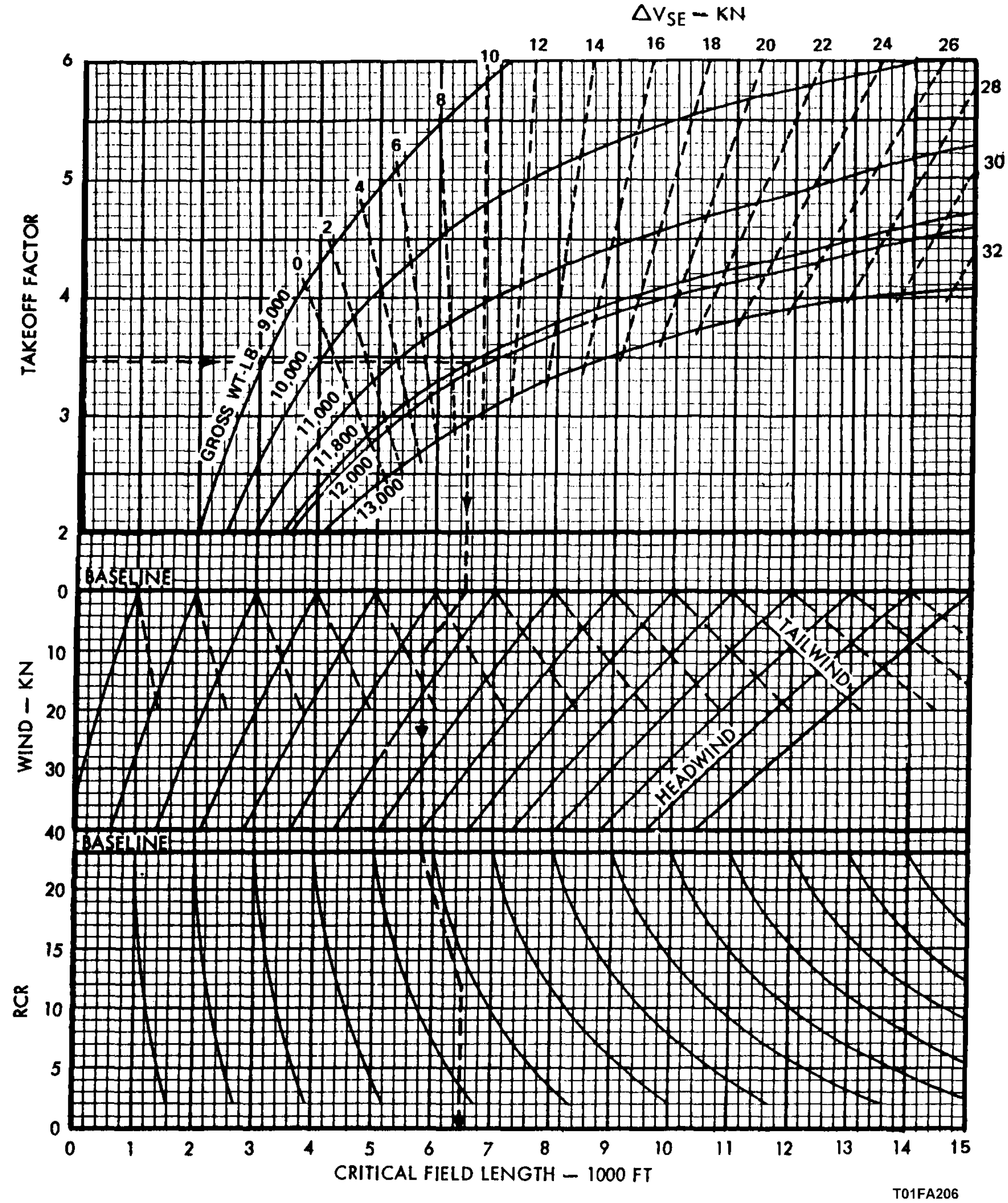
Figure A2-6

CRITICAL FIELD LENGTH

MAX THRUST
FLAPS – 60%

MODEL: T-38A
DATA: 1 AUGUST 1981
DATA BASIS: **ESTIMATED DATA**

ENGINE: (2) J85-GE-5
FUEL: JP-4
FUEL DENSITY: 6.5 LB/US GAL



NOTE

- For single-engine takeoff speed, add ΔV_{SE} to takeoff speed.
- Increase critical field length 5 percent for each percent of uphill runway slope.
- With the WSSP/MXU-548/SUU-11/SUU-20 installed, increase the critical field length by the same distance that the takeoff distance was increased.

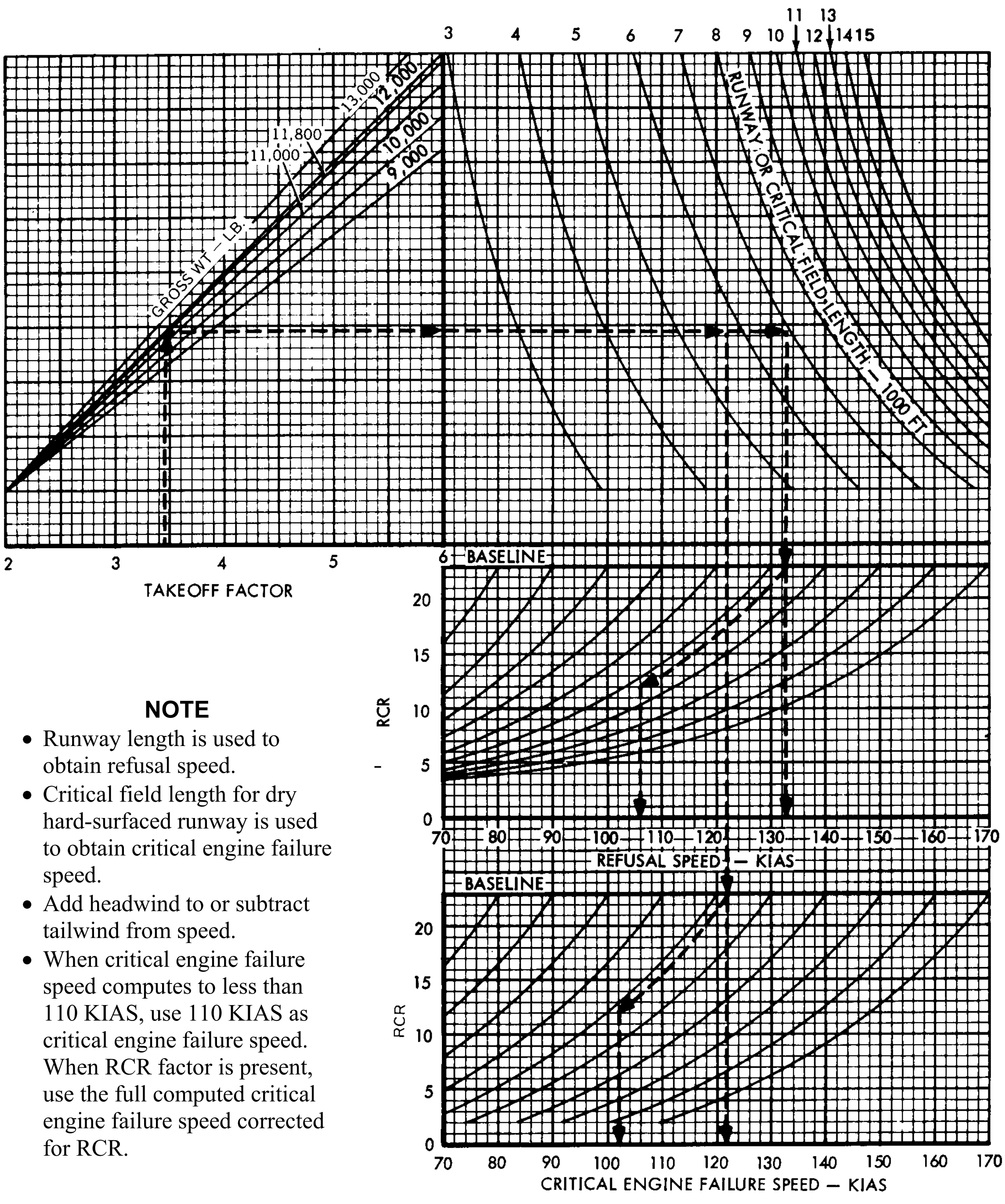
Figure A2-7

REFUSAL SPEED OR CRITICAL ENGINE FAILURE SPEED

MAX THRUST
FLAPS – 60%

MODEL: T-38A
DATA: 1 AUGUST 1981
DATA BASIS: **ESTIMATED DATA**

ENGINE: (2) J85-GE-5
FUEL: JP-4
FUEL DENSITY: 6.5 LB/US GAL



NOTE

- Runway length is used to obtain refusal speed.
- Critical field length for dry hard-surfaced runway is used to obtain critical engine failure speed.
- Add headwind to or subtract tailwind from speed.
- When critical engine failure speed computes to less than 110 KIAS, use 110 KIAS as critical engine failure speed. When RCR factor is present, use the full computed critical engine failure speed corrected for RCR.

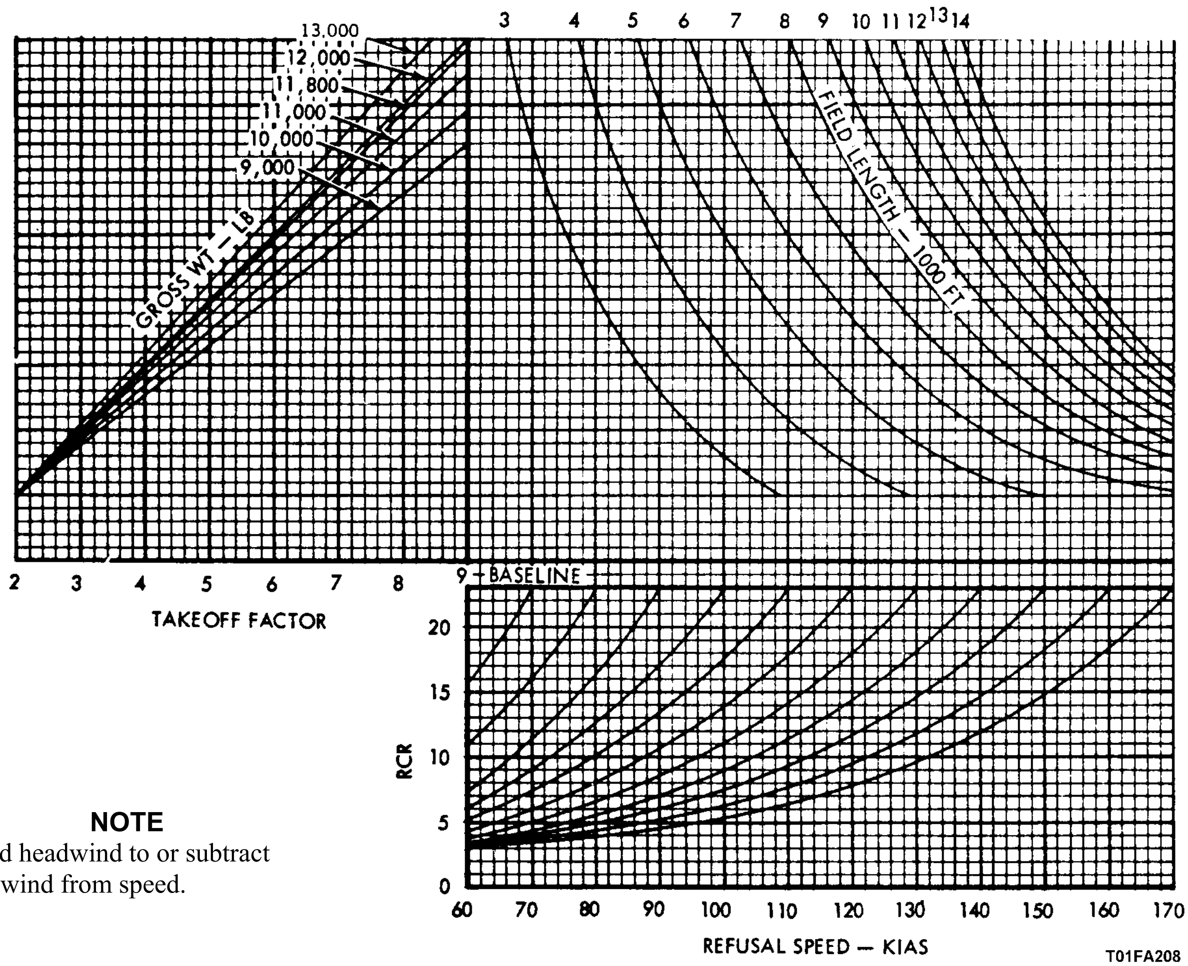
Figure A2-8

REFUSAL SPEED

MAX THRUST
FLAPS – 60%

MODEL: T-38A
DATA: 1 JULY 1978
DATA BASIS: **ESTIMATED DATA**

ENGINE: (2) J85-GE-5
FUEL: JP-4
FUEL DENSITY: 6.5 LB/US GAL



NOTE
Add headwind to or subtract tailwind from speed.

Figure A2-9

DECISION SPEED

MAX THRUST
DRY, HARD-SURFACED RUNWAY
FLAPS – 60%

MODEL: T-38A
DATA: 1 JULY 1978
DATA BASIS: **ESTIMATED DATA**

ENGINE: (2) J85-GE-5
FUEL: JP-4
FUEL DENSITY: 6.5 LB/US GAL

NOTE
Obtain ΔV_{SE} from critical Field Length Chart (Figure A2-6).

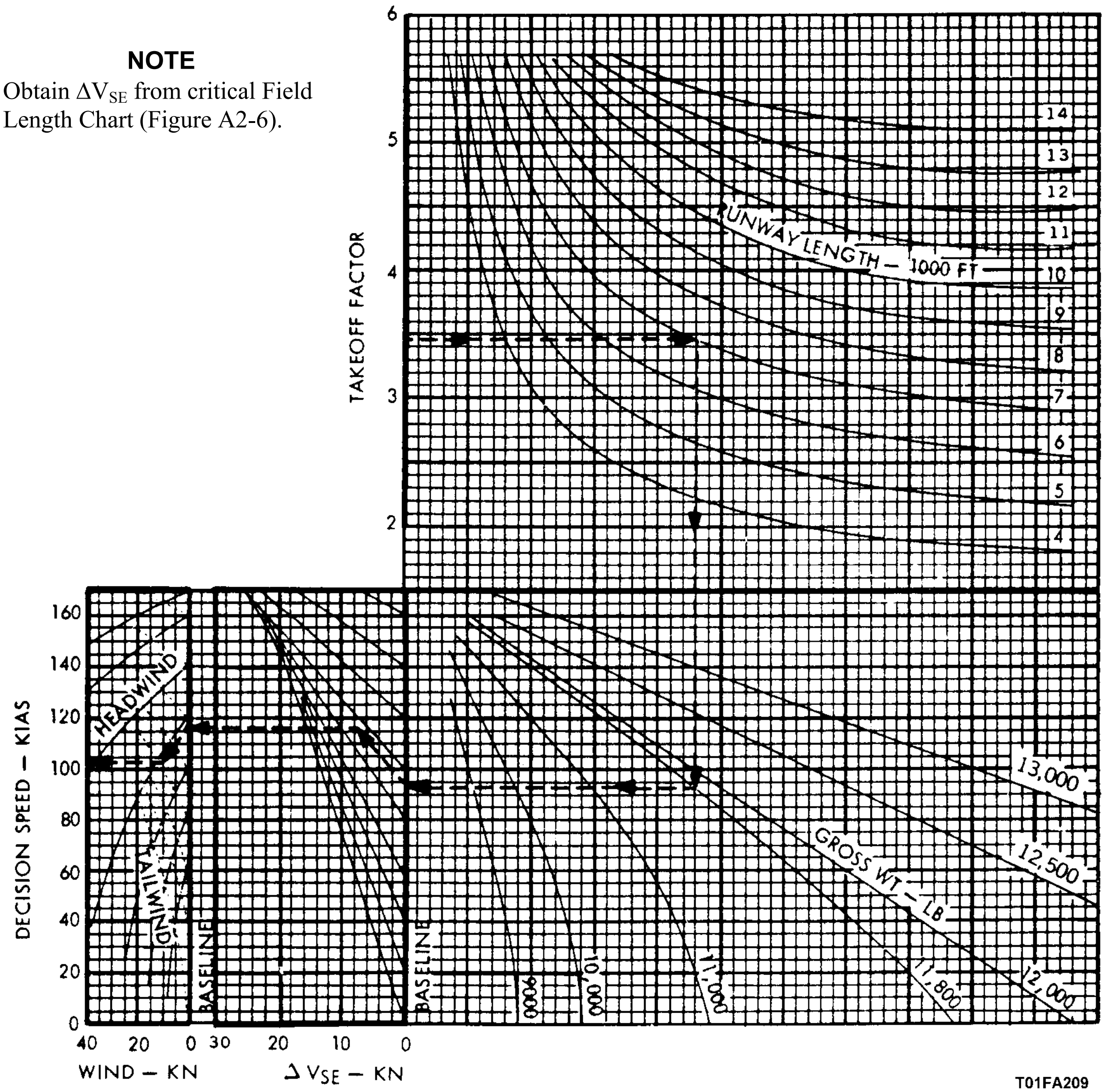


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Figure A2-10

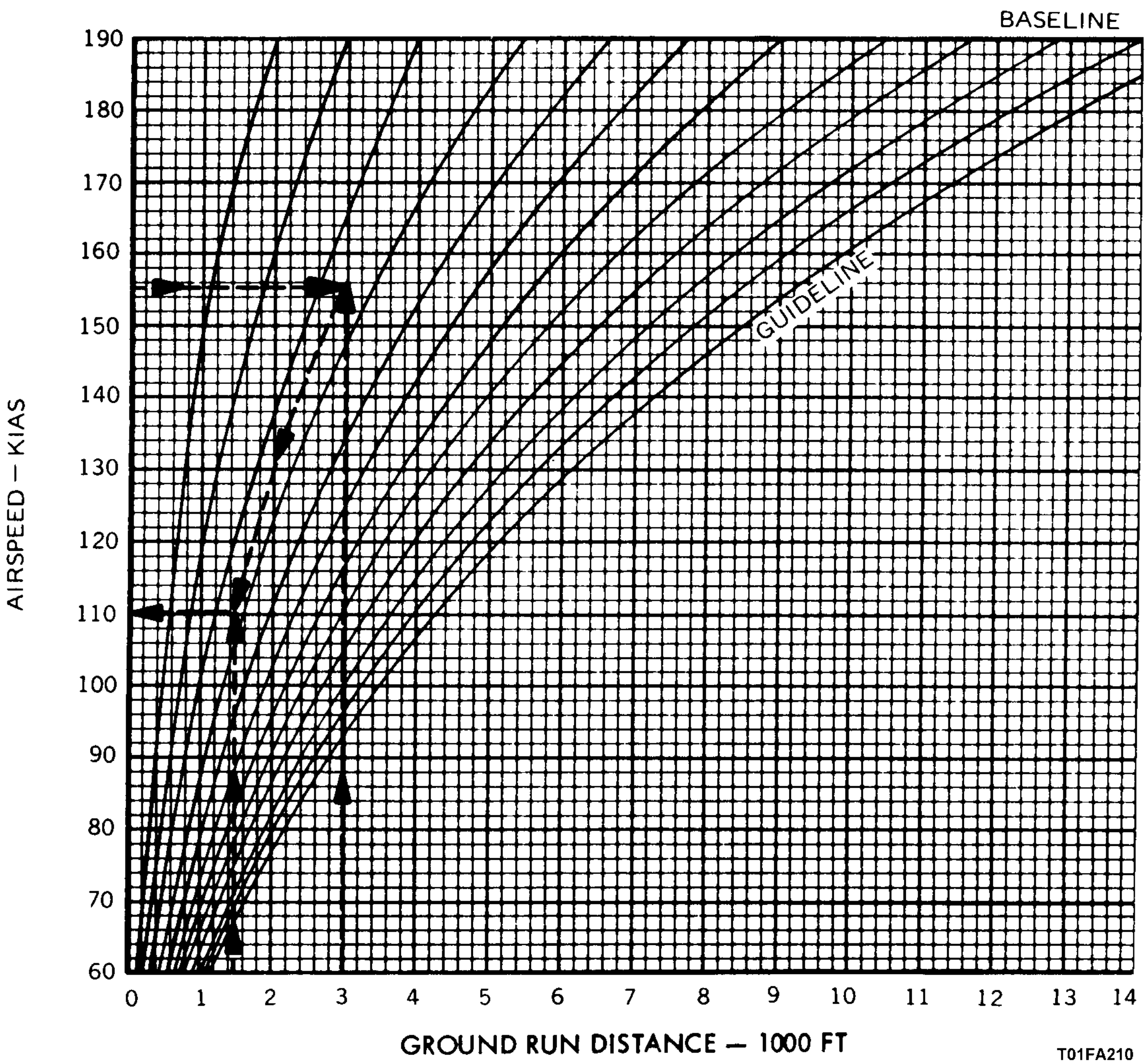
VELOCITY DURING TAKEOFF GROUND RUN

DRY, HARD-SURFACED RUNWAY

FLAPS – 60%

MODEL: T-38A
DATA: 1 JULY 1978
DATA BASIS: **ESTIMATED DATA**

ENGINE: (2) J85-GE-5
FUEL: JP-4
FUEL DENSITY: 6.5 LB/US GAL



NOTE

To compute MACS, subtract 3 knots for each 1,000 feet of runway in excess of the critical field length, not to exceed 10 knots.

Figure A2-11

VELOCITY DURING TAKEOFF GROUND RUN

MAXIMUM THRUST
FLAPS – 60%

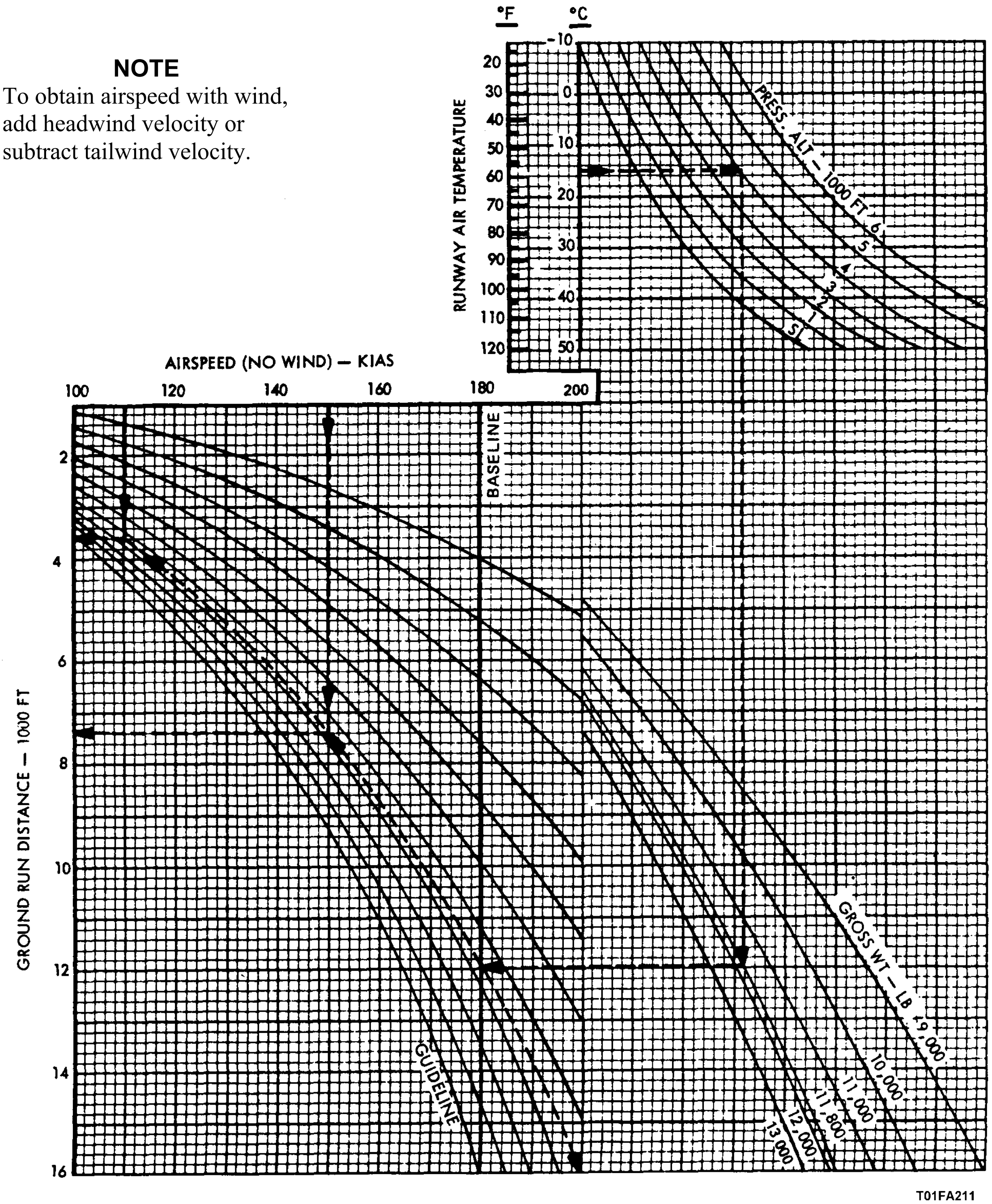
SINGLE ENGINE

MODEL: T-38A
DATA: 1 JULY 1978
DATA BASIS: **ESTIMATED DATA**

ENGINE: (2) J85-GE-5
FUEL: JP-4
FUEL DENSITY: 6.5 LB/US GAL

NOTE

To obtain airspeed with wind, add headwind velocity or subtract tailwind velocity.



CLIMB

PART 3

TABLE OF CONTENTS

PURPOSE OF CHARTS

The charts provide a means of determining the aircraft climb performance. Included are ceilings to which the aircraft may climb in the performance of missions.

CLIMB CHARTS

The climb charts (Figure A3-1 through Figure A3-5) show the climb performance for MIL thrust for both two engines and single engine and MAX thrust for two engines. Two-engine MIL and MAX thrust climb charts are included for both restricted and unrestricted climb schedules. The restricted climb charts (Figure A3-1 and Figure A3-3) show performance data which reflects a MIL thrust climb at 300 KCAS to 10,000 feet followed by a level acceleration to unrestricted climb speed and continuation of climb. The restricted climb charts should be used for all climbs not performed in a military climb corridor. The unrestricted climb charts MIL and MAX THRUST CLIMB (Figure A3-2 and Figure A3-4) are used when a military climb corridor is available. All of the charts show climb performance in terms of gross weight versus fuel used, time, and distance. Climb speed schedules and allowances prior to climb are provided on each chart. The charts require successive approximations when climbing from an altitude other than sea level. The fuel, air distance, and time shown include the effects of kinetic energy change and weight reduction during climb. The fuel allowance for taxi, takeoff, and acceleration to climb speed is noted and should be subtracted from gross weight before entering the chart when climb follows a takeoff.

USE OF CLIMB CHARTS

The chase-thru lines on the MIL thrust restricted climb chart (Figure A3-1) show 565 pounds of fuel used in climb from sea level to 35,000 feet pressure altitude at an initial gross weight of 11,500 pounds and a temperature 10ºC hotter than standard day. The corresponding time and air distance are 8.3 minutes and 67 nautical miles, respectively. Had the initial altitude been 15,000 feet and the gross weight 11,270 pounds, by using successive approximations, the sea level gross weight would be 11,500 pounds (same as above). From sea level to 15,000 feet, the fuel used, time, and distance are 290 pounds, 3.0 minutes, and 23 miles, respectively. Then from 15,000 feet to 35,000 feet, the fuel used is 275 pounds (565 - 290), 5.3 minutes (8.3 - 3.0), and the distance is 44 nautical miles (67 - 23). The MIL thrust climb charts (Figure A3-2) show that 480 pounds of fuel are required to climb from sea level to 35,000 feet, and correspondingly, it takes 7.3 minutes and 62 nautical miles. This climb is started at 11,400 pounds; however, since 95 more pounds of fuel are required for acceleration to climb speed, the MIL thrust restricted climb and the MIL thrust climb from 15,000 feet to 35,000 feet are identical.

OPTIMUM CRUISE-CLIMB ALTITUDE

The optimum cruise-climb altitude chart (Figure A3-6) shows this altitude versus gross weight for two-engine and single-engine operation. Normal thrust cruise ceilings are included and show the limitations of the optimum cruise-climb altitude.

USE OF OPTIMUM CRUISE-CLIMB ALTITUDE CHART

Assume two-engine operation and a gross weight of 10,500 pounds at end of climb. The chase-thru-lines show optimum cruise-climb altitude from Figure A3-6 is 41,200 feet. The optimum cruise-climb altitude will increase as the fuel is used in cruise. This altitude is not limited by the normal thrust cruise ceiling.

SINGLE-ENGINE SERVICE CEILING

The single-engine service ceiling chart (Figure A3-7) shows the service ceiling that can be attained by flying with MAX or MIL thrust at the climb schedules shown.

USE OF SINGLE-ENGINE SERVICE CEILING CHART

The chase-thru lines in Figure A3-7 show a single-engine service ceiling of 24,500 feet for MIL thrust and a gross weight of 10,500 pounds.

Figure A3-1 (Sheet 1 of 2)

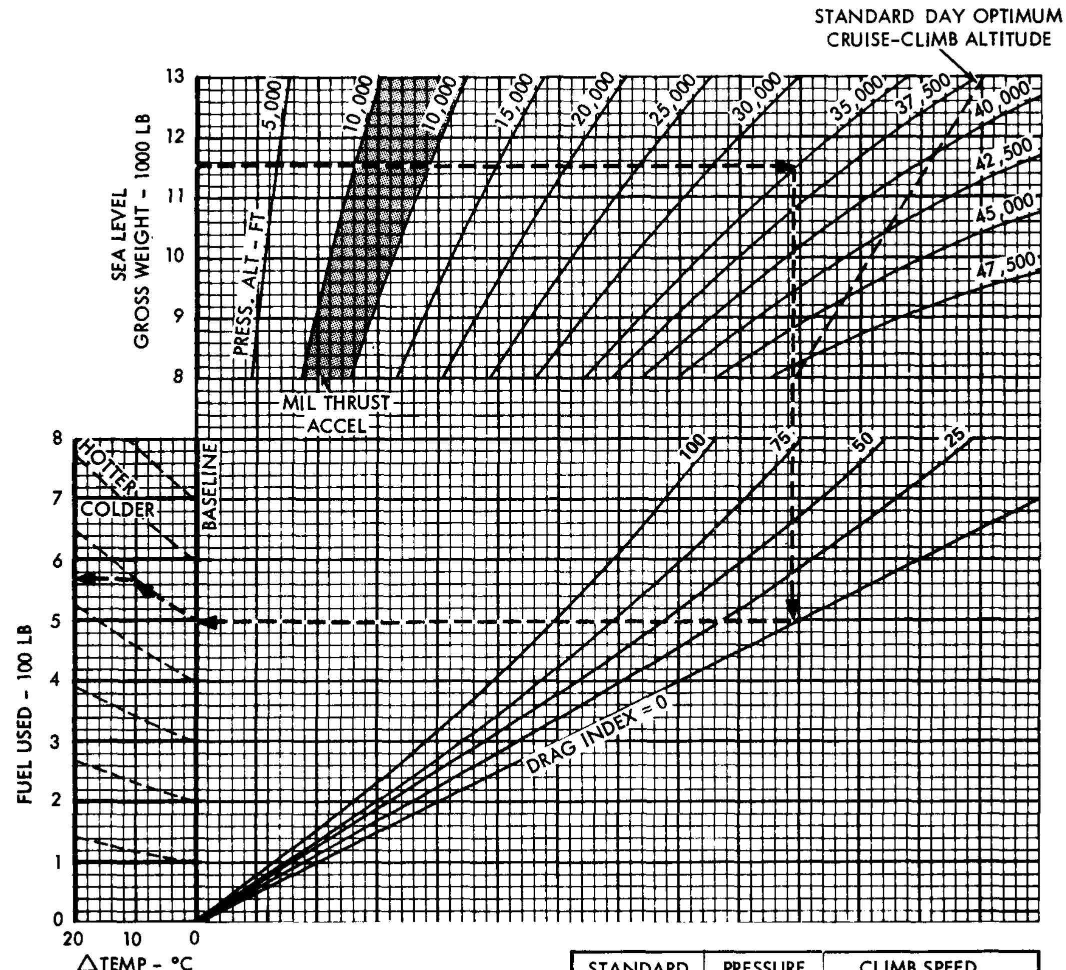
MIL THRUST CLIMB

RESTRICTED CLIMB SCHEDULE

FUEL USED

MODEL: T-38A
DATA: 1 OCTOBER 1976
DATA BASIS: **ESTIMATED DATA**

ENGINE: (2) J85-GE-5
FUEL: JP-4
FUEL DENSITY: 6.5 LB/US GAL



FUEL, TIME, AND DISTANCE ALLOWANCE PRIOR TO CLIMB	
GROUND TAXI: 18 LB/MIN	
FROM BRAKE RELEASE TO BEGIN CLIMB USING MAXIMUM THRUST	
FUEL (LB)	190
TIME (MIN)	0.6
DISTANCE (NMI)	2.0

STANDARD DAY TEMP - °C	PRESSURE ALTITUDE (FEET)	CLIMB SPEED SCHEDULE	
		KCAS	TMN
15.0	SL	300	0.45
5.1	5,000	300	0.50
-4.8	10,000	300	0.55
-4.8	10,000	435	0.78
-14.7	15,000	406	0.79
-24.6	20,000	377	0.81
-34.5	25,000	349	0.83
-44.4	30,000	322	0.84
-54.3	35,000	295	0.86
-56.5 AT	40,000	264	0.87
37,000 FT	45,000	236	0.87
& ABOVE	50,000	210	0.87

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Figure A3-1 (Sheet 2 of 2)

MIL THRUST CLIMB

RESTRICTED CLIMB SCHEDULE

TIME TO CLIMB AND DISTANCE TRAVELED

MODEL: T-38A
DATA: 1 OCTOBER 1976
DATA BASIS: **ESTIMATED DATA**

ENGINE: (2) J85-GE-5
FUEL: JP-4
FUEL DENSITY: 6.5 LB/US GAL

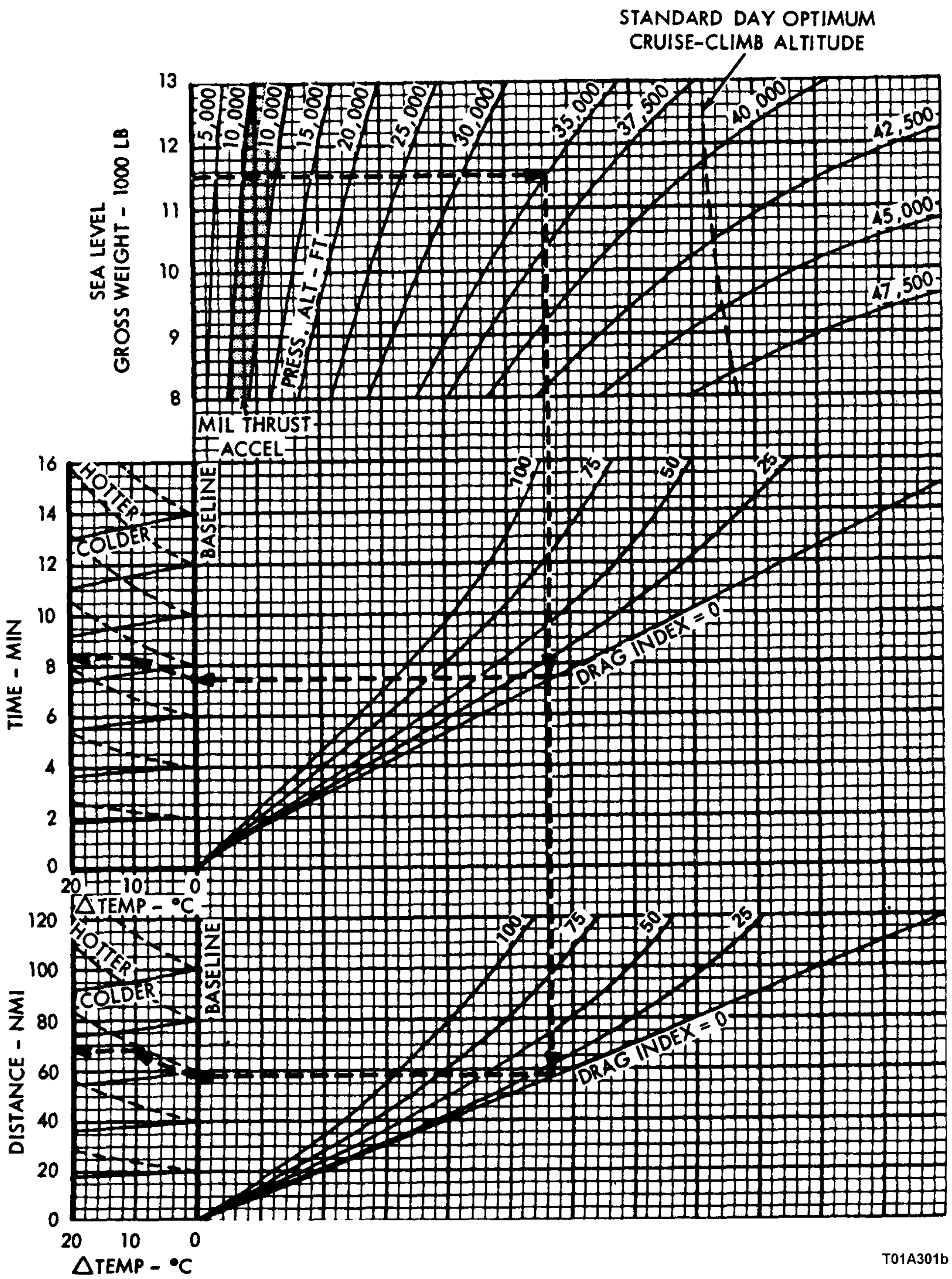


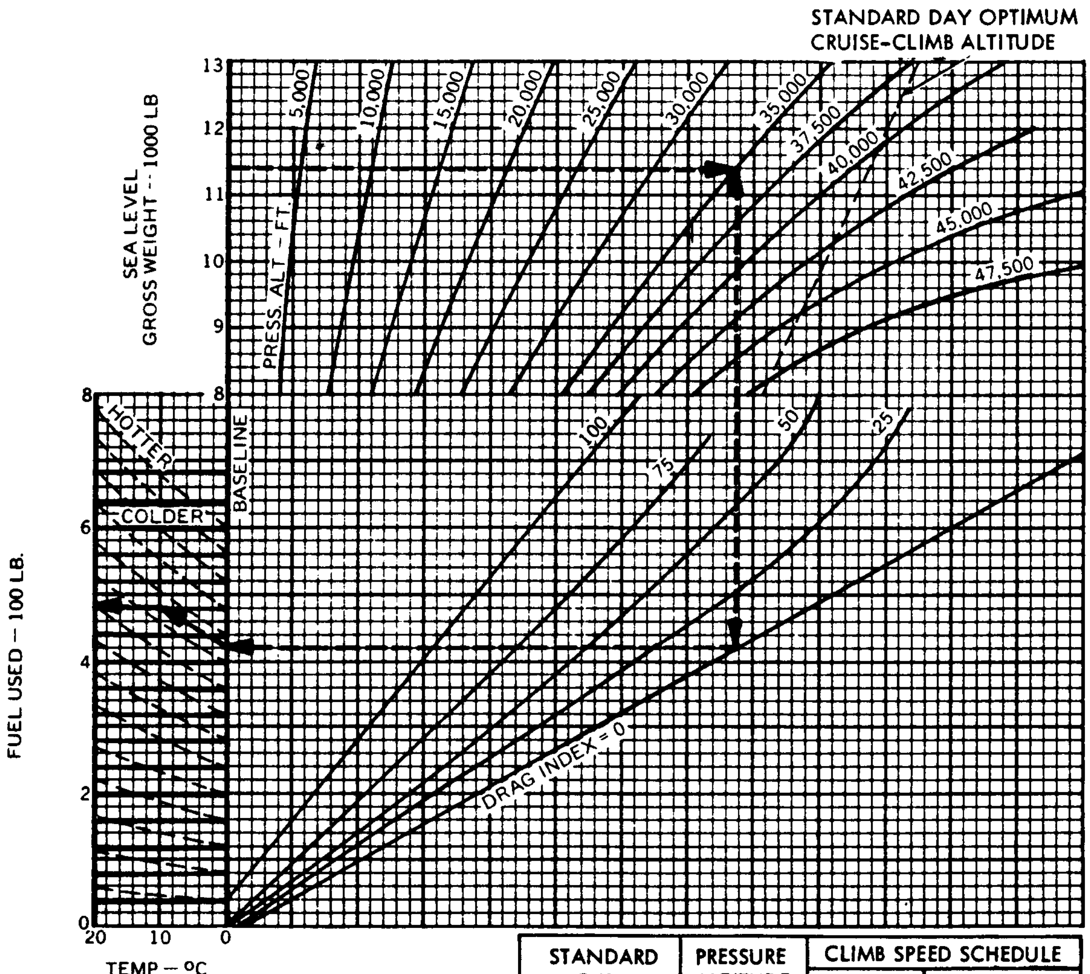
Figure A3-2 (Sheet 1 of 2)

MIL THRUST CLIMB

FUEL USED

MODEL: T-38A
DATA: 1 OCTOBER 1976
DATA BASIS: **ESTIMATED DATA**

ENGINE: (2) J85-GE-5
FUEL: JP-4
FUEL DENSITY: 6.5 LB/US GAL



FUEL, TIME, AND DISTANCE ALLOWANCE PRIOR TO CLIMB	
GROUND TAXI: 18 LB/MIN	
FROM BRAKE RELEASE TO BEGIN CLIMB USING MAXIMUM THRUST	
FUEL (LB)	285
TIME (MIN)	1.0
DISTANCE (NMI)	4.0

STANDARD DAY TEMP — °C	PRESSURE ALTITUDE — FEET	CLIMB SPEED SCHEDULE KCAS	CLIMB SPEED SCHEDULE TRUE MACH NO.
15.0	SEA LEVEL	496	0.75
5.1	5,000	466	0.76
-4.8	10,000	435	0.78
-14.7	15,000	406	0.79
-24.6	20,000	377	0.81
-34.5	25,000	349	0.83
-44.4	30,000	322	0.84
-54.3	35,000	295	0.86
-56.5 AT	40,000	264	0.87
37,000 FT	45,000	236	0.87
AND ABOVE	50,000	210	0.87

Figure A3-2 (Sheet 2 of 2)

MIL THRUST CLIMB

TIME TO CLIMB AND DISTANCE TRAVELED

MODEL: T-38A
DATA: 1 OCTOBER 1976
DATA BASIS: **ESTIMATED DATA**

ENGINE: (2) J85-GE-5
FUEL: JP-4
FUEL DENSITY: 6.5 LB/US GAL

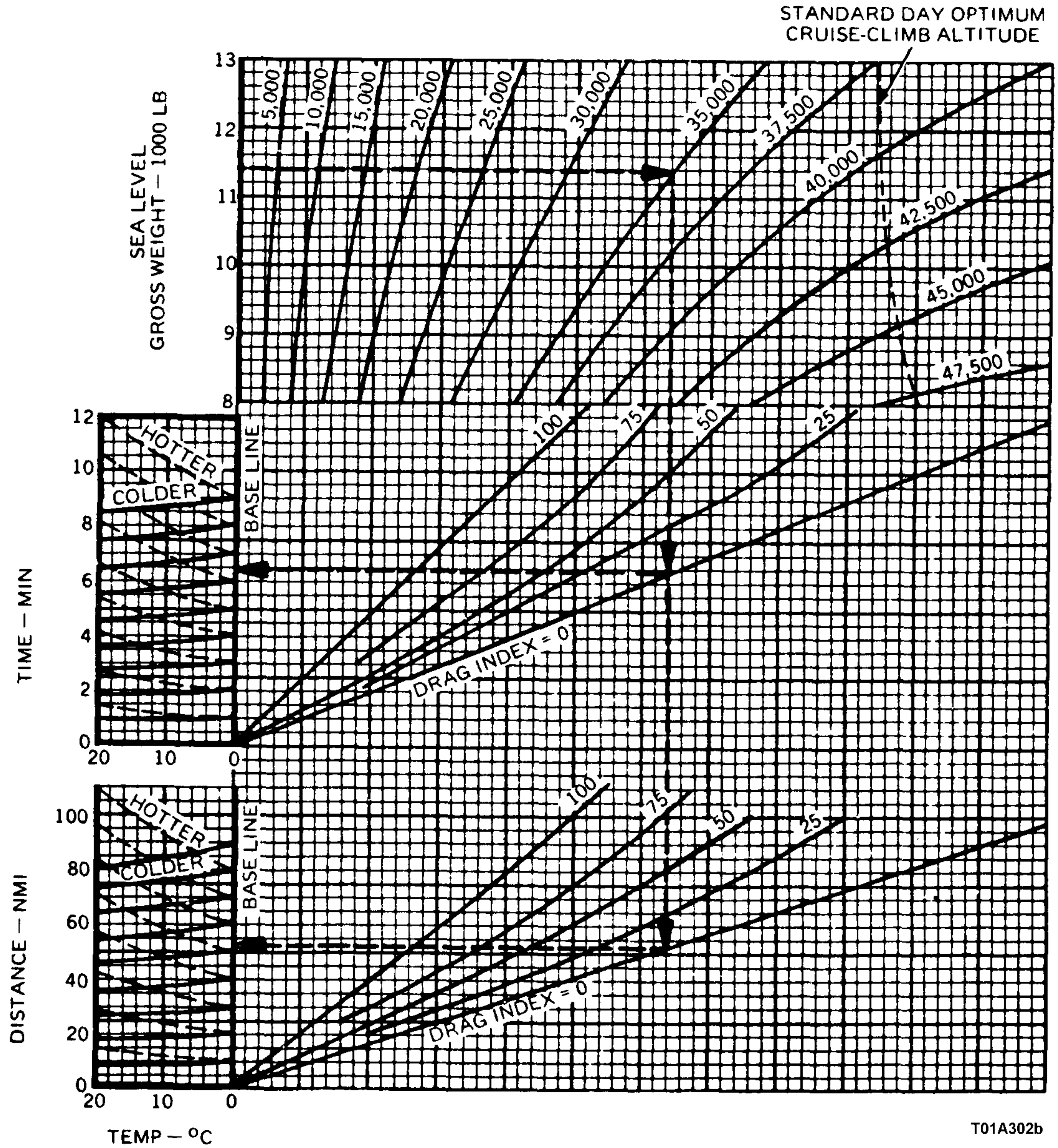


Figure A3-3 (Sheet 1 of 2)

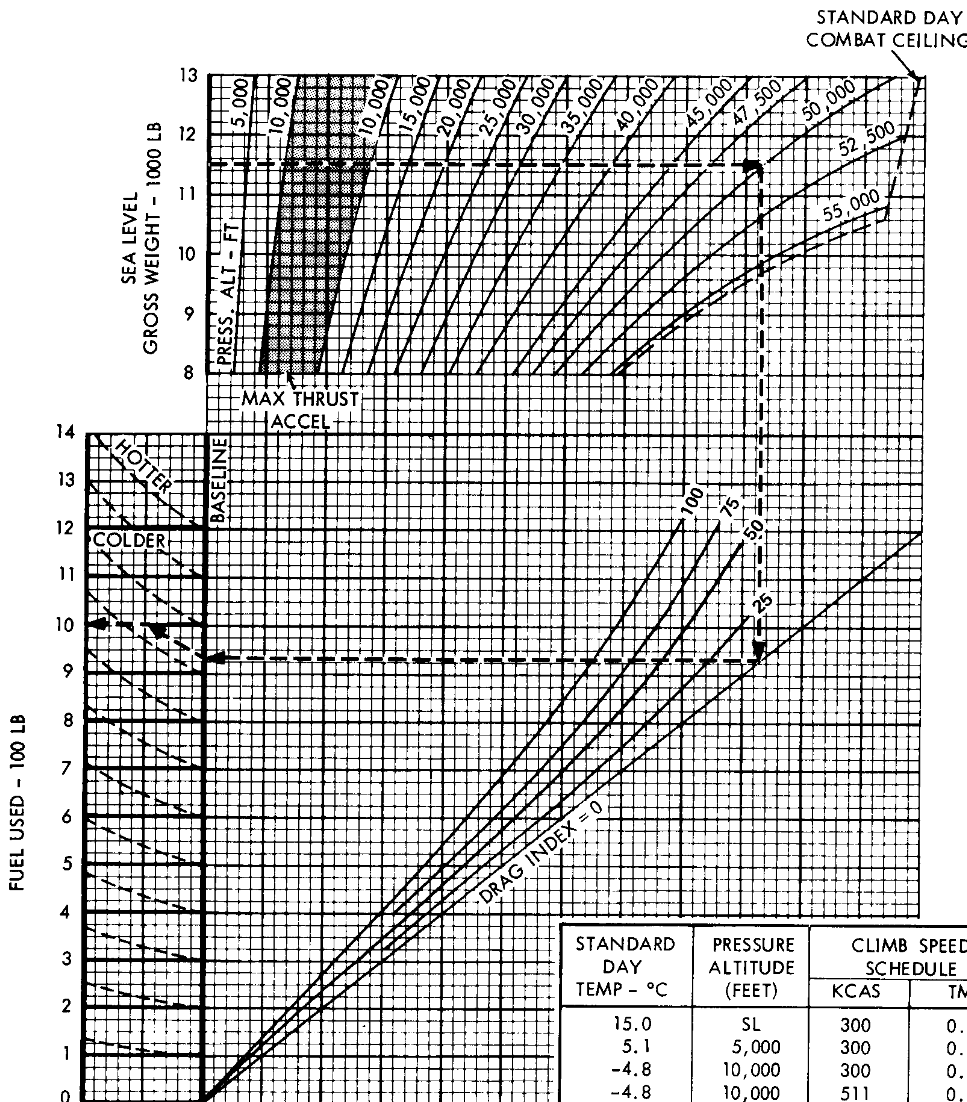
MAX THRUST CLIMB

RESTRICTED CLIMB SCHEDULE

FUEL USED

MODEL: T-38A
DATA: 1 OCTOBER 1976
DATA BASIS: **ESTIMATED DATA**

ENGINE: (2) J85-GE-5
FUEL: JP-4
FUEL DENSITY: 6.5 LB/US GAL



STANDARD DAY TEMP - °C	PRESSURE ALTITUDE (FEET)	CLIMB SPEED SCHEDULE	
		KCAS	TMN
15.0	SL	300	0.45
5.1	5,000	300	0.50
-4.8	10,000	300	0.55
-4.8	10,000	511	0.91
-14.7	15,000	470	0.91
-24.6	20,000	431	0.92
-34.5	25,000	393	0.92
-44.4	30,000	357	0.93
-54.3	35,000	322	0.93
-56.5 AT 37,000 FT & ABOVE	40,000	287	0.93
	45,000	256	0.93
	50,000	228	0.93
	55,000	203	0.93

FUEL, TIME, AND DISTANCE ALLOWANCE PRIOR TO CLIMB	
GROUND TAXI: 18 LB/MIN	
FROM BRAKE RELEASE TO BEGIN CLIMB USING MAXIMUM THRUST	
FUEL (LB)	190
TIME (MIN)	0.6
DISTANCE (NMI)	2.0

T01A303a

Figure A3-3 (Sheet 2 of 2)

MAX THRUST CLIMB

RESTRICTED CLIMB SCHEDULE

TIME TO CLIMB AND DISTANCE TRAVELED

MODEL: T-38A
DATA: 1 OCTOBER 1978
DATA BASIS: **ESTIMATED DATA**

ENGINE: (2) J85-GE-5
FUEL: JP-4
FUEL DENSITY: 6.5 LB/US GAL

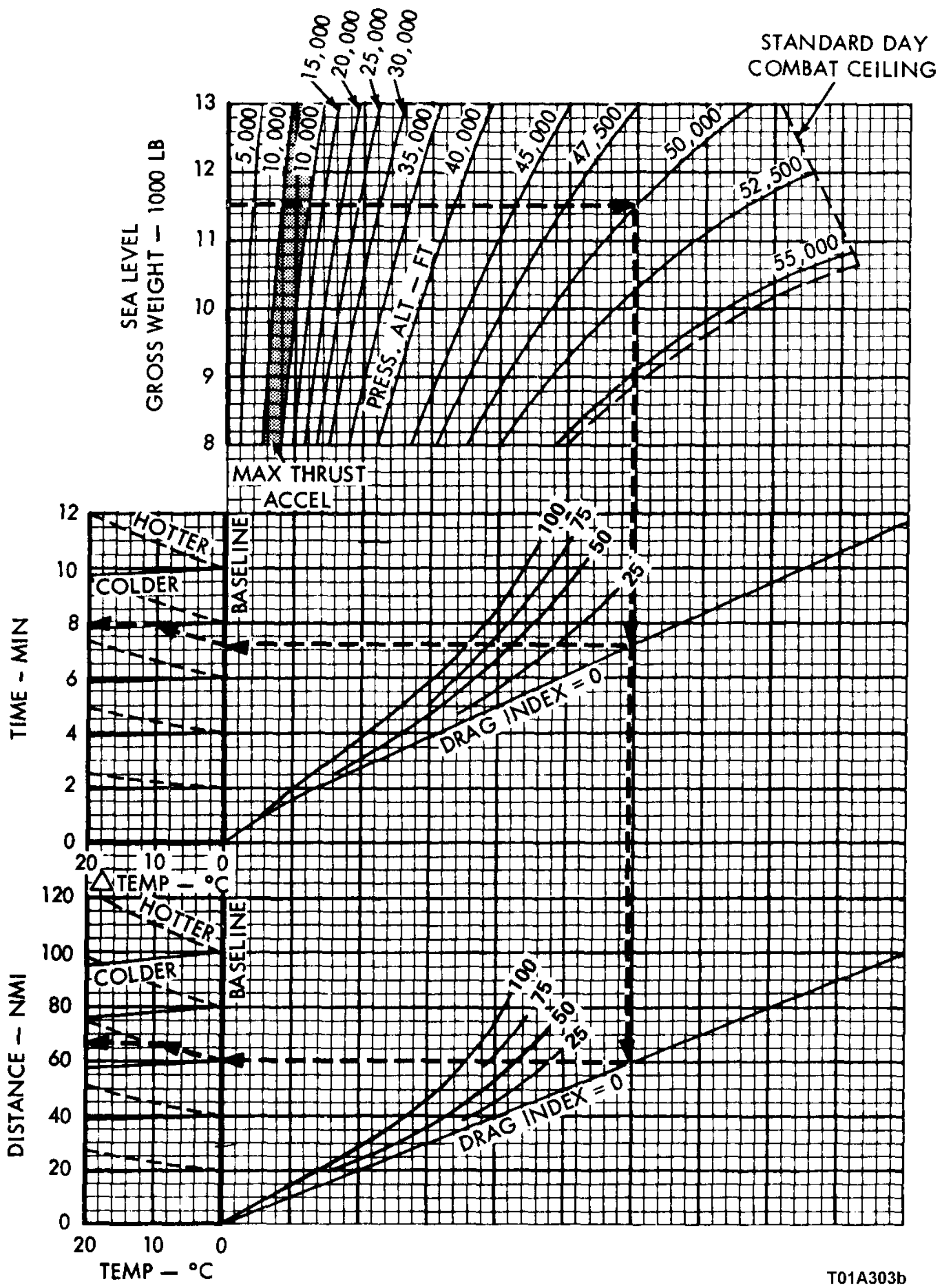


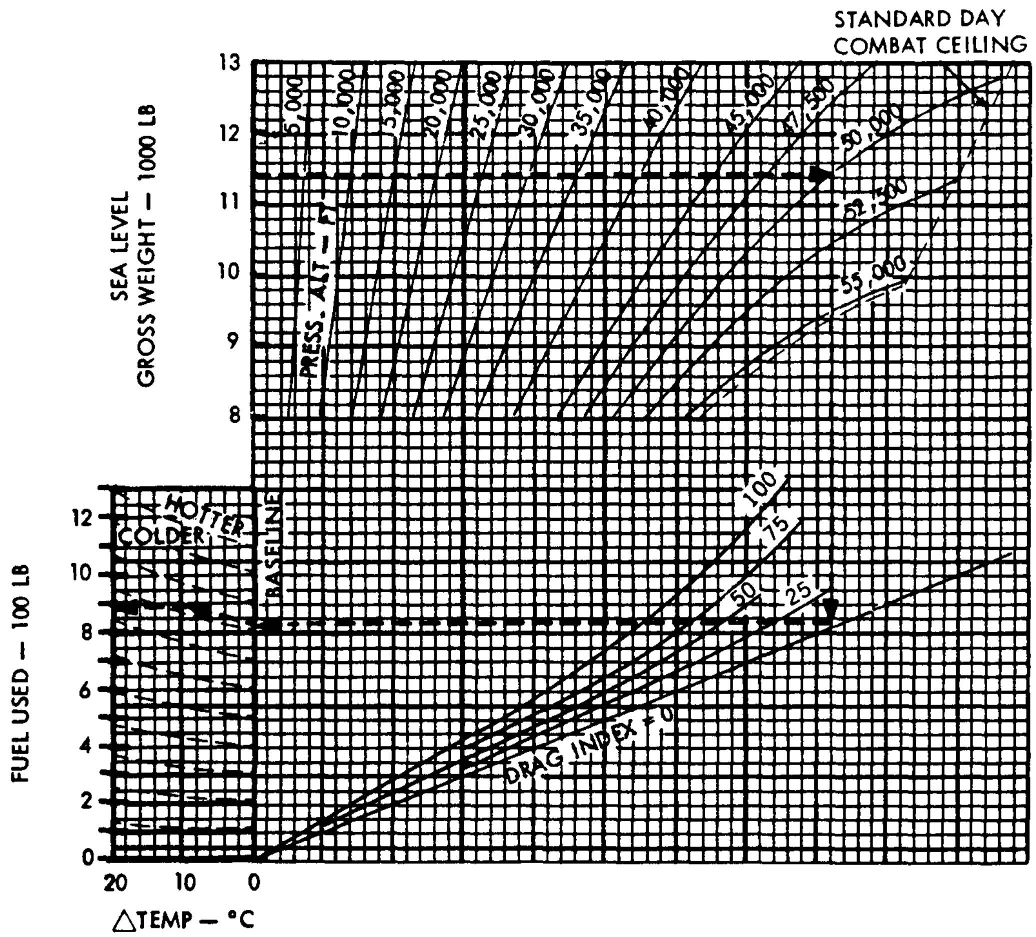
Figure A3-4 (Sheet 1 of 2)

MAX THRUST CLIMB

FUEL USED

MODEL: T-38A
DATA: 1 OCTOBER 1976
DATA BASIS: **ESTIMATED DATA**

ENGINE: (2) J85-GE-5
FUEL: JP-4
FUEL DENSITY: 6.5 LB/US GAL



FUEL, TIME, AND DISTANCE ALLOWANCE PRIOR TO CLIMB	
GROUND TAXI: 18 LB/MIN	
FROM BRAKE RELEASE TO BEGIN CLIMB USING MAXIMUM THRUST	
FUEL (LB)	315
TIME (MIN)	1.2
DISTANCE (NMI)	6.0

STANDARD DAY TEMP — °C	PRESSURE ALTITUDE — FEET	CLIMB SPEED SCHEDULE	
		KCAS	TRUE MACH NO.
15.0	SEA LEVEL	596	0.90
5.1	5,000	553	0.90
-4.8	10,000	511	0.91
-14.7	15,000	470	0.91
-24.6	20,000	431	0.92
-34.5	25,000	393	0.92
-44.4	30,000	357	0.93
-54.3	35,000	322	0.93
-56.5 AT	40,000	287	0.93
37,000 FT	45,000	256	0.93
AND ABOVE	50,000	228	0.93
	55,000	203	0.93

T01A304a

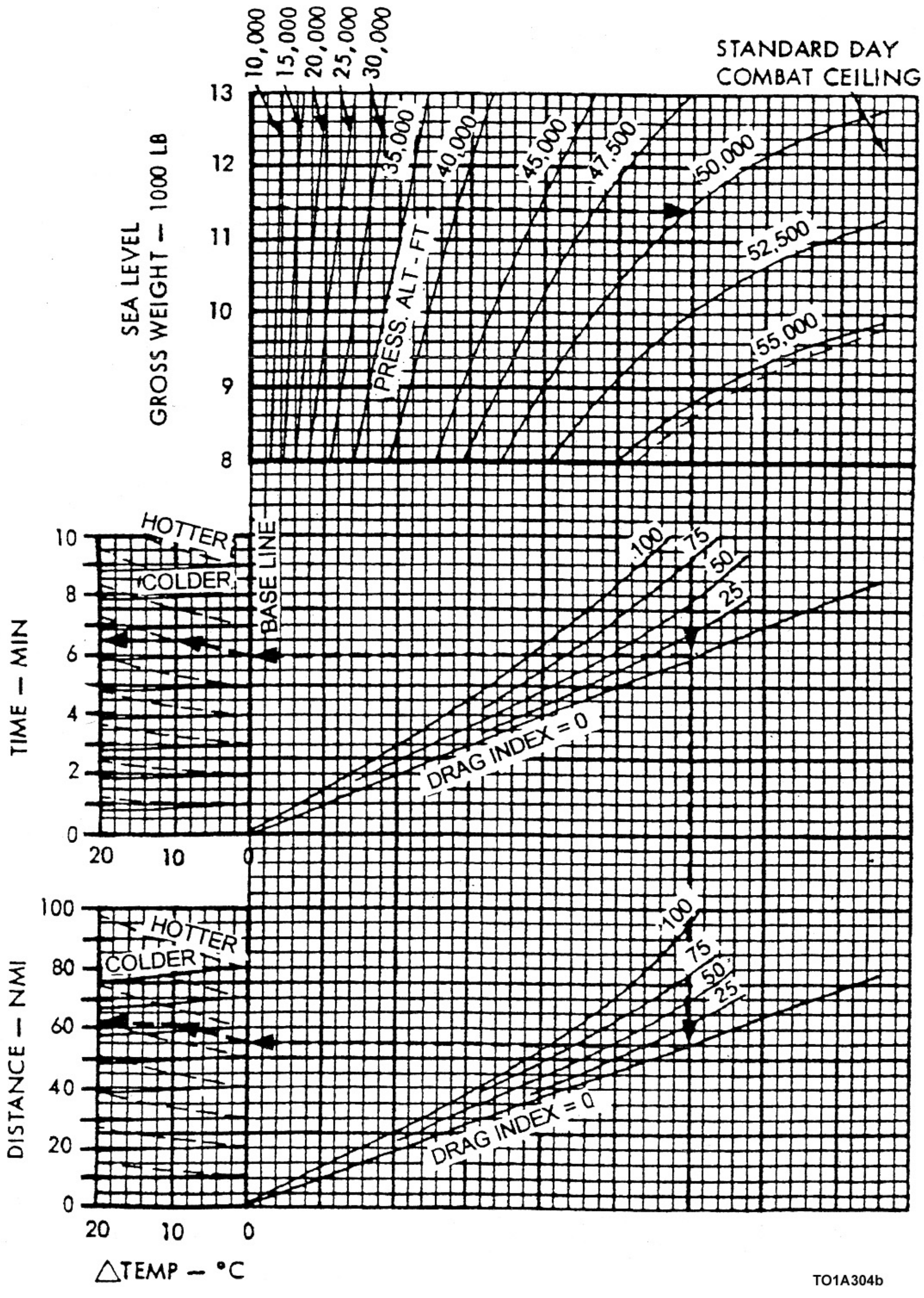
Figure A3-4 (Sheet 2 of 2)

MAX THRUST CLIMB

TIME TO CLIMB AND DISTANCE TRAVELED

MODEL: T-38A
DATA: 1 OCTOBER 1976
DATA BASIS: **ESTIMATED DATA**

ENGINE: (2) J85-GE-5
FUEL: JP-4
FUEL DENSITY: 6.5 LB/US GAL



Verify that this is the correct version before use.

Figure A3-5 (Sheet 1 of 2)

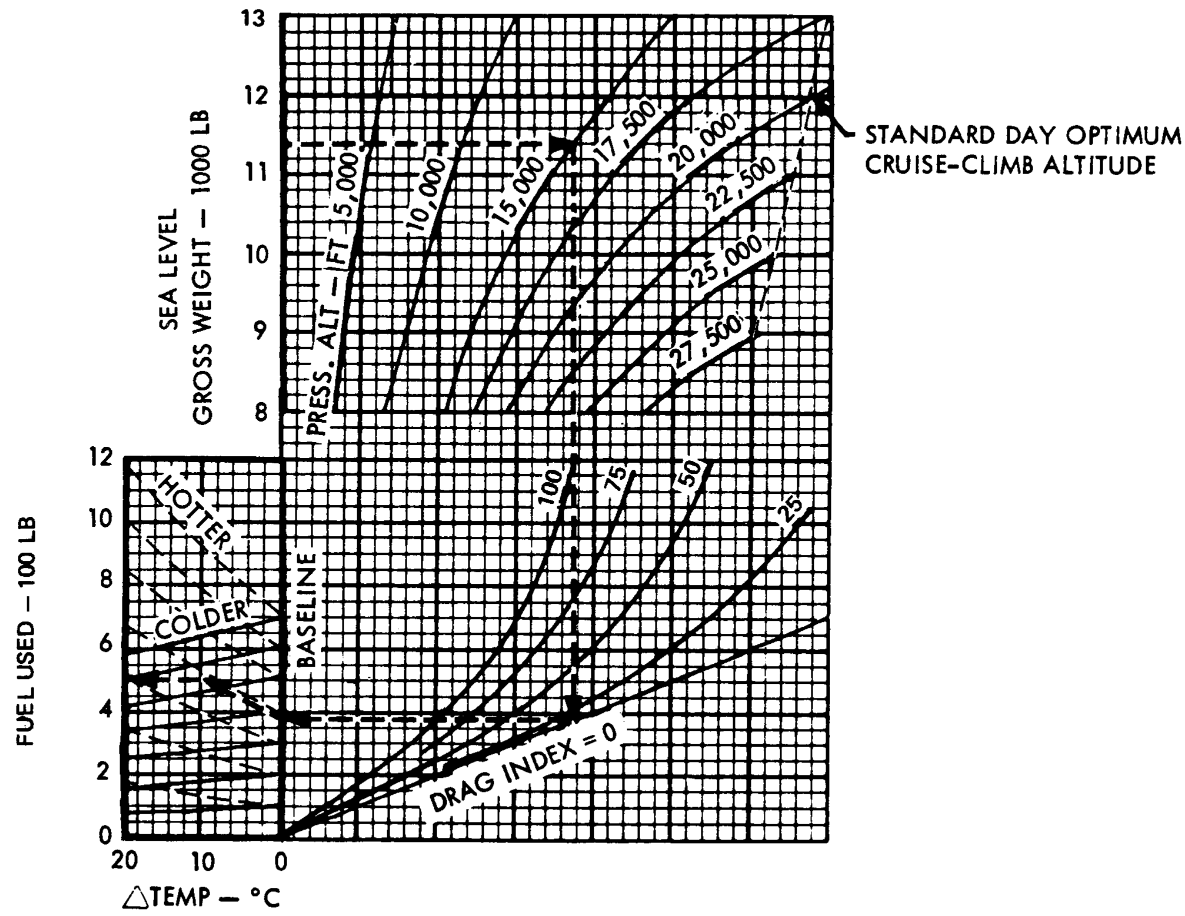
MIL THRUST CLIMB

SINGLE ENGINE

FUEL USED

MODEL: T-38A
DATA: 1 OCTOBER 1976
DATA BASIS: **ESTIMATED DATA**

ENGINE: (2) J85-GE-5
FUEL: JP-4
FUEL DENSITY: 6.5 LB/US GAL



STANDARD DAY TEMP — °C	PRESSURE ALTITUDE — FEET	CLIMB SPEED SCHEDULE	
		KCAS	TRUE MACH NO.
15.0	SEA LEVEL	281	0.43
5.1	5,000	278	0.46
- 4.8	10,000	271	0.49
-14.7	15,000	264	0.52
-24.6	20,000	256	0.56
-34.5	25,000	246	0.59
-44.4	30,000	227	0.61

T01A305a

Figure A3-5 (Sheet 2 of 2)

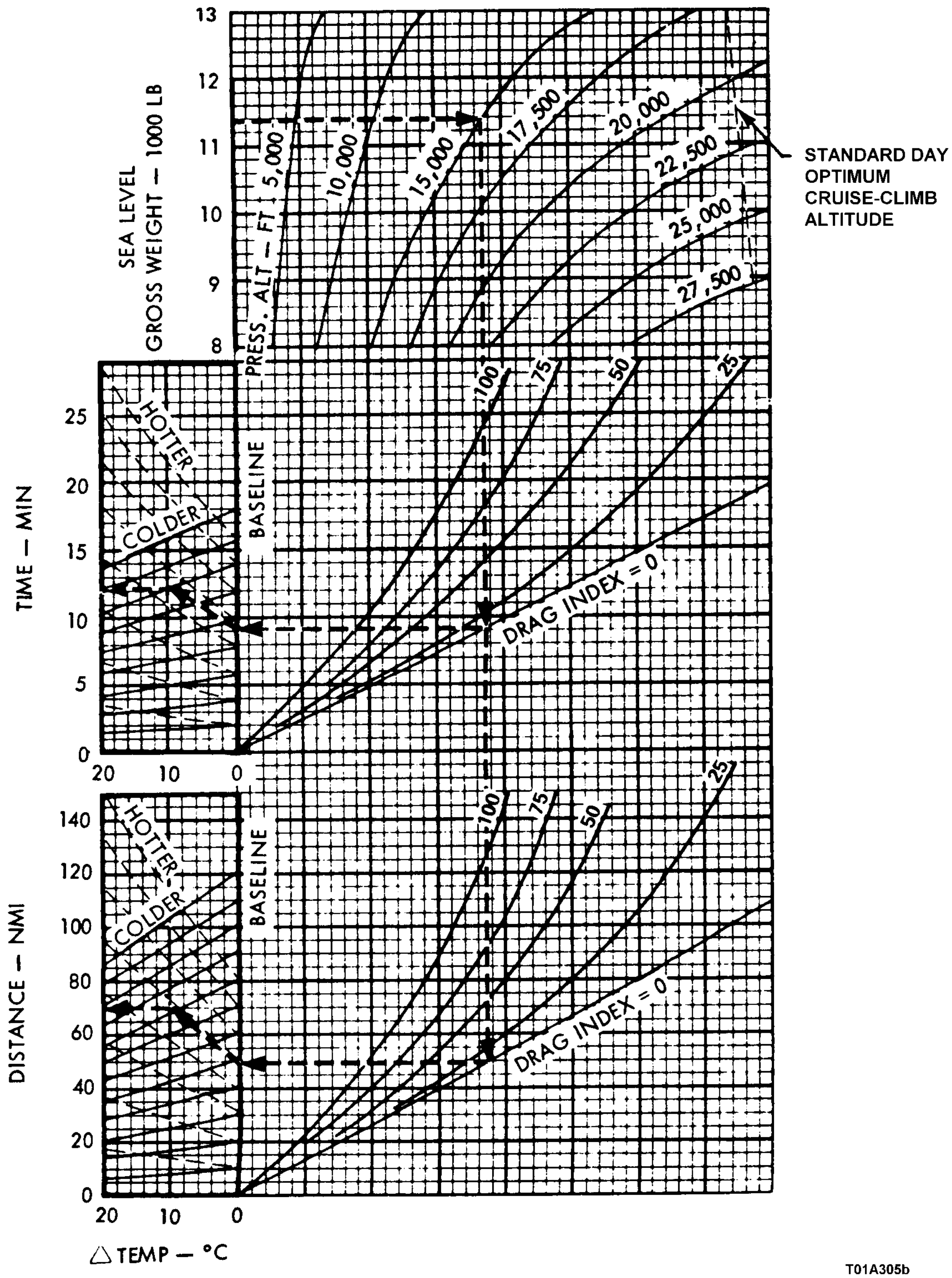
MIL THRUST CLIMB

SINGLE ENGINE

TIME TO CLIMB AND DISTANCE TRAVELED

MODEL: T-38A
DATA: 1 OCTOBER 1978
DATA BASIS: **ESTIMATED DATA**

ENGINE: (2) J85-GE-5
FUEL: JP-4
FUEL DENSITY: 6.5 LB/US GAL



T01A305b

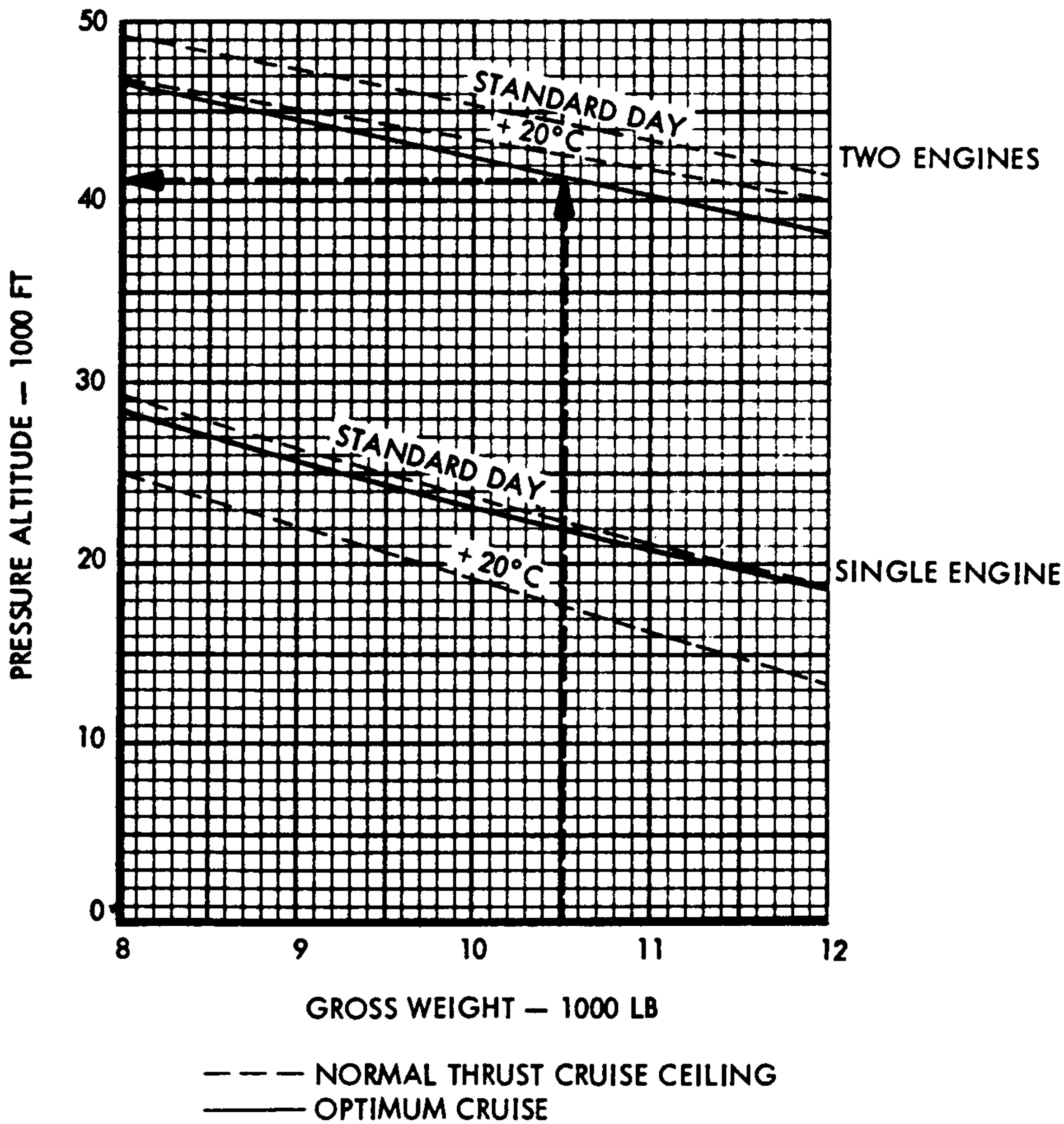
Figure A3-6

OPTIMUM CRUISE – CLIMB ALTITUDE

DRAG INDEX = 0

MODEL: T-38A
DATA: 1 AUGUST 1965
DATA BASIS: **FLIGHT TEST**

ENGINE: (2) J85-GE-5
FUEL: JP-4
FUEL DENSITY: 6.5 LB/US GAL



T01A306

Figure A3-7

SINGLE ENGINE SERVICE CEILING

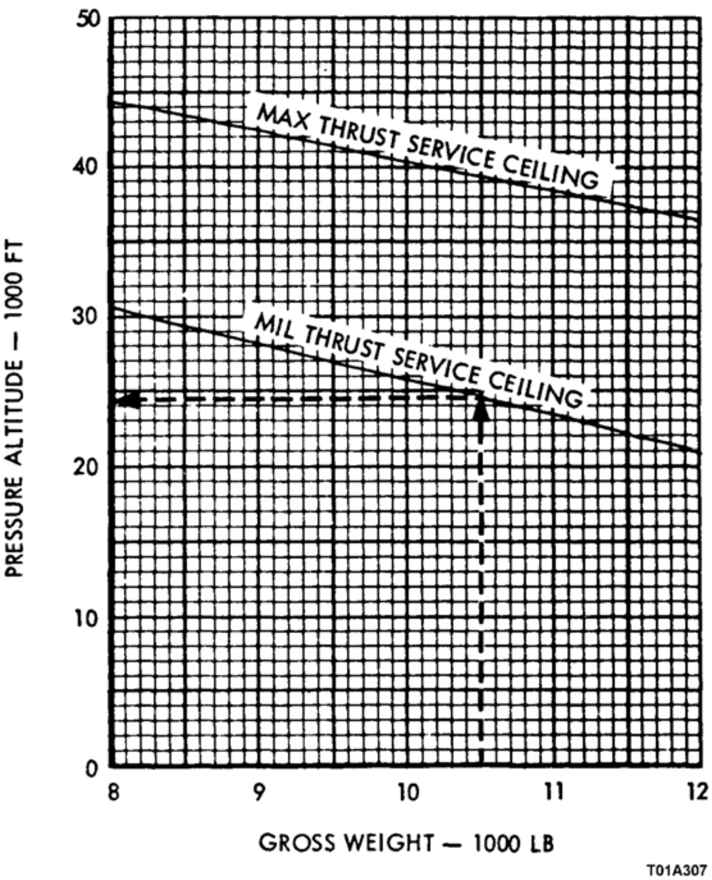
STANDARD DAY
DRAG INDEX = 0

MODEL: T-38A
DATA: 1 AUGUST 1965
DATA BASIS: **FLIGHT TEST**

ENGINE: (2) J85-GE-5
FUEL: JP-4
FUEL DENSITY: 6.5 LB/US GAL

NOTE

For each 10°C rise in air temperature above standard day conditions, decrease service ceiling 2,600 feet.



ALT 1,000 FT.	CLIMB SCHEDULE			
	MIL THRUST		MAX THRUST	
	KCAS	MACH NO.	KCAS	MACH NO.
45	—	—	216	0.80
40	—	—	242	0.80
35	—	—		
30	227	0.61	295	0.78
25	246	0.59	313	0.75
20	256	0.56	331	0.72
15	264	0.52	349	0.69
10	272	0.49	365	0.65
5	278	0.46	377	0.62
SL	281	0.43	394	0.60

CRUISE

PART 4

TABLE OF CONTENTS

PURPOSE OF CHARTS

The cruise charts provide cruise and loiter data that can be used to determine the subsonic cruise and loiter portions of any type of flight plan. Charts for constant altitude cruise and optimum cruise altitude for short-range missions are included. Diversion range summary tables are provided in tabular form for two-engine and single-engine operation.

CRUISE CHARTS

The cruise charts (Figure A4-1 and Figure A4-2) are for two-engine and single-engine operation. They provide cruise and loiter data throughout the speed range from maximum endurance to military thrust. Each chart is composed of three pages whose parameters are weight, altitude, mach number, ambient temperature, true airspeed, fuel flow, drag number, and nautical miles per pound of fuel. The average gross weight used in the charts is the average of the gross weights at the beginning and the end of the cruise or cruise interval. This average gross weight is equal to the gross weight at the beginning of cruise less one half of the fuel necessary for cruise. An ICAO standard day temperature table is included on sheet 3 of each chart.

USE OF CRUISE CHART

Assume a constant altitude cruise at 0.8 mach number and a pressure altitude of 20,000 feet when the temperature is -20ºC and the average gross weight is 10,400 pounds. The chase-thru lines on sheet 1 of Figure A4-1 show the maximum range mach number of 0.702. Then, by following the guidelines from the intersection with the baseline (maximum range) to the assumed mach number (0.8), the basic reference number is 2.75. The chase-thru lines on sheet 3 show 0.225 nautical miles per pound of fuel for the assumed mach number and the basic reference number determined on sheet 1 and 2. Entering sheet 4 with the assumed mach number and the nautical miles per pound from sheet 3 the chase-thru lines show a true airspeed of 495 knots and fuel flow of 1,100 pounds per hour per engine. If the fuel available is 1,000 pounds, the cruise distance is 225 nautical miles (0.225 X 1000) and the time is 27 minutes (1,000 X 60 ÷ 1,100 X 2). When the distance is known instead of the fuel available, the fuel required is computed by the reverse process (225 ÷ 0.225 = 1,000) and the average gross weight is obtained by successive approximations, knowing the gross weight at the start of the cruise.

CONSTANT ALTITUDE CRUISE CHARTS

The constant altitude cruise charts (Figure A4-3 and Figure A4-4) are for two-engine and single-engine operation. The charts are used to determine cruise performance at a particular pressure altitude, temperature, wind velocity, and average gross weight. The charts provide data for air and ground speeds, time, nautical miles per pound of fuel, fuel flow, and fuel required. When the fuel required is unknown, the average gross weight is obtained by successive approximations.

USE OF CONSTANT ALTITUDE CRUISE CHARTS

The chase-thru lines on Figure A4-3 are for an average gross weight of 10,020 pounds, a constant altitude cruise of 35,000 feet, a temperature of -46ºC, a headwind of 50 knots, and a distance of 400 nautical miles. On sheet 1, the chase-thru lines show a mach number of 0.83, a true airspeed (airspeed reflector) and groundspeed of 485 knots and 435 knots, respectively, and a time of 55 minutes. Using the airspeed of 485 knots and the time of 55 minutes, the chase-thru lines on sheet 2 show 0.338 nautical miles per pound of fuel, a fuel flow of 720 pounds per hour per engine, and 1,320 pounds of fuel. Since 1,320 pounds of fuel is required, the gross weight at the start of the cruise is 10,680 pounds (10,020 + 1/2 X 1,320).

OPTIMUM CRUISE ALTITUDE FOR SHORT RANGE MISSIONS

For short-range flights, it is not economical to climb to the same optimum cruise altitude as used for long-range missions. Figure A4-5 presents the optimum constant altitude cruise for short-range missions and also indicates when the mission is in the short-range category; that is, below the optimum cruise-climb altitude.

USE OF OPTIMUM CRUISE ALTITUDE FOR SHORT RANGE MISSIONS CHART

For a short-range mission 100 nautical miles from base and a start climb gross weight of 11,400 pounds, the chase-thru lines show the optimum cruise at constant altitude (Figure A4-5) is 28,000 feet. Had the distance been 150 nautical miles, the optimum cruise-climb altitude would be the most economical.

DIVERSION RANGE SUMMARY TABLES

Diversion range summary tables are presented in Figure A4-6 through Figure A4-13 for two-engine and single-engine operation. These tables show, in quick reference form, the range available and the time required to return to base with 600, 800, 1,000 or 1,400 pounds of fuel available. The range is based on having 300 pounds of fuel remaining for the approach and landing after the descent is completed. The 300 pounds of fuel is ample for one missed approach. Range and time data are shown in the tables for three optional return profiles, together with the optimum altitudes for cruise. The optimum altitude is the constant cruise altitude that provides the maximum range for the particular type of flight profile. Climb is made to the cruise altitude, using military thrust.

NOTE

The Mil Thrust Climb Speed Schedule at the bottom of each table must be used to obtain the maximum ranges in the table.

Cruise speeds and descent data are provided at the bottom of the tables.

The three types of flight profiles are:

1. a. Cruise at initial altitude to base.
   b. Descend to sea level with idle thrust and speed brake closed after arrival over base.
2. a. Climb on course to optimum cruise altitude.
   b. Cruise at optimum altitude to base.
   c. Descend to sea level with idle thrust and speed brake open after arrival over base.
3. a. Climb on course to optimum cruise altitude.
   b. Cruise at optimum altitude.
   c. Descend on course to sea level with idle thrust and speed brake closed.

USE OF DIVERSION RANGE SUMMARY TABLES

Assume the following conditions prevail: Single-engine operation, fuel remaining is 1,240 pounds, and the aircraft is 200 NM from the base at 15,000 feet altitude. Drag Index = 0.

Determine which flight profiles in Figure A4-10 provide necessary range in return to base.

1. In Figure A4-10, enter the chart at the top of the column marked 15,000 feet initial altitude.
2. Proceed downward to the section of the chart for 1,000 pounds of fuel shown at the left side of the page.
3. The ranges available with the three profile options are as follows:
   First option.......................... 168 NM.
   Second option .... 179 NM.
   Third option .... 211 NM.
4. As the required range is 200 nmi, the flight profile for the third option must be used.
5. Climb with MIL thrust from 15,000 at mach number 0.52 (footnote number 5) to 25,000 at mach number 0.59. At 25,000 feet, cruise at 0.62 mach; engine fuel flow will be approximately 1,275 lb/hr. At 40 NM from the base, descend on course at 240 KCAS, idle thrust, with the speed brake closed.
6. The time required with no wind is 36 minutes for 211 NM, and the fuel used is 1,000 pounds by the time the landing is completed. As the fuel available was 1,240 pounds, 240 pounds of this amount would be available for headwind conditions.

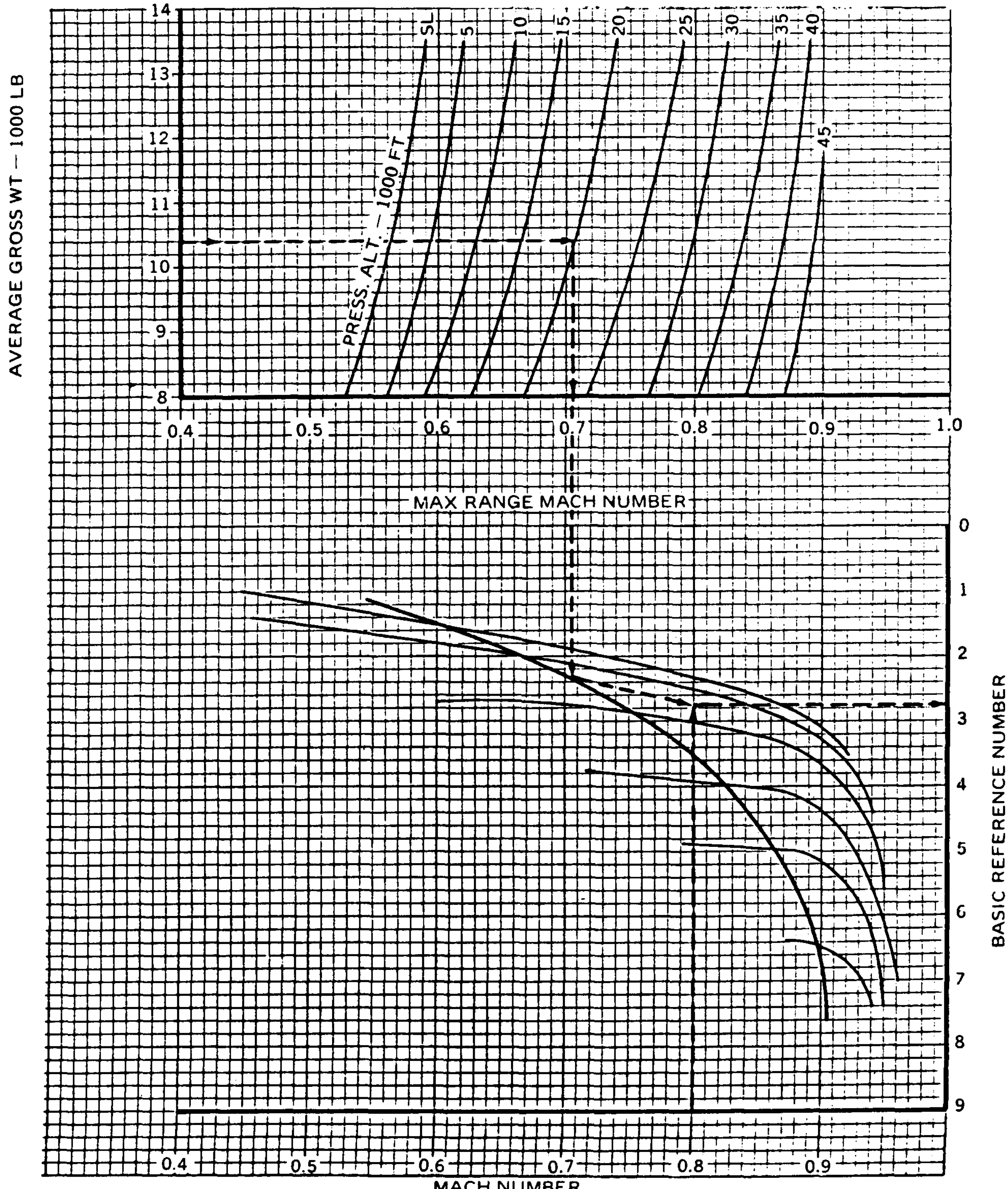
Figure A4-1 (Sheet 1 of 4)

CRUISE

MACH NUMBER AND REFERENCE NUMBER

MODEL: T-38A
DATA: 1 OCTOBER 1976
DATA BASIS: **ESTIMATED DATA**

ENGINE: (2) J85-GE-5
FUEL: JP-4
FUEL DENSITY: 6.5 LB/US GAL



T01A401a

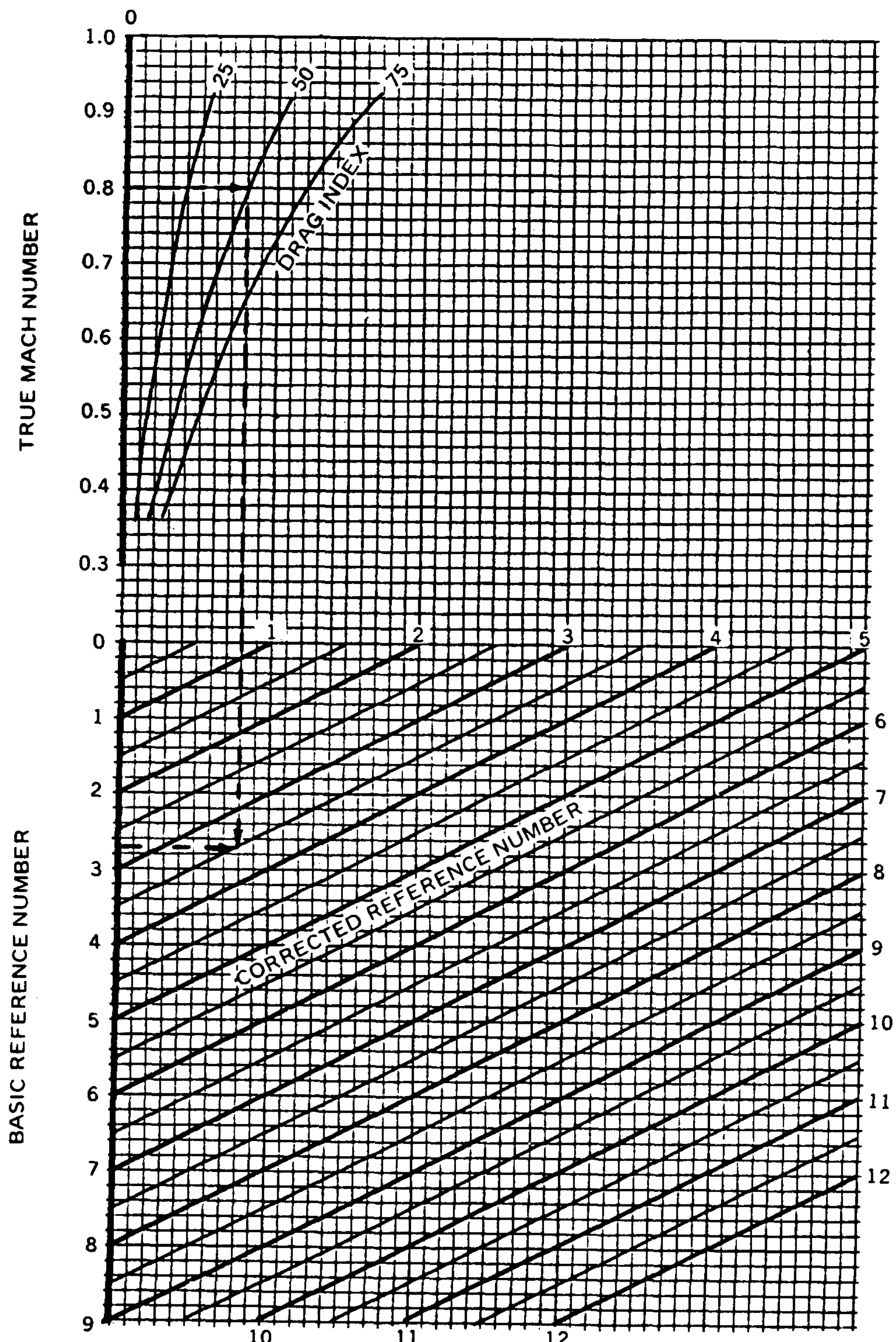
Figure A4-1 (Sheet 2 of 4)

CRUISE

CORRECTED REFERENCE NUMBER
FOR EXTERNAL STORES

MODEL: T-38A
DATA: 1 OCTOBER 1976
DATA BASIS: **ESTIMATED DATA**

ENGINE: (2) J85-GE-5
FUEL: JP-4
FUEL DENSITY: 6.5 LB/US GAL



T01A401b

Verify that this is the correct version before use.

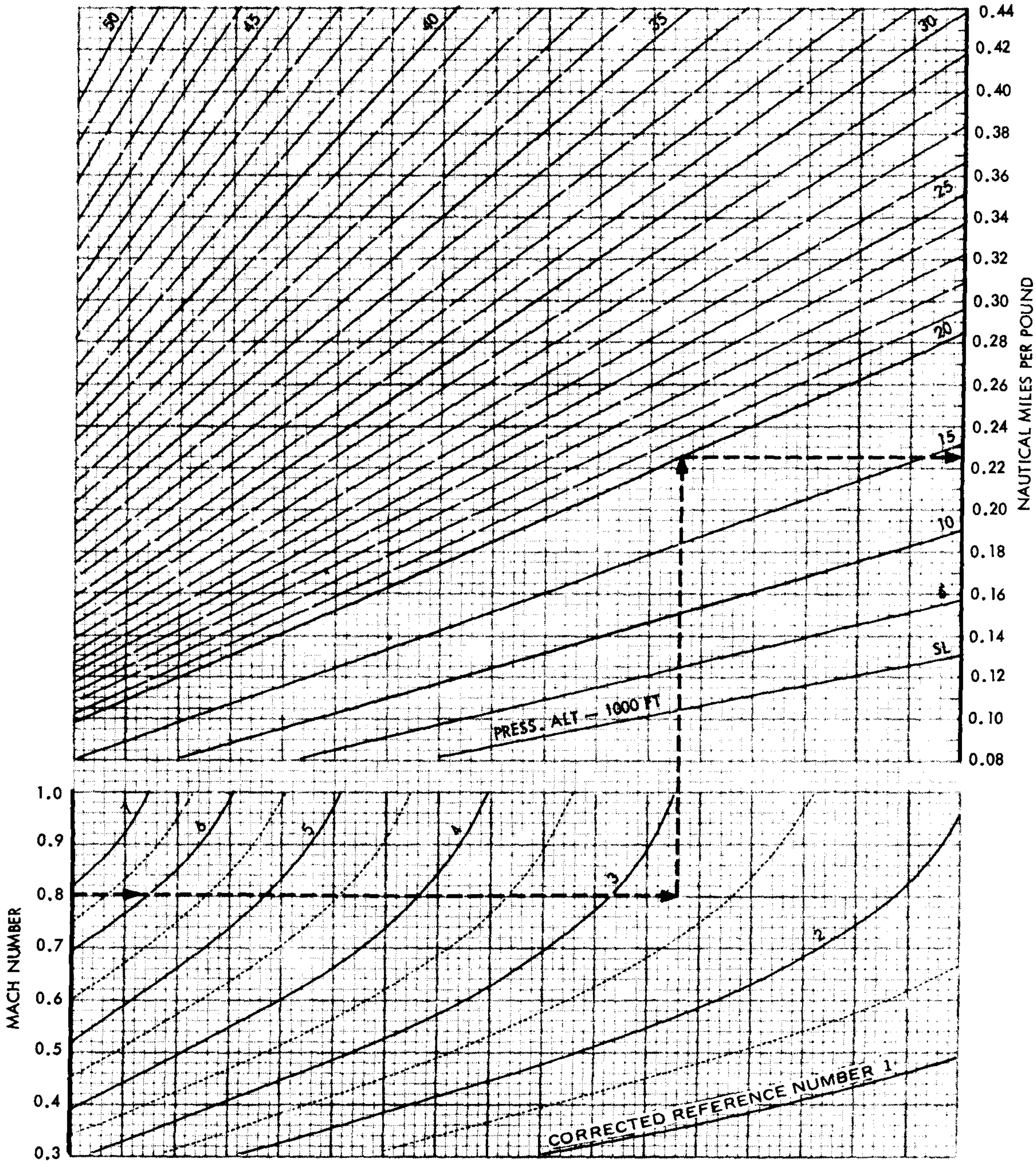
Figure A4-1 (Sheet 3 of 4)

CRUISE

NAUTICAL MILES PER POUND

MODEL: T-38A
DATA: 1 OCTOBER 1976
DATA BASIS: **ESTIMATED DATA**

ENGINE: (2) J85-GE-5
FUEL: JP-4
FUEL DENSITY: 6.5 LB/US GAL



T01A401c

Verify that this is the correct version before use.

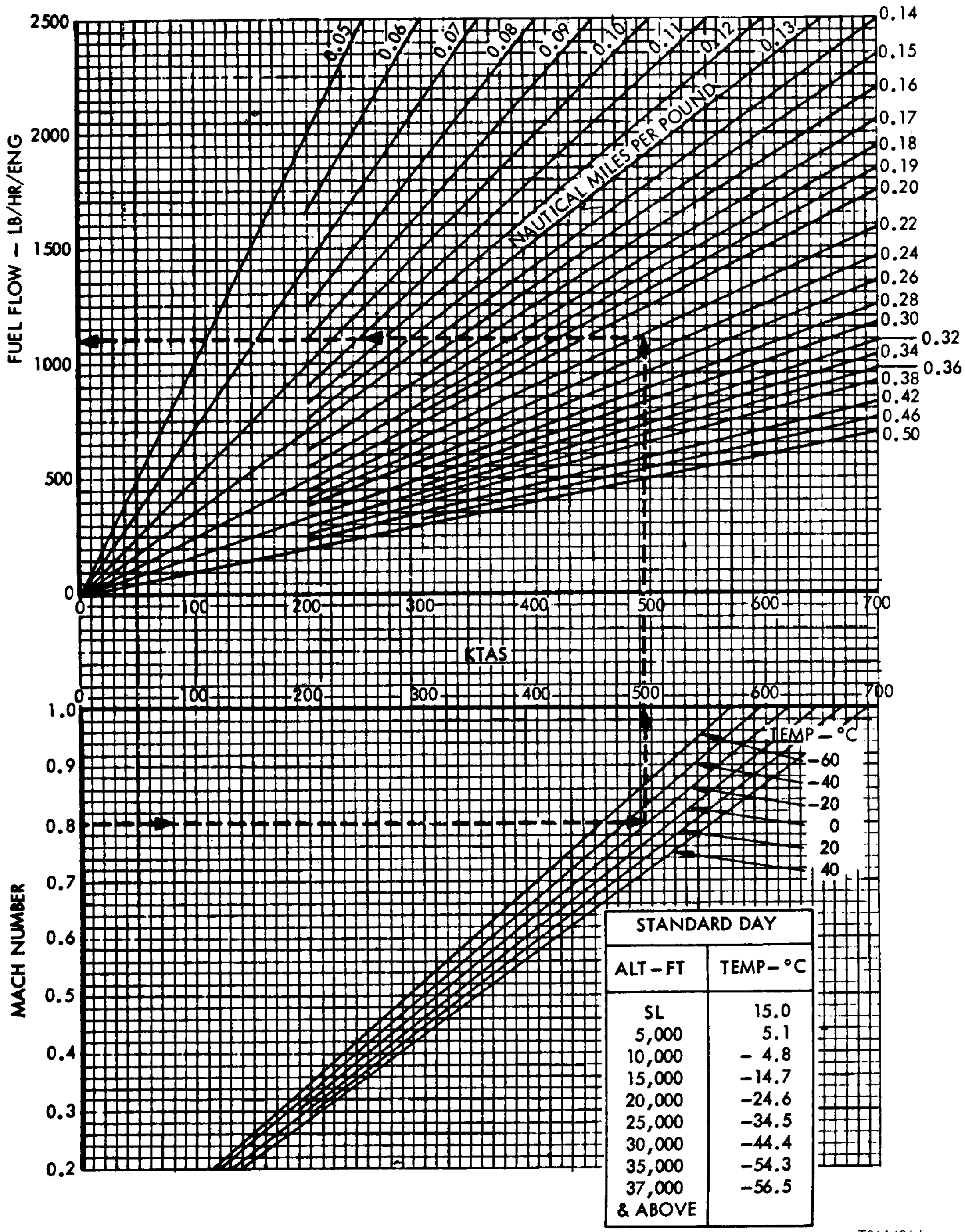
Figure A4-1 (Sheet 4 of 4)

CRUISE

FUEL FLOW AND TRUE AIRSPEED

MODEL: T-38A
DATA: 1 OCTOBER 1976
DATA BASIS: **ESTIMATED DATA**

ENGINE: (2) J85-GE-5
FUEL: JP-4
FUEL DENSITY: 6.5 LB/US GAL



STANDARD DAY	
ALT – FT	TEMP – °C
SL	15.0
5,000	5.1
10,000	- 4.8
15,000	-14.7
20,000	-24.6
25,000	-34.5
30,000	-44.4
35,000	-54.3
37,000 & ABOVE	-56.5

T01A401d

Figure A4-2 (Sheet 1 of 4)

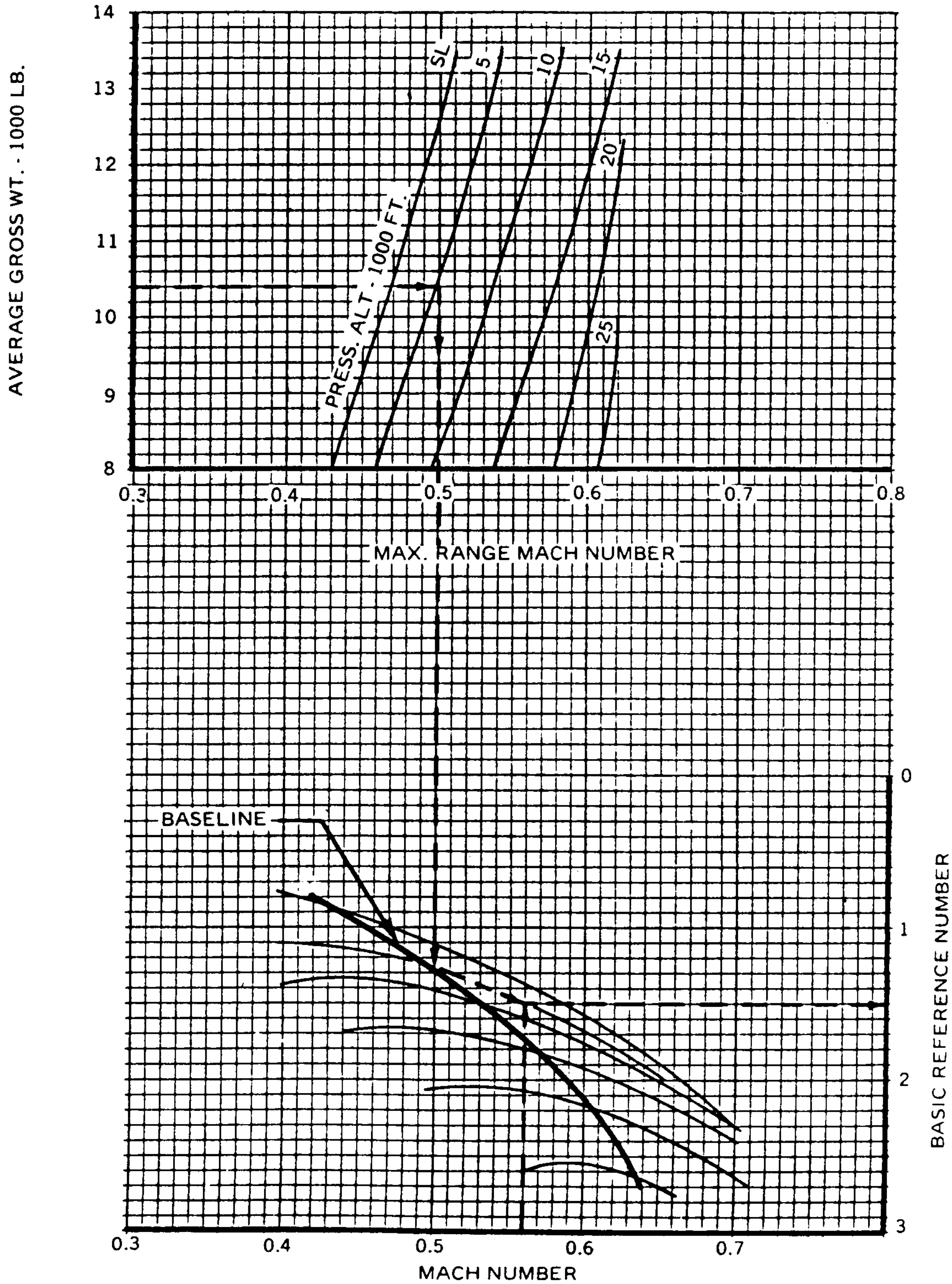
CRUISE

MACH NUMBER AND REFERENCE NUMBER

MODEL: T-38A
DATA: 1 OCTOBER 1976
DATA BASIS: **ESTIMATED DATA**

SINGLE ENGINE

ENGINE: (2) J85-GE-5
FUEL: JP-4
FUEL DENSITY: 6.5 LB/US GAL



T01A402a

Figure A4-2 (Sheet 2 of 4)

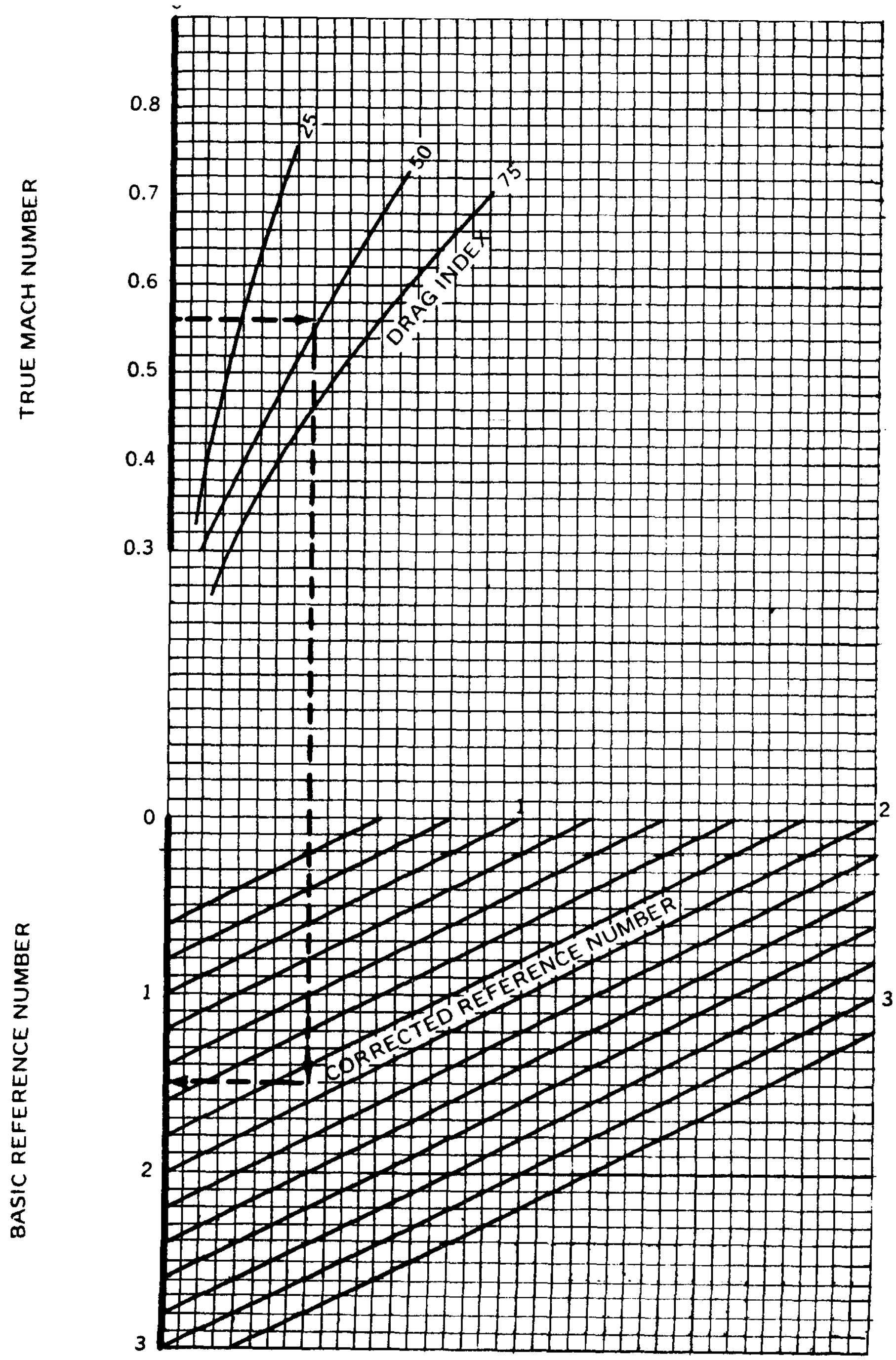
CRUISE

CORRECTED REFERENCE NUMBER
FOR EXTERNAL STORES

MODEL: T-38A
DATA: 1 OCTOBER 1976
DATA BASIS: **FLIGHT TEST**

SINGLE ENGINE

ENGINE: (2) J85-GE-5
FUEL: JP-4
FUEL DENSITY: 6.5 LB/US GAL



T01A402b

Figure A4-2 (Sheet 3 of 4)

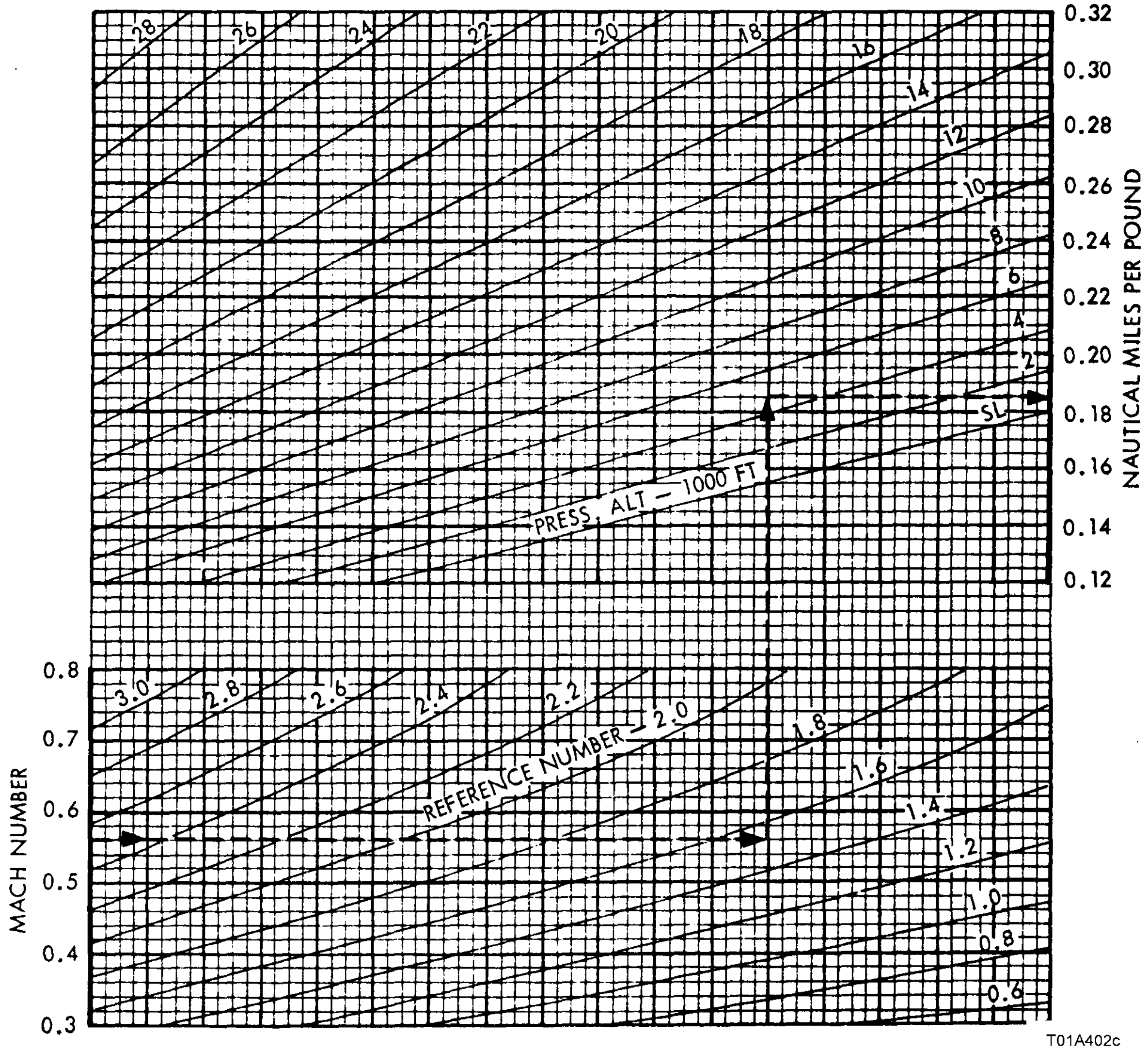
CRUISE

NAUTICAL MILES PER POUND

MODEL: T-38A
DATA: 1 OCTOBER 1976
DATA BASIS: **ESTIMATED DATA**

SINGLE ENGINE

ENGINE: (2) J85-GE-5
FUEL: JP-4
FUEL DENSITY: 6.5 LB/US GAL



T01A402c

Figure A4-2 (Sheet 4 of 4)

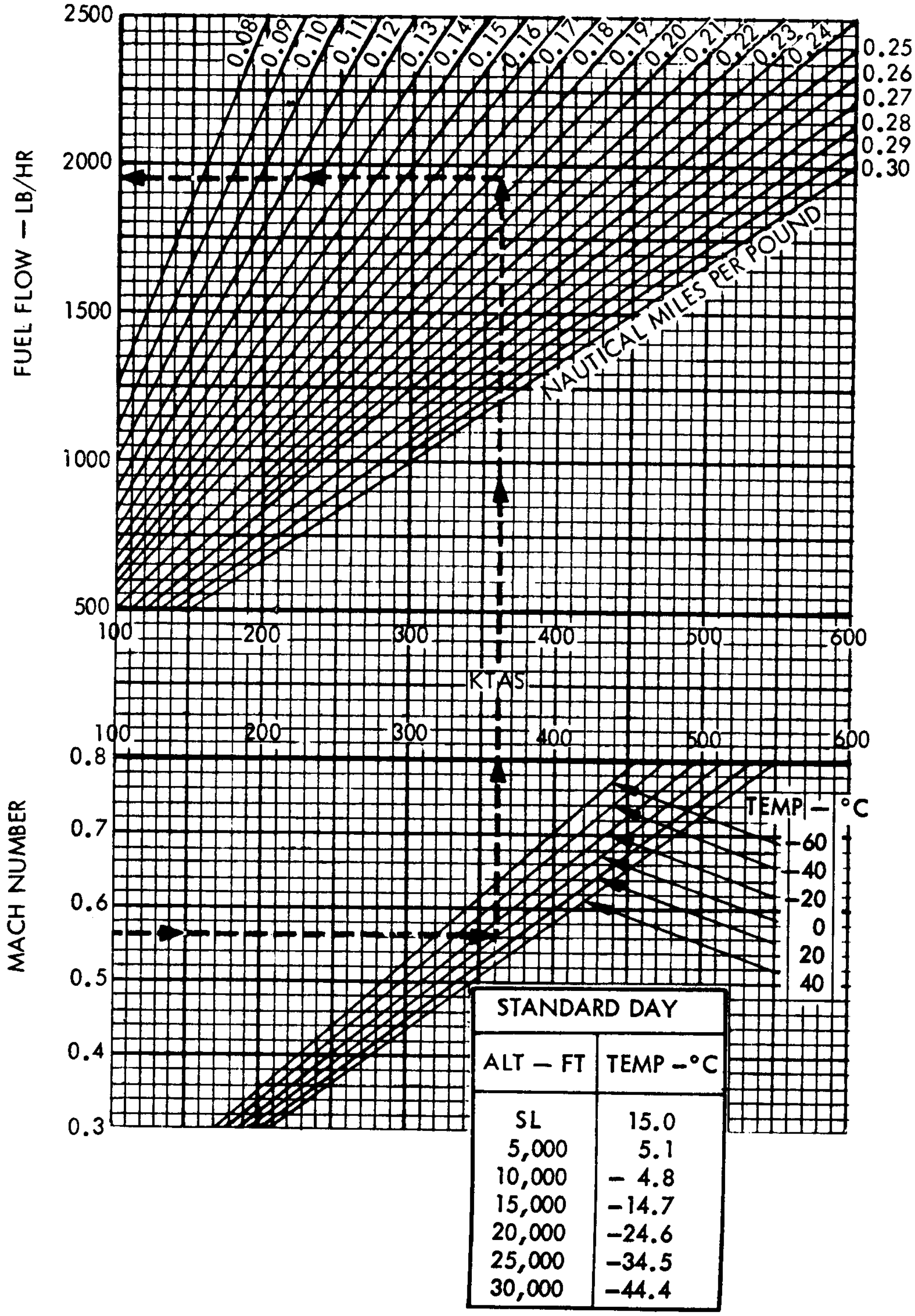
CRUISE

FUEL FLOW AND TRUE AIRSPEED

MODEL: T-38A
DATA: 1 OCTOBER 1976
DATA BASIS: **ESTIMATED DATA**

SINGLE ENGINE

ENGINE: (2) J85-GE-5
FUEL: JP-4
FUEL DENSITY: 6.5 LB/US GAL



T01A402d

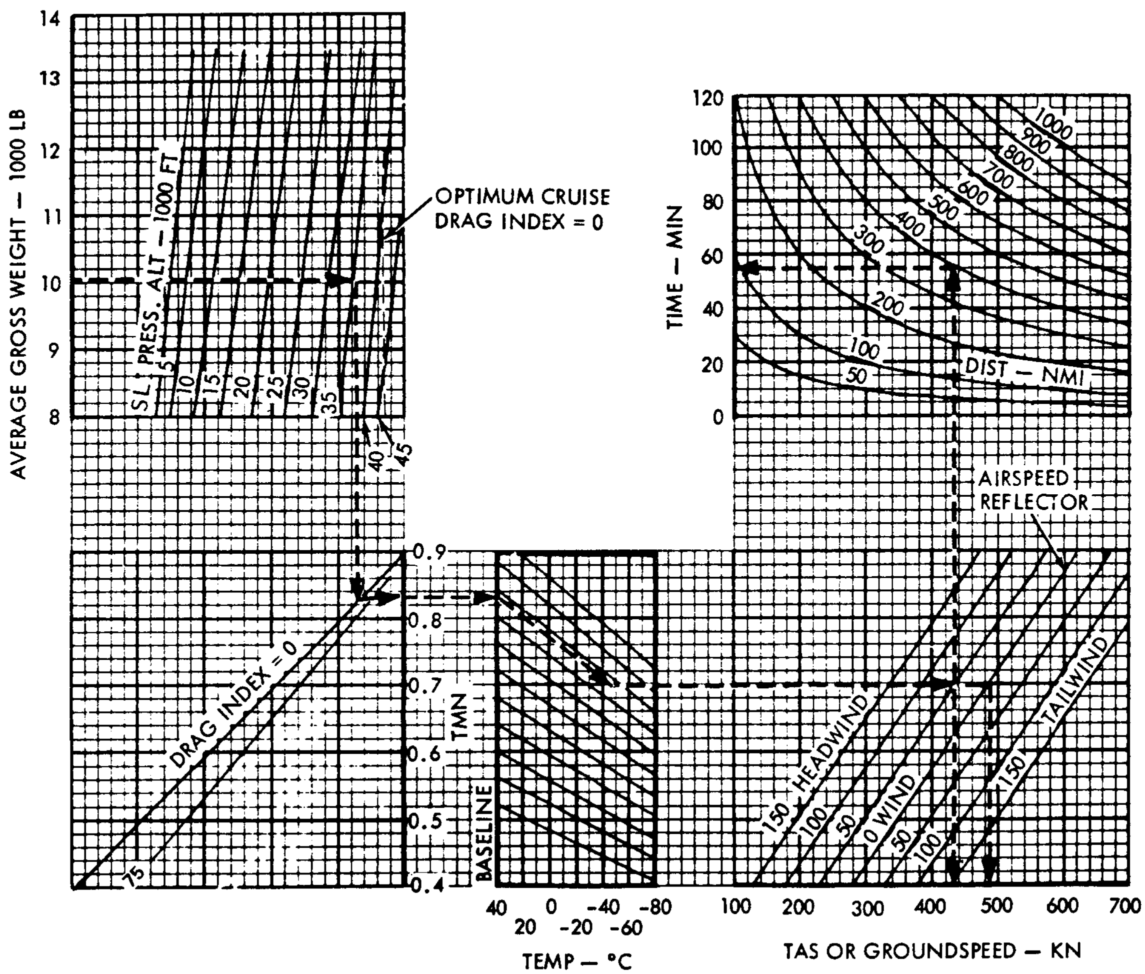
Figure A4-3 (Sheet 1 of 2)

CONSTANT ALTITUDE CRUISE

TIME AND AIRSPEED

MODEL: T-38A
DATA: 1 OCTOBER 1976
DATA BASIS: **ESTIMATED DATA**

ENGINE: (2) J85-GE-5
FUEL: JP-4
FUEL DENSITY: 6.5 LB/US GAL



T01A403a

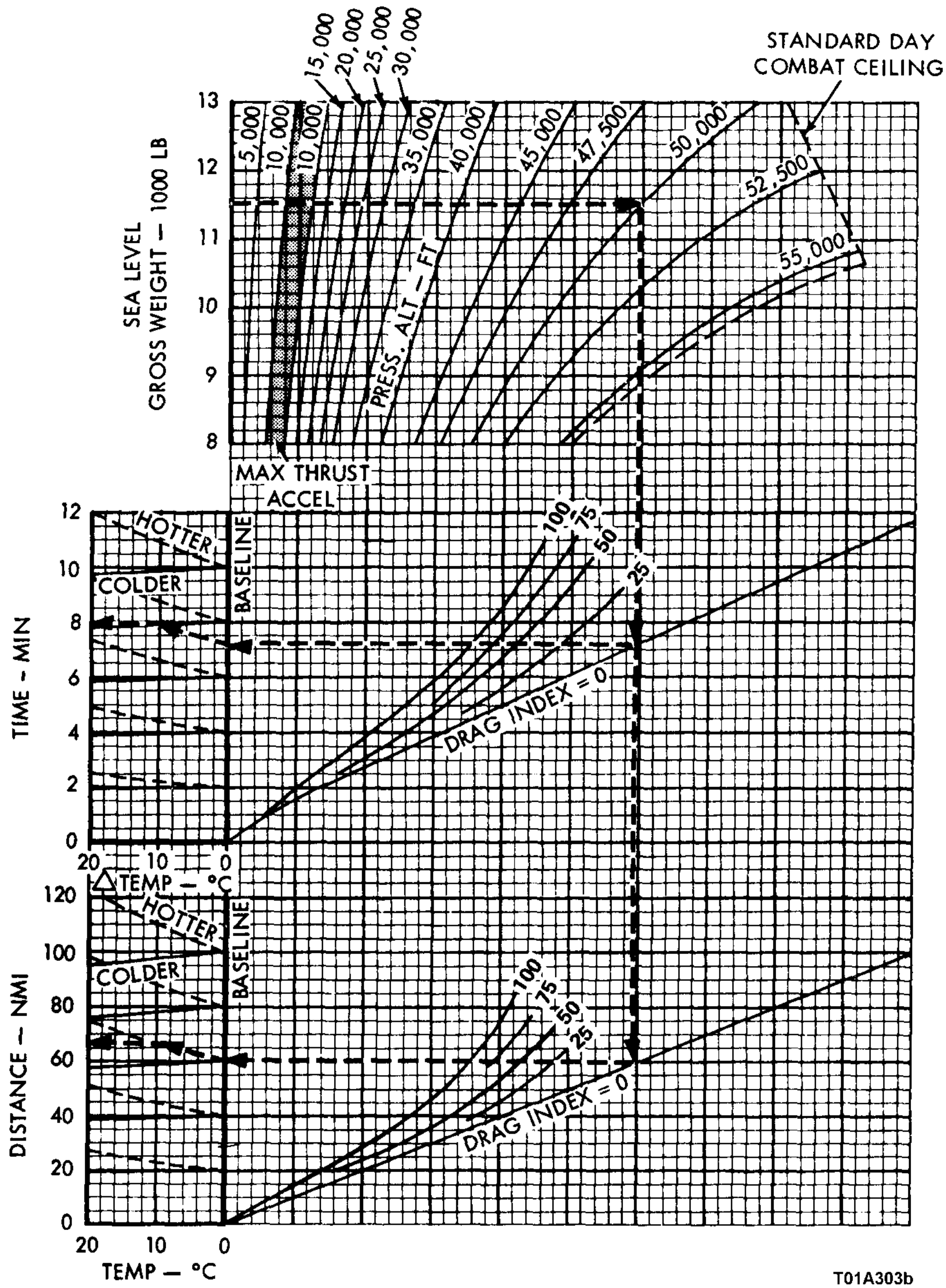
Figure A4-3 (Sheet 2 of 2)

CONSTANT ALTITUDE CRUISE

FUEL FLOW AND FUEL REQUIRED

MODEL: T-38A
DATA: 1 OCTOBER 1976
DATA BASIS: **ESTIMATED DATA**

ENGINE: (2) J85-GE-5
FUEL: JP-4
FUEL DENSITY: 6.5 LB/US GAL



Verify that this is the correct version before use.

Figure A4-4 (Sheet 1 of 2)

CONSTANT ALTITUDE CRUISE

TIME AND AIRSPEED

MODEL: T-38A
DATA: 1 OCTOBER 1976
DATA BASIS: **ESTIMATED DATA**

SINGLE ENGINE

ENGINE: (2) J85-GE-5
FUEL: JP-4
FUEL DENSITY: 6.5 LB/US GAL

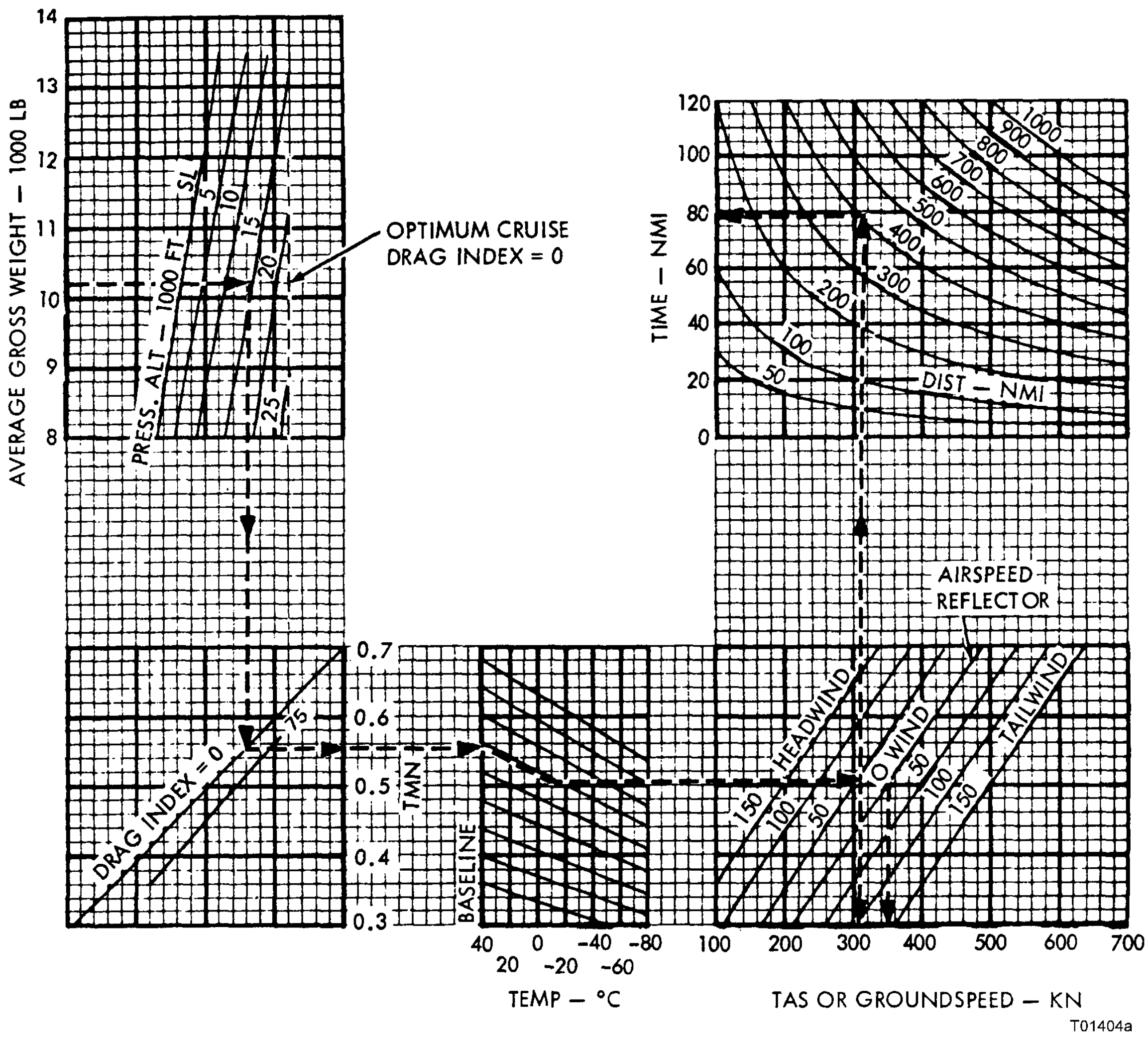


Figure A4-4 (Sheet 2 of 2)

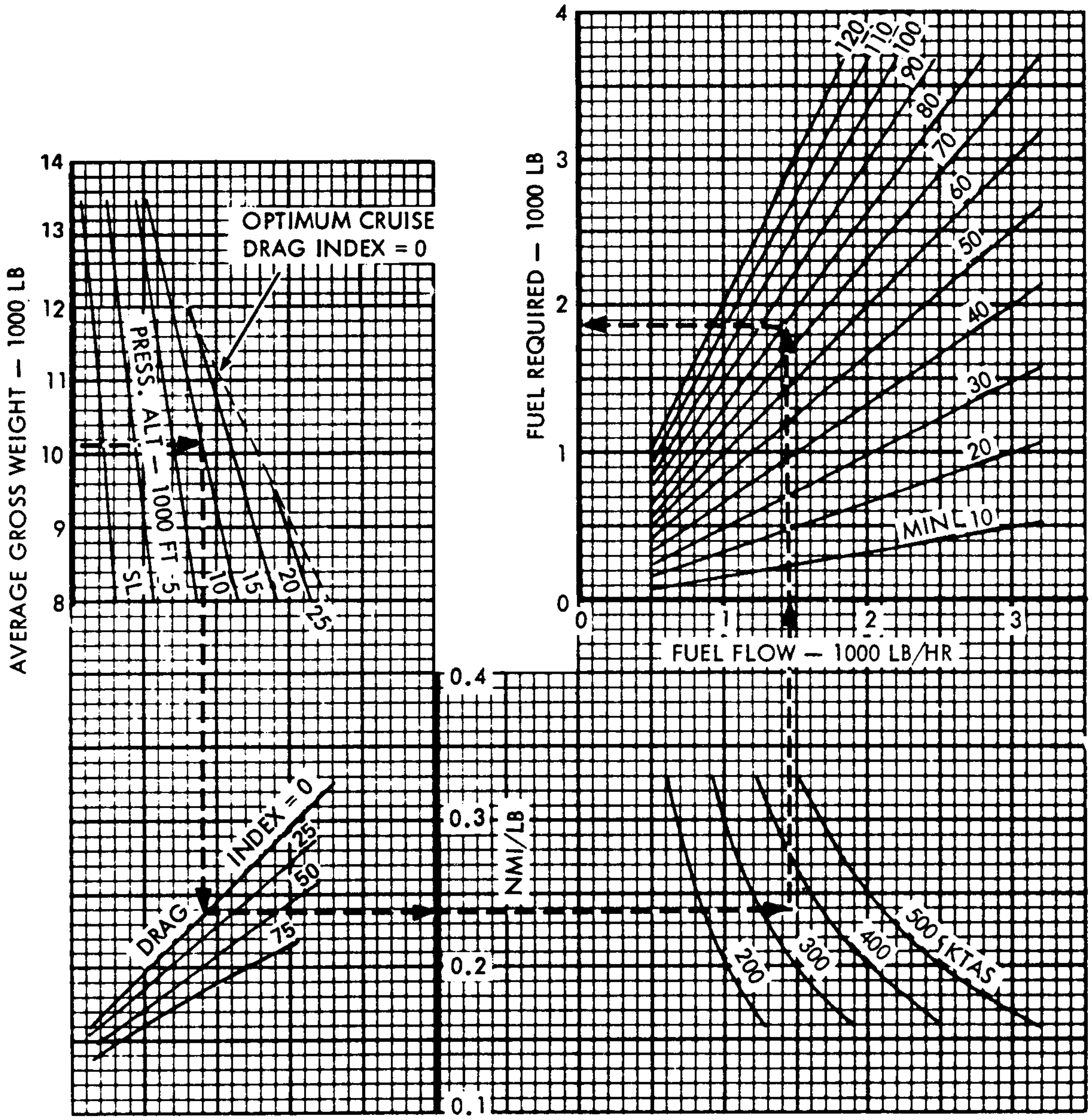
CONSTANT ALTITUDE CRUISE

FUEL FLOW AND FUEL REQUIRED

MODEL: T-38A
DATA: 1 OCTOBER 1976
DATA BASIS: **ESTIMATED DATA**

SINGLE ENGINE

ENGINE: (2) J85-GE-5
FUEL: JP-4
FUEL DENSITY: 6.5 LB/US GAL



T01A404b

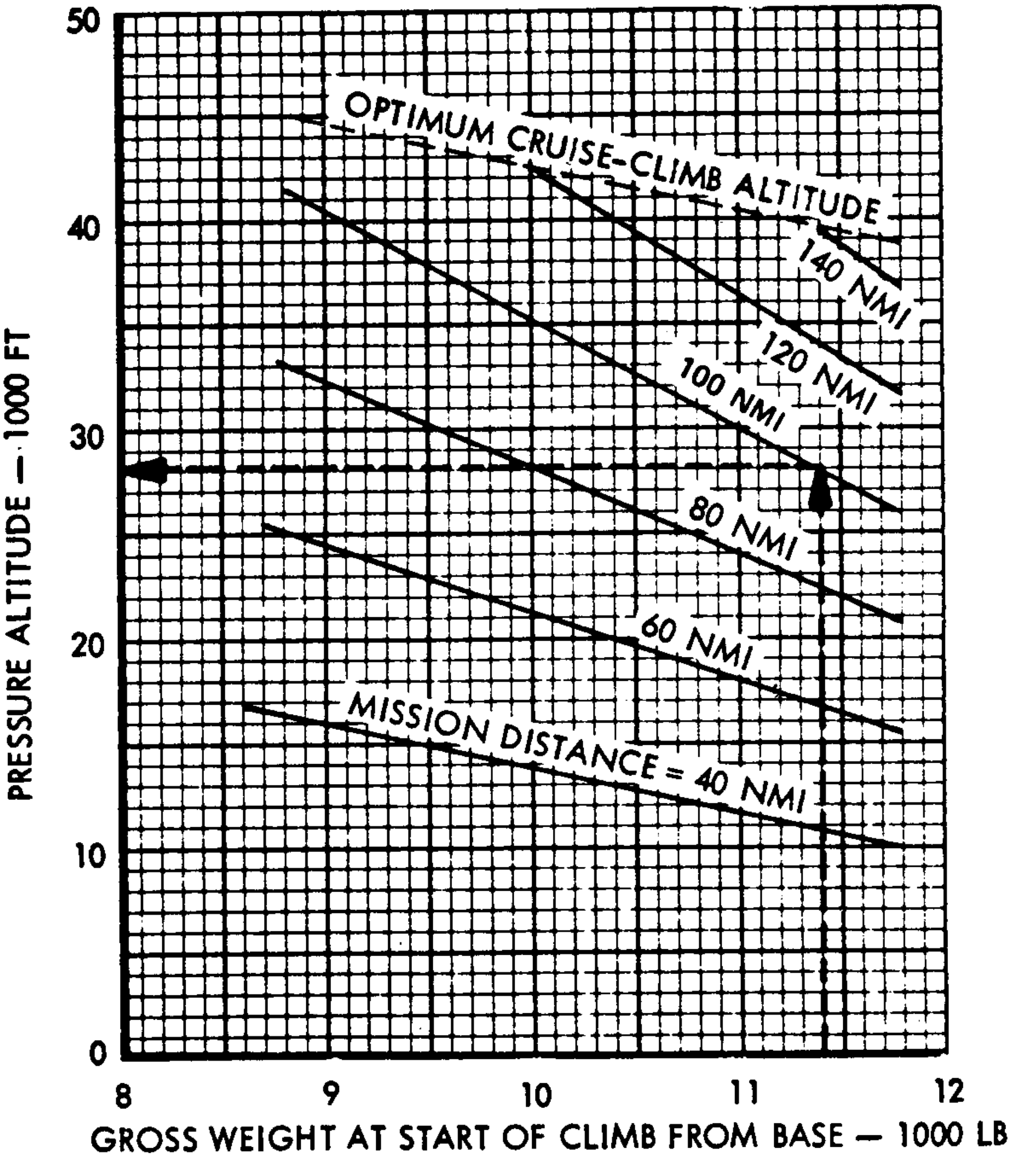
Figure A4-5

OPTIMUM CRUISE ALTITUDE FOR SHORT RANGE MISSIONS

CONSTANT ALTITUDE CRUISE
DRAG INDEX = 0

MODEL: T-38A
DATA: 1 AUGUST 1965
DATA BASIS: **FLIGHT TEST**

ENGINE: (2) J85-GE-5
FUEL: JP-4
FUEL DENSITY: 6.5 LB/US GAL



T01A405

NOTE

MIL thrust climb on course included in mission distance.

Figure A4-6

DIVERSION RANGE SUMMARY TABLE

CONSTANT ALTITUDE CRUISE
STANDARD DAY ZERO WIND

MODEL: T-38A
DATE: 1 JULY 1978
DATA BASIS: **ESTIMATED DATA**

TWO ENGINE
DRAG INDEX=0

ENGINE: (2) J85-GE-5
FUEL: JP-4
FUEL DENSITY: 6.5 LB/US GAL

FUEL	1,000 FT.	SL	5	10	15	20	25	30	35	40	45	PROCEDURE
		RANGE AND TIME REMAINING WITH 300-LB RESERVES AT SEA LEVEL — INITIAL ALTITUDE										
600 LB	NMI	39	46	51	56	60	65	70	73	76	73	CRUISE AT INITIAL ALTITUDE TO BASE [1]
	MIN	7	10	12	13	16	17	18	20	21	23	
	1,000 FT	10/20	10/25	15/30	20/35	25/35	30/40	30/40	35/45	40/45	40/45	OPTIMUM ALTITUDE
	NMI	43	48	54	60	66	74	82	87	94	95	USE OPTIMUM ALTITUDE UNTIL OVER BASE [2]
	MIN	8	9	10	12	13	14	15	17	18	18	
	NMI	64	74	84	95	105	117	128	138	148	154	USE OPTIMUM ALTITUDE AND DESCEND ON COURSE [3]
	MIN	11	12	15	16	17	18	19	21	22	23	
800 LB	NMI	65	76	86	96	106	118	130	139	148	147	CRUISE AT INITIAL ALTITUDE TO BASE [2]
		11	15	18	20	22	24	26	29	30	31	
	1,000 FT	25/35	30/40	30/40	30/45	35/45	40/45	40/45	40/45	40/45	45	OPTIMUM ALTITUDE
	NMI	84	95	106	116	126	137	148	157	166	168	USE OPTIMUM ALTITUDE UNTIL OVER BASE [2]
	MIN	15	17	18	20	22	23	24	25	26	27	
	NMI	124	139	152	166	179	191	203	213	222	228	USE OPTIMUM ALTITUDE AND DESCEND ON COURSE [3]
	MIN	19	20	22	24	26	27	29	30	31	31	
1,000 LB	NMI	90	106	121	137	152	170	189	204	219	220	CRUISE AT INITIAL ALTITUDE TO BASE [1]
	MIN	15	20	23	26	29	31	34	37	39	40	
	1,000 FT	35-45	40/45	40/45	40/45	40/45	40/45	40/45	40/45	40/45	45	OPTIMUM ALTITUDE
	NMI	143	157	171	185	197	208	219	229	237	240	USE OPTIMUM ALTITUDE UNTIL OVER BASE [2]
	MIN	24	25	27	29	30	32	33	34	35	35	
	NMI	196	212	226	240	252	264	276	286	295	301	USE OPTIMUM ALTITUDE AND DESCEND ON COURSE [3]
	MIN	28	30	31	33	34	36	37	38	39	40	
1,400 LB	NMI	142	166	192	217	244	273	306	332	360	360	CRUISE AT INITIAL ALTITUDE TO BASE [1]
	MIN	24	29	34	38	42	45	50	54	56	56	
	1,000 FT	40/45	40/45	40/45	40/45	40/45	40/45	40/45	40/45	40/45	45	OPTIMUM ALTITUDE
	NMI	282	297	311	324	337	348	359	369	378	381	USE OPTIMUM ALTITUDE UNTIL OVER BASE [2]
	MIN	41	43	44	46	47	49	50	51	52	53	
	NMI	339	352	369	382	395	406	418	428	437	441	USE OPTIMUM ALTITUDE AND DESCEND ON COURSE [3]
	MIN	45	47	48	50	51	53	54	55	56	56	
CRUISE ALT		SL	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	
CRUISE MACH NO.		0.54	0.56	0.59	0.64	.068	0.73	0.77	0.81	0.85	0.89	
APPROX FUEL FLOW LB/HR		1325	1200	1050	975	900	825	750	700	675	650	
DESCENT 240 KCAS IDLE [4]	NMI REMAINING		8	16	24	32	40	49	59	70	81	
	MIN REMAINING		2	4	5	7	8	9	11	12	14	
	FUEL REMAINING		312	328	340	352	363	375	386	397	407	

NOTE

With more than 1,400 pounds fuel, cruise at 0.90 MACH, pressure altitude 43,000 feet.

[1] FUEL AND TIME INCLUDED FOR DESCENT AT DESTINATION WITHOUT DISTANCE CREDIT, SPEED BRAKE CLOSED.
[2] TIME AND FUEL INCLUDED FOR CLIMB TO OPTIMUM ALTITUDE AND DESCENT AT DESTINATION; NO DISTANCE CREDIT FOR DESCENT TO SEA LEVEL DESTINATION, SPEED BRAKE OPEN.
[3] TIME AND FUEL INCLUDED FOR CLIMB TO OPTIMUM ALTITUDE AND DESCENT AT DESTINATION RANGE INCLUDES DISTANCE FOR ON-COURSE DESCENT TO SEA LEVEL DESTINATION, SPEED BRAKE CLOSED.
[4] DESCENT DATA TABULATED FOR SPEED BRAKE CLOSED; WITH SPEED BRAKE OPEN, USE ONE-HALF OF THE VALUES.
[5] CLIMB USING FOLLOWING MIL THRUST CLIMB SPEED SCHEDULE.
[6] TIME, DISTANCE, AND FUEL (APPROXIMATELY 120 POUNDS) FOR ACCELERATION TO CLIMB SPEED NOT INCLUDED.

PRESS. ALT (1,000 FT.)	SL	5	10	15	20	25	30	35	40	45
TRUE MACH	0.75	0.76	0.78	0.79	0.81	0.83	0.84	0.86	0.87	0.87
KCAS	496	466	435	406	377	349	322	295	264	236

Figure A4-7

DIVERSION RANGE SUMMARY TABLE

CONSTANT ALTITUDE CRUISE
STANDARD DAY ZERO WIND

MODEL: T-38A
DATE: 1 JULY 1978
DATA BASIS: **ESTIMATED DATA**

TWO ENGINE

DRAG INDEX=50

ENGINE: (2) J85-GE-5
FUEL: JP-4
FUEL DENSITY: 6.5 LB/US GAL

RANGE AND TIME REMAINING WITH 300-LB RESERVES AT SEA LEVEL												PROCEDURE
FUEL	**1,000 FT.**	**INITIAL ALTITUDE**										
		SL	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	
600 LB	NMI	37	43	48	53	57	62	68	71	75	75	CRUISE AT INITIAL ALTITUDE TO BASE **[1]**
	MIN	7	9	11	13	14	16	18	19	20	21	
	1,000 FT	5/15	10/20	10/25	15/30	20/35	25/40	30/40	35/40	40/45	45	OPTIMUM ALTITUDE
	NMI	39	44	50	56	63	70	77	82	89	89	USE OPTIMUM ALTITUDE UNTIL OVER BASE **[2]**
	MIN	7	8	10	11	12	13	15	16	16	17	
	NMI	54	66	74	87	98	108	119	128	138	142	USE OPTIMUM ALTITUDE AND DESCEND ON COURSE **[3]**
	MIN	10	11	12	14	16	17	18	19	20	21	
800 LB	NMI	61	72	81	91	101	111	124	132	141	141	CRUISE AT INITIAL ALTITUDE TO BASE **[1]**
	MIN	11	14	16	19	21	23	26	27	28	29	
	1,000 FT	20/35	25/35	30/40	30/40	35/40	40/45	40/45	40/45	40/45	45	OPTIMUM ALTITUDE
	NMI	75	85	96	107	116	126	137	147	155	157	USE OPTIMUM ALTITUDE UNTIL OVER BASE **[2]**
	MIN	14	15	17	19	20	21	22	24	25	25	
	NMI	108	123	137	151	163	175	187	197	207	210	USE OPTIMUM ALTITUDE AND DESCEND ON COURSE **[3]**
	MIN	17	19	20	22	23	25	26	27	28	29	
1,000 LB	NMI	86	100	114	129	144	160	179	192	207	208	CRUISE AT INITIAL ALTITUDE TO BASE **[1]**
	MIN	16	19	22	25	27	30	33	35	36	36	
	1,000 FT	30/40	35/45	40/45	40/45	40/45	40/45	40/45	40/45	45	45	OPTIMUM ALTITUDE
	NMI	126	140	154	168	180	191	203	212	222	224	USE OPTIMUM ALTITUDE UNTIL OVER BASE **[2]**
	MIN	21	23	25	26	28	29	30	32	32	32	
	NMI	171	188	204	218	231	243	255	265	275	277	USE OPTIMUM ALTITUDE AND DESCEND ON COURSE **[3]**
	MIN	25	27	28	30	31	33	34	35	36	36	
1,400 LB	NMI	134	156	180	204	230	257	288	310	336	-	CRUISE AT INITIAL ALTITUDE TO BASE **[1]**
	MIN	24	29	32	36	40	43	48	50	52	-	
	1,000 FT	40/45	45	45	45	45	45	45	45	45	45	OPTIMUM ALTITUDE
	NMI	251	268	284	298	312	325	339	341	350	355	USE OPTIMUM ALTITUDE UNTIL OVER BASE **[2]**
	MIN	36	38	40	42	43	45	46	48	49	49	
	NMI	304	321	337	352	365	378	392	395	398	400	USE OPTIMUM ALTITUDE AND DESCEND ON COURSE **[3]**
	MIN	40	42	44	46	47	49	51	51	52	43	
CRUISE ALT		SL	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	
CRUISE MACH NO.		0.50	0.54	0.58	0.63	0.67	0.71	0.76	0.80	0.85	0.89	
APPROX FUEL FLOW LB/HR		1350	1225	1100	1025	950	875	800	750	725	725	
DESCENT 240 KCAS IDLE [4]	NMI REMAINING		7	15	22	30	38	45	53	62	69	
	MIN REMAINING		2	3	5	6	7	9	10	11	12	
	FUEL REMAINING		312	225	337	347	356	365	373	382	390	

NOTE

With more than 1,400 pounds fuel, cruise at 0.88 MACH, pressure altitude 43,000 feet.

[1] FUEL AND TIME INCLUDED FOR DESCENT AT DESTINATION WITHOUT DISTANCE CREDIT, SPEED BRAKE CLOSED.
[2] TIME AND FUEL INCLUDED FOR CLIMB TO OPTIMUM ALTITUDE AND DESCENT AT DESTINATION; NO DISTANCE CREDIT FOR DESCENT TO SEA LEVEL DESTINATION, SPEED BRAKE OPEN.
[3] TIME AND FUEL INCLUDED FOR CLIMB TO OPTIMUM ALTITUDE AND DESCENT AT DESTINATION RANGE INCLUDES DISTANCE FOR ON-COURSE DESCENT TO SEA LEVEL DESTINATION, SPEED BRAKE CLOSED.
[4] DESCENT DATA TABULATED FOR SPEED BRAKE CLOSED; WITH SPEED BRAKE OPEN, USE ONE-HALF OF THE VALUES.
[5] CLIMB USING FOLLOWING MIL THRUST CLIMB SPEED SCHEDULE.
[6] TIME, DISTANCE, AND FUEL (APPROXIMATELY 120 POUNDS) FOR ACCELERATION TO CLIMB SPEED NOT INCLUDED.

PRESS. ALT (1,000 FT.)	SL	5	10	15	20	25	30	35	40	45
TRUE MACH	0.75	0.76	0.78	0.79	0.81	0.83	0.84	0.86	0.87	0.87
KCAS	496	466	435	406	377	349	322	295	264	236

Figure A4-8

DIVERSION RANGE SUMMARY TABLE

CONSTANT ALTITUDE CRUISE
STANDARD DAY ZERO WIND

MODEL: T-38A
DATE: 1 JULY 1978
DATA BASIS: **ESTIMATED DATA**

TWO ENGINE
DRAG INDEX=50

ENGINE: (2) J85-GE-5
FUEL: JP-4
FUEL DENSITY: 6.5 LB/US GAL

RANGE AND TIME REMAINING WITH 300-LB RESERVES AT SEA LEVEL												PROCEDURE
FUEL	**1,000 FT.**	**INITIAL ALTITUDE**										
		SL	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	
600 LB	NMI	35	48	45	50	55	59	65	68	71	-	CRUISE AT INITIAL ALTITUDE TO BASE **[1]**
	MIN	7	8	11	12	14	16	17	18	19	-	
	1,000 FT	5/15	5/20	10/25	15/30	20/30	25/35	30/40	35/40	40	40	OPTIMUM ALTITUDE
	NMI	36	42	47	53	59	66	73	77	82	83	USE OPTIMUM ALTITUDE UNTIL OVER BASE **[2]**
	MIN	6	8	10	10	12	13	14	15	15	15	
	NMI	48	59	69	80	89	99	110	120	128	131	USE OPTIMUM ALTITUDE AND DESCEND ON COURSE **[3]**
	MIN	8	10	12	13	14	15	17	18	19	19	
800 LB	NMI	58	68	77	86	96	106	117	124	132	-	CRUISE AT INITIAL ALTITUDE TO BASE **[1]**
	MIN	11	13	16	18	21	22	24	25	26	-	
	1,000 FT	15/30	20/30	25/35	30/40	30/40	35/40	40	40	40	40	OPTIMUM ALTITUDE
	NMI	67	77	87	98	107	116	126	135	143	144	USE OPTIMUM ALTITUDE UNTIL OVER BASE **[2]**
	MIN	12	14	15	17	18	20	21	22	23	23	
	NMI	94	108	122	136	148	160	171	181	189	192	USE OPTIMUM ALTITUDE AND DESCEND ON COURSE **[3]**
	MIN	15	17	18	20	21	23	24	25	26	27	
1,000 LB	NMI	81	95	108	122	137	151	169	180	192	-	CRUISE AT INITIAL ALTITUDE TO BASE **[1]**
	MIN	16	18	21	23	27	29	31	33	34	-	
	1,000 FT	30/40	30/40	35/40	40	40	40	40	40	40	40	OPTIMUM ALTITUDE
	NMI	110	125	138	151	163	175	186	196	204	204	USE OPTIMUM ALTITUDE UNTIL OVER BASE **[2]**
	MIN	19	21	22	24	25	27	28	29	30	31	
	NMI	148	166	182	196	208	220	232	241	249	252	USE OPTIMUM ALTITUDE AND DESCEND ON COURSE **[3]**
	MIN	21	24	25	27	29	30	32	33	34	35	
1,400 LB	NMI	127	148	170	193	218	242	271	289	311	-	CRUISE AT INITIAL ALTITUDE TO BASE **[1]**
	MIN	24	27	32	34	39	41	45	47	49	-	
	1,000 FT	40	40	40	40	40	40	40	40	40	40	OPTIMUM ALTITUDE
	NMI	221	239	255	269	282	294	305	314	322	323	USE OPTIMUM ALTITUDE UNTIL OVER BASE **[2]**
	MIN	32	35	37	38	40	41	43	44	45	45	
	NMI	226	284	300	314	327	339	350	360	368	370	USE OPTIMUM ALTITUDE AND DESCEND ON COURSE **[3]**
	MIN	36	38	40	42	44	45	46	48	49	49	
CRUISE ALT		SL	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	
CRUISE MACH NO.		0.47	.052	0.56	0.61	0.65	0.70	0.75	0.79	0.84	DESCEND TO 40,000 FT	
APPROX FUEL FLOW LB/HR		1350	1250	1125	1075	1000	900	850	775	775		
DESCENT 240 KCAS IDLE [4]	NMI REMAINING	7	14	20	27	34	42	49	57	64		
	MIN REMAINING	1	3	4	6	7	8	9	10	11		
	FUEL REMAINING	310	323	333	342	352	360	368	375	382		

NOTE

With more than 1,400 pounds fuel, cruise at 0.86 MACH, pressure altitude 43,000 feet.

[1] FUEL AND TIME INCLUDED FOR DESCENT AT DESTINATION WITHOUT DISTANCE CREDIT, SPEED BRAKE CLOSED.
[2] TIME AND FUEL INCLUDED FOR CLIMB TO OPTIMUM ALTITUDE AND DESCENT AT DESTINATION; NO DISTANCE CREDIT FOR DESCENT TO SEA LEVEL DESTINATION, SPEED BRAKE OPEN.
[3] TIME AND FUEL INCLUDED FOR CLIMB TO OPTIMUM ALTITUDE AND DESCENT AT DESTINATION RANGE INCLUDES DISTANCE FOR ON-COURSE DESCENT TO SEA LEVEL DESTINATION, SPEED BRAKE CLOSED.
[4] DESCENT DATA TABULATED FOR SPEED BRAKE CLOSED; WITH SPEED BRAKE OPEN, USE ONE-HALF OF THE VALUES.
[5] CLIMB USING FOLLOWING MIL THRUST CLIMB SPEED SCHEDULE.
[6] TIME, DISTANCE, AND FUEL (APPROXIMATELY 120 POUNDS) FOR ACCELERATION TO CLIMB SPEED NOT INCLUDED.

PRESS. ALT (1,000 FT.)	SL	5	10	15	20	25	30	35	40	45
TRUE MACH	0.75	0.76	0.78	0.79	0.81	0.83	0.84	0.86	0.87	0.87
KCAS	496	466	435	406	377	349	322	295	264	236

Figure A4-9

DIVERSION RANGE SUMMARY TABLE

CONSTANT ALTITUDE CRUISE
STANDARD DAY ZERO WIND

MODEL: T-38A
DATE: 1 JULY 1978
DATA BASIS: **ESTIMATED DATA**

TWO ENGINE
DRAG INDEX=75

ENGINE: (2) J85-GE-5
FUEL: JP-4
FUEL DENSITY: 6.5 LB/US GAL

RANGE AND TIME REMAINING WITH 300-LB RESERVES AT SEA LEVEL												PROCEDURE
FUEL	**1,000 FT.**	**INITIAL ALTITUDE**										
		SL	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	
600 LB	NMI	33	39	44	48	52	57	62	64	67	-	CRUISE AT INITIAL ALTITUDE TO BASE **[1]**
	MIN	6	8	10	12	13	14	16	17	17	-	
	1,000 FT	0/10	5/15	10/20	15/25	20/30	25/30	30/35	35/40	40	40	OPTIMUM ALTITUDE
	NMI	33	39	45	50	56	62	69	73	77	77	USE OPTIMUM ALTITUDE UNTIL OVER BASE **[2]**
	MIN	6	8	9	10	11	12	13	14	14	14	
	NMI	42	52	62	72	83	92	101	112	120	123	USE OPTIMUM ALTITUDE AND DESCEND ON COURSE **[3]**
	MIN	7	9	10	11	13	14	15	16	17	18	
800 LB	NMI	55	64	73	82	91	100	110	117	123	-	CRUISE AT INITIAL ALTITUDE TO BASE **[1]**
	MIN	11	13	15	17	19	20	22	24	25	-	
	1,000 FT	10/25	15/30	20/30	25/35	30/40	30/40	30/40	35/40	40	40	OPTIMUM ALTITUDE
	NMI	60	69	79	88	99	108	117	125	133	134	USE OPTIMUM ALTITUDE UNTIL OVER BASE **[2]**
	MIN	11	13	14	15	17	18	20	21	21	22	
	NMI	80	95	109	121	135	147	159	168	176	179	USE OPTIMUM ALTITUDE AND DESCEND ON COURSE **[3]**
	MIN	12	14	16	18	19	21	22	23	25	26	
1,000 LB	NMI	77	90	103	116	129	143	159	169	179	-	CRUISE AT INITIAL ALTITUDE TO BASE **[1]**
	MIN	15	17	20	23	24	27	29	31	32	-	
	1,000 FT	25/30	30/35	30/40	30/40	35/40	40	40	40	40	40	OPTIMUM ALTITUDE
	NMI	96	110	125	137	149	160	172	181	189	189	USE OPTIMUM ALTITUDE UNTIL OVER BASE
	MIN	16	18	20	22	23	24	26	27	28	29	
	NMI	126	144	162	177	191	203	215	224	232	234	USE OPTIMUM ALTITUDE AND DESCEND ON COURSE **[3]**
	MIN	18	21	22	24	26	28	29	30	32	32	
1,400 LB	NMI	121	141	162	183	205	228	254	272	289	-	CRUISE AT INITIAL ALTITUDE TO BASE **[1]**
	MIN	23	27	30	33	36	39	42	44	45	-	
	1,000 FT	40	40	40	40	40	40	40	40	40	40	OPTIMUM ALTITUDE
	NMI	191	211	229	244	258	270	282	291	299	301	USE OPTIMUM ALTITUDE UNTIL OVER BASE **[2]**
	MIN	28	31	33	35	37	38	40	41	42	43	
	NMI	234	254	272	287	301	313	325	334	342	346	USE OPTIMUM ALTITUDE AND DESCEND ON COURSE **[3]**
	MIN	31	34	36	38	40	41	43	44	45	46	
CRUISE ALT		SL	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	DESCEND TO 40,000 FT	
CRUISE MACH NO.		0.47	0.52	0.56	0.61	0.65	0.70	0.75	0.79	0.84		
APPROX FUEL FLOW LB/HR		1400	1300	1200	1125	1050	975	900	850	825		
DESCENT 240 KCAS IDLE [4]	NMI REMAINING		6	13	19	25	32	39	45	53		
	MIN REMAINING		1	3	4	5	6	7	8	9		
	FUEL REMAINING		310	320	330	339	348	356	363	370		

NOTE

With more than 1,400 pounds fuel, cruise at 0.86 MACH, pressure altitude 39,000 feet.

[1] FUEL AND TIME INCLUDED FOR DESCENT AT DESTINATION WITHOUT DISTANCE CREDIT, SPEED BRAKE CLOSED.
[2] TIME AND FUEL INCLUDED FOR CLIMB TO OPTIMUM ALTITUDE AND DESCENT AT DESTINATION; NO DISTANCE CREDIT FOR DESCENT TO SEA LEVEL DESTINATION, SPEED BRAKE OPEN.
[3] TIME AND FUEL INCLUDED FOR CLIMB TO OPTIMUM ALTITUDE AND DESCENT AT DESTINATION RANGE INCLUDES DISTANCE FOR ON-COURSE DESCENT TO SEA LEVEL DESTINATION, SPEED BRAKE CLOSED.
[4] DESCENT DATA TABULATED FOR SPEED BRAKE CLOSED; WITH SPEED BRAKE OPEN, USE ONE-HALF OF THE VALUES.
[5] CLIMB USING FOLLOWING MIL THRUST CLIMB SPEED SCHEDULE.
[6] TIME, DISTANCE, AND FUEL (APPROXIMATELY 120 POUNDS) FOR ACCELERATION TO CLIMB SPEED NOT INCLUDED.

PRESS. ALT (1,000 FT.)	SL	5	10	15	20	25	30	35	40	45
TRUE MACH	0.75	0.76	0.78	0.79	0.81	0.83	0.84	0.86	0.87	0.87
KCAS	496	466	435	406	377	349	322	295	264	236

Figure A4-10

DIVERSION RANGE SUMMARY TABLE

CONSTANT ALTITUDE CRUISE
STANDARD DAY ZERO WIND

MODEL: T-38A
DATE: 1 JULY 1978
DATA BASIS: **ESTIMATED DATA**

SINGLE ENGINE

DRAG INDEX=0

ENGINE: (2) J85-GE-5
FUEL: JP-4
FUEL DENSITY: 6.5 LB/US GAL

RANGE AND TIME REMAINING WITH 300-LB RESERVES AT SEA LEVEL												PROCEDURE
FUEL	1,000 FT.	INITIAL ALTITUDE										
		SL	5	10	15	20	25	30	35	40	45	
600 LB	NMI	53	60	65	71	76	28	-	-	-	-	CRUISE AT INITIAL ALTITUDE TO BASE [1]
	MIN	11	14	16	18	20	21	-	-	-	-	
	1,000 FT	5/15	10/20	10/20	15/20	20/25	25	25	25	25	25	OPTIMUM ALTITUDE
	NMI	55	60	67	73	80	83	88	97	106	116	USE OPTIMUM ALTITUDE UNTIL OVER BASE [2]
	MIN	12	14	15	16	17	17	18	20	20	22	
	NMI	70	80	91	100	110	118	124	132	142	151	USE OPTIMUM ALTITUDE AND DESCEND ON COURSE [3]
	MIN	14	16	17	19	20	21	21	23	24	25	
800 LB	NMI	87	99	110	119	131	134	-	-	-	-	CRUISE AT INITIAL ALTITUDE TO BASE [1]
	MIN	18	22	25	26	29	30	-	-	-	-	
	1,000 FT	10/20	15/25	20/25	20/25	20/25	25	20/25	20/25	20/25	20/25	OPTIMUM ALTITUDE
	NMI	97	106	116	126	134	139	146	155	164	174	USE OPTIMUM ALTITUDE UNTIL OVER BASE [2]
	MIN	21	22	24	25	26	26	27	29	30	32	
	NMI	123	134	146	156	166	174	180	188	198	208	USE OPTIMUM ALTITUDE AND DESCEND ON COURSE [3]
	MIN	23	25	26	28	29	30	30	32	33	34	
1,000 LB	NMI	122	138	154	168	185	189	-	-	-	-	CRUISE AT INITIAL ALTITUDE TO BASE [1]
	MIN	25	29	33	35	38	38	-	-	-	-	
	1,000 FT	20/25	20/25	20/25	20/25	20/25	25	20/25	20/25	20/25	20/25	OPTIMUM ALTITUDE
	NMI	148	159	169	179	188	194	200	209	218	228	USE OPTIMUM ALTITUDE UNTIL OVER BASE [2]
	MIN	29	31	33	34	35	35	36	38	39	41	
	NMI	178	190	201	211	221	229	235	244	253	263	USE OPTIMUM ALTITUDE AND DESCEND ON COURSE [3]
	MIN	32	34	35	36	38	38	39	41	42	43	
1,400 LB	NMI	189	214	239	261	288	294	-	-	-	-	CRUISE AT INITIAL ALTITUDE TO BASE [1]
	MIN	39	44	49	51	55	55	-	-	-	-	
	1,000 FT	20/25	20/25	20/25	20/25	20/25	25	25	25	25	25	OPTIMUM ALTITUDE
	NMI	250	261	272	282	291	299	304	313	322	332	USE OPTIMUM ALTITUDE UNTIL OVER BASE [2]
	MIN	47	48	50	51	53	52	53	54	55	57	
	NMI	282	294	305	316	325	334	339	348	358	367	USE OPTIMUM ALTITUDE AND DESCEND ON COURSE [3]
	MIN	49	51	52	53	55	55	56	58	58	60	

CRUISE ALT		SL	5	10	15	20	25	DESCEND TO 20,000 OR 25,000 FT
CRUISE MACH NO.		0.44	0.47	0.50	0.54	0.58	0.62	USE IDLE THRUST AND 240 KCAS WITH SPEED BRAKE CLOSED.
APPROX FUEL FLOW LB/HR		1650	1550	1400	1350	1300	1275	
DESCENT 240 KCAS IDLE [4]	NMI REMAINING		8	16	24	32	40	
	MIN REMAINING		2	4	5	7	8	
	FUEL REMAINING		306	314	320	326	332	

NOTE

With more than 1,400 pounds fuel, cruise at 0.62 MACH, pressure altitude 23,000 feet.

[1] FUEL AND TIME INCLUDED FOR DESCENT AT DESTINATION WITHOUT DISTANCE CREDIT, SPEED BRAKE CLOSED.
[2] TIME AND FUEL INCLUDED FOR CLIMB TO OPTIMUM ALTITUDE AND DESCENT AT DESTINATION; NO DISTANCE CREDIT FOR DESCENT TO SEA LEVEL DESTINATION, SPEED BRAKE OPEN.
[3] TIME AND FUEL INCLUDED FOR CLIMB TO OPTIMUM ALTITUDE AND DESCENT AT DESTINATION RANGE INCLUDES DISTANCE FOR ON-COURSE DESCENT TO SEA LEVEL DESTINATION, SPEED BRAKE CLOSED.
[4] DESCENT DATA TABULATED FOR SPEED BRAKE CLOSED; WITH SPEED BRAKE OPEN, USE ONE-HALF OF THE VALUES.
[5] CLIMB USING FOLLOWING MIL THRUST CLIMB SPEED SCHEDULE.
[6] TIME, DISTANCE, AND FUEL (APPROXIMATELY 120 POUNDS) FOR ACCELERATION TO CLIMB SPEED NOT INCLUDED.

PRESS. ALT (1,000 FT.)	SL	5	10	15	20	25
TRUE MACH	0.43	0.46	0.49	0.52	0.56	0.59
KCAS	281	278	271	264	256	246

Figure A4-11

DIVERSION RANGE SUMMARY TABLE

CONSTANT ALTITUDE CRUISE
STANDARD DAY ZERO WIND

MODEL: T-38A
DATE: 1 JULY 1978
DATA BASIS: **ESTIMATED DATA**

SINGLE ENGINE

DRAG INDEX=25

ENGINE: (2) J85-GE-5
FUEL: JP-4
FUEL DENSITY: 6.5 LB/US GAL

RANGE AND TIME REMAINING WITH 300-LB RESERVES AT SEA LEVEL												PROCEDURE
FUEL	1,000 FT.	INITIAL ALTITUDE										
		SL	5	10	15	20	25	30	35	40	45	
600 LB	NMI	49	55	61	65	71	-	-	-	-	-	CRUISE AT INITIAL ALTITUDE TO BASE [1]
	MIN	11	13	15	17	18	-	-	-	-	-	
	1,000 FT	5/15	5/15	10/20	15/20	20	20	20	20	20	20	OPTIMUM ALTITUDE
	NMI	50	56	62	67	74	76	85	92	100	106	USE OPTIMUM ALTITUDE UNTIL OVER BASE [2]
	MIN	11	12	13	15	16	16	18	19	20	21	
	NMI	63	72	84	93	101	107	112	119	127	133	USE OPTIMUM ALTITUDE AND DESCEND ON COURSE [3]
	MIN	13	14	16	17	18	19	21	21	22	23	
800 LB	NMI	81	92	102	110	120	-	-	-	-	-	CRUISE AT INITIAL ALTITUDE TO BASE [1]
	MIN	18	21	23	25	27	-	-	-	-	-	
	1,000 FT	10/20	15/20	20	20	20/25	20	20	20	20	20	OPTIMUM ALTITUDE
	NMI	89	97	106	116	123	126	135	142	150	156	USE OPTIMUM ALTITUDE UNTIL OVER BASE [2]
	MIN	19	20	22	23	24	25	27	27	28	29	
	NMI	111	123	133	143	153	156	162	169	177	183	USE OPTIMUM ALTITUDE AND DESCEND ON COURSE [3]
	MIN	21	23	24	26	26	27	29	30	31	32	
1,000 LB	NMI	113	128	142	154	169	-	-	-	-	-	CRUISE AT INITIAL ALTITUDE TO BASE [1]
	MIN	25	28	30	33	35	-	-	-	-	-	
	1,000 FT	20	20/25	20/25	20/25	20	20	20	20	20	20	OPTIMUM ALTITUDE
	NMI	133	144	155	165	172	174	183	190	198	204	USE OPTIMUM ALTITUDE UNTIL OVER BASE [2]
	MIN	27	29	30	31	33	33	35	36	37	37	
	NMI	160	171	185	194	199	205	210	217	225	231	USE OPTIMUM ALTITUDE AND DESCEND ON COURSE [3]
	MIN	29	31	32	33	35	36	37	38	39	40	
1,400 LB	NMI	176	198	221	240	262	-	-	-	-	-	CRUISE AT INITIAL ALTITUDE TO BASE [1]
	MIN	39	43	45	48	51	-	-	-	-	-	
	1,000 FT	20	20	20	20	20	20	20	20	20	20	OPTIMUM ALTITUDE
	NMI	226	237	248	257	265	267	276	283	291	297	USE OPTIMUM ALTITUDE UNTIL OVER BASE [2]
	MIN	43	45	46	47	48	49	51	52	53	53	
	NMI	253	264	275	284	292	297	303	310	318	324	USE OPTIMUM ALTITUDE AND DESCEND ON COURSE [3]
	MIN	45	47	49	50	51	52	53	54	55	56	

CRUISE ALT		SL	**5**	**10**	**15**	**20**	**25**
CRUISE MACH NO.		0.41	0.45	0.49	0.53	0.57	0.62
APPROX FUEL FLOW LB/HR		1650	1575	1500	1450	1375	1400
DESCENT 240 KCAS IDLE [4]	NMI REMAINING		7	15	22	30	28
	MIN REMAINING		2	3	5	6	7
	FUEL REMAINING		306	313	319	325	330

USE IDLE THRUST AND 240 KCAS WITH SPEED BRAKE CLOSED.

NOTE

With more than 1,400 pounds fuel, cruise at 0.60 MACH, pressure altitude 20,000 feet.

[1] FUEL AND TIME INCLUDED FOR DESCENT AT DESTINATION WITHOUT DISTANCE CREDIT, SPEED BRAKE CLOSED.
[2] TIME AND FUEL INCLUDED FOR CLIMB TO OPTIMUM ALTITUDE AND DESCENT AT DESTINATION; NO DISTANCE CREDIT FOR DESCENT TO SEA LEVEL DESTINATION, SPEED BRAKE OPEN.
[3] TIME AND FUEL INCLUDED FOR CLIMB TO OPTIMUM ALTITUDE AND DESCENT AT DESTINATION RANGE INCLUDES DISTANCE FOR ON-COURSE DESCENT TO SEA LEVEL DESTINATION, SPEED BRAKE CLOSED.
[4] DESCENT DATA TABULATED FOR SPEED BRAKE CLOSED; WITH SPEED BRAKE OPEN, USE ONE-HALF OF THE VALUES.
[5] CLIMB USING FOLLOWING MIL THRUST CLIMB SPEED SCHEDULE.
[6] TIME, DISTANCE, AND FUEL (APPROXIMATELY 120 POUNDS) FOR ACCELERATION TO CLIMB SPEED NOT INCLUDED.

PRESS. ALT (1,000 FT.)	SL	5	10	15	20	25
TRUE MACH	0.43	0.46	0.49	0.52	0.56	0.59
KCAS	281	278	271	264	256	246

Figure A4-12

DIVERSION RANGE SUMMARY TABLE

CONSTANT ALTITUDE CRUISE
STANDARD DAY ZERO WIND

MODEL: T-38A
DATE: 1 JULY 1978
DATA BASIS: **ESTIMATED DATA**

SINGLE ENGINE

DRAG INDEX=50

ENGINE: (2) J85-GE-5
FUEL: JP-4
FUEL DENSITY: 6.5 LB/US GAL

RANGE AND TIME REMAINING WITH 300-LB RESERVES AT SEA LEVEL												**PROCEDURE**
FUEL	**1,000 FT.**	**INITIAL ALTITUDE**										
		SL	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	
600 LB	NMI	45	52	56	60	64	-	-	-	-	-	CRUISE AT INITIAL ALTITUDE TO BASE [1]
	MIN	10	12	14	15	17	-	-	-	-	-	
	1,000 FT	5/15	5/15	10/15	15/20	20	20	20	20	20	20	OPTIMUM ALTITUDE
	NMI	47	52	58	62	67	69	79	85	92	98	USE OPTIMUM ALTITUDE UNTIL OVER BASE [2]
	MIN	10	12	13	14	15	15	16	17	18	19	
	NMI	57	66	74	85	91	96	103	109	117	123	USE OPTIMUM ALTITUDE AND DESCEND ON COURSE [3]
	MIN	12	13	14	16	17	18	19	20	21	22	
800 LB	NMI	77	86	95	102	109	-	-	-	-	-	CRUISE AT INITIAL ALTITUDE TO BASE [1]
	MIN	17	19	22	23	25	-	-	-	-	-	
	1,000 FT	10/15	10/20	15/20	20	20	20	20	20	20	20	OPTIMUM ALTITUDE
	NMI	82	89	97	105	111	113	123	130	137	143	USE OPTIMUM ALTITUDE UNTIL OVER BASE [2]
	MIN	18	19	20	22	23	23	24	25	26	27	
	NMI	98	111	121	130	136	141	148	154	161	168	USE OPTIMUM ALTITUDE AND DESCEND ON COURSE [3]
	MIN	19	21	23	24	26	26	27	28	29	29	
1,000 LB	NMI	107	120	133	143	153	-	-	-	-	-	CRUISE AT INITIAL ALTITUDE TO BASE [1]
	MIN	24	26	29	31	33	-	-	-	-	-	
	1,000 FT	15/20	20	20	20	20	20	20	20	20	20	OPTIMUM ALTITUDE
	NMI	121	130	140	149	155	157	167	174	181	187	USE OPTIMUM ALTITUDE UNTIL OVER BASE [2]
	MIN	25	27	28	30	31	31	32	33	34	35	
	NMI	145	155	165	174	180	185	192	198	205	212	USE OPTIMUM ALTITUDE AND DESCEND ON COURSE [3]
	MIN	28	29	31	33	33	34	35	36	36	37	
1,400 LB	NMI	165	185	206	221	236	-	-	-	-	-	CRUISE AT INITIAL ALTITUDE TO BASE [1]
	MIN	35	40	43	46	48	-	-	-	-	-	
	1,000 FT	20	20	20	20	20	20	20	20	20	20	OPTIMUM ALTITUDE
	NMI	204	215	225	233	239	241	251	257	265	271	USE OPTIMUM ALTITUDE UNTIL OVER BASE [2]
	MIN	40	42	43	44	44	46	47	48	49	50	
	NMI	229	239	249	258	263	269	276	282	389	295	USE OPTIMUM ALTITUDE AND DESCEND ON COURSE [3]
	MIN	43	44	46	47	48	49	50	50	51	52	

CRUISE ALT		SL	**5**	**10**	**15**	**20**	**25**	DESCEND TO 20,000 FT
CRUISE MACH NO.		0.41	0.45	0.49	0.53	0.57		USE IDLE THRUST AND 240 KCAS WITH SPEED BRAKE CLOSED.
APPROX FUEL FLOW LB/HR		1850	1700	1625	1575	1525		
DESCENT 240 KCAS IDLE [4]	NMI REMAINING		7	14	20	27		
	MIN REMAINING		1	3	4	6		
	FUEL REMAINING		305	312	317	321		

NOTE

With more than 1,400 pounds fuel, cruise at 0.58 MACH, pressure altitude 20,000 feet.

[1] FUEL AND TIME INCLUDED FOR DESCENT AT DESTINATION WITHOUT DISTANCE CREDIT, SPEED BRAKE CLOSED.
[2] TIME AND FUEL INCLUDED FOR CLIMB TO OPTIMUM ALTITUDE AND DESCENT AT DESTINATION; NO DISTANCE CREDIT FOR DESCENT TO SEA LEVEL DESTINATION, SPEED BRAKE OPEN.
[3] TIME AND FUEL INCLUDED FOR CLIMB TO OPTIMUM ALTITUDE AND DESCENT AT DESTINATION RANGE INCLUDES DISTANCE FOR ON-COURSE DESCENT TO SEA LEVEL DESTINATION, SPEED BRAKE CLOSED.
[4] DESCENT DATA TABULATED FOR SPEED BRAKE CLOSED; WITH SPEED BRAKE OPEN, USE ONE-HALF OF THE VALUES.
[5] CLIMB USING FOLLOWING MIL THRUST CLIMB SPEED SCHEDULE.
[6] TIME, DISTANCE, AND FUEL (APPROXIMATELY 120 POUNDS) FOR ACCELERATION TO CLIMB SPEED NOT INCLUDED.

PRESS. ALT (1,000 FT.)	SL	5	10	15	20	25
TRUE MACH	0.43	0.46	0.49	0.52	0.56	0.59
KCAS	281	278	271	264	256	246

Figure A4-13

DIVERSION RANGE SUMMARY TABLE

CONSTANT ALTITUDE CRUISE
STANDARD DAY ZERO WIND

MODEL: T-38A
DATE: 1 JULY 1978
DATA BASIS: **ESTIMATED DATA**

SINGLE ENGINE

DRAG INDEX=75

ENGINE: (2) J85-GE-5
FUEL: JP-4
FUEL DENSITY: 6.5 LB/US GAL

RANGE AND TIME REMAINING WITH 300-LB RESERVES AT SEA LEVEL												PROCEDURE
FUEL	1,000 FT.	INITIAL ALTITUDE										
		SL	5	10	15	20	25	30	35	40	45	
600 LB	NMI	44	48	53	56	59	-	-	-	-	-	CRUISE AT INITIAL ALTITUDE TO BASE [1]
	MIN	10	11	13	15	16	-	-	-	-	-	
	1,000 FT	5/10	5/10	10/15	15	20	20	20	20	20	20	OPTIMUM ALTITUDE
	NMI	44	49	54	58	61	63	73	78	85	91	USE OPTIMUM ALTITUDE UNTIL OVER BASE [2]
	MIN	10	11	12	13	13	14	15	16	17	18	
	NMI	53	60	69	75	84	89	96	101	108	113	USE OPTIMUM ALTITUDE AND DESCEND ON COURSE [3]
	MIN	11	12	13	15	16	16	17	18	19	20	
800 LB	NMI	72	81	89	95	100	-	-	-	-	-	CRUISE AT INITIAL ALTITUDE TO BASE [1]
	MIN	16	18	20	22	23	-	-	-	-	-	
	1,000 FT	10/15	10/15	15	20	20	20	20	20	20	20	OPTIMUM ALTITUDE
	NMI	76	83	90	97	102	104	114	119	126	132	USE OPTIMUM ALTITUDE UNTIL OVER BASE [2]
	MIN	17	18	19	20	21	21	22	23	24	25	
	NMI	91	100	108	120	125	130	136	142	149	154	USE OPTIMUM ALTITUDE AND DESCEND ON COURSE [3]
	MIN	18	19	21	22	23	24	24	25	26	27	
1,000 LB	NMI	101	113	124	133	131	-	-	-	-	-	CRUISE AT INITIAL ALTITUDE TO BASE [1]
	MIN	23	25	27	29	28	-	-	-	-	-	
	1,000 FT	10/15	15/20	20	20	20	20	20	20	20	20	OPTIMUM ALTITUDE
	NMI	111	120	129	138	140	144	154	159	166	172	USE OPTIMUM ALTITUDE UNTIL OVER BASE [2]
	MIN	23	25	26	27	27	28	30	30	31	32	
	NMI	129	142	152	161	156	170	177	182	189	195	USE OPTIMUM ALTITUDE AND DESCEND ON COURSE [3]
	MIN	25	27	28	29	28	31	32	33	33	34	
1,400 LB	NMI	156	174	192	206	210	-	-	-	-	-	CRUISE AT INITIAL ALTITUDE TO BASE [1]
	MIN	35	38	41	43	44	-	-	-	-	-	
	1,000 FT	20	20	20	20	20	20	20	20	20	20	OPTIMUM ALTITUDE
	NMI	187	197	208	217	220	224	229	234	237	242	USE OPTIMUM ALTITUDE UNTIL OVER BASE [2]
	MIN	37	38	40	41	41	42	43	44	45	46	
	NMI	210	220	231	236	240	244	250	254	261	265	USE OPTIMUM ALTITUDE AND DESCEND ON COURSE [3]
	MIN	39	40	42	43	43	44	45	46	47	48	

CRUISE ALT		SL	5	10	15	20	25	DESCEND TO 20,000 FT
CRUISE MACH NO.		0.40	0.44	0.48	0.51	0.55		USE IDLE THRUST AND 240 KCAS WITH SPEED BRAKE CLOSED.
APPROX FUEL FLOW LB/HR		1825	1750	1700	1625	1600		
DESCENT 240 KCAS IDLE [4]	NMI REMAINING		6	13	19	25		
	MIN REMAINING		1	3	4	5		
	FUEL REMAINING		305	310	315	320		

NOTE

With more than 1,400 pounds fuel, cruise at 0.56 MACH, pressure altitude 18,000 feet.

[1] FUEL AND TIME INCLUDED FOR DESCENT AT DESTINATION WITHOUT DISTANCE CREDIT, SPEED BRAKE CLOSED.
[2] TIME AND FUEL INCLUDED FOR CLIMB TO OPTIMUM ALTITUDE AND DESCENT AT DESTINATION; NO DISTANCE CREDIT FOR DESCENT TO SEA LEVEL DESTINATION, SPEED BRAKE OPEN.
[3] TIME AND FUEL INCLUDED FOR CLIMB TO OPTIMUM ALTITUDE AND DESCENT AT DESTINATION RANGE INCLUDES DISTANCE FOR ON-COURSE DESCENT TO SEA LEVEL DESTINATION, SPEED BRAKE CLOSED.
[4] DESCENT DATA TABULATED FOR SPEED BRAKE CLOSED; WITH SPEED BRAKE OPEN, USE ONE-HALF OF THE VALUES.
[5] CLIMB USING FOLLOWING MIL THRUST CLIMB SPEED SCHEDULE.
[6] TIME, DISTANCE, AND FUEL (APPROXIMATELY 120 POUNDS) FOR ACCELERATION TO CLIMB SPEED NOT INCLUDED.

PRESS. ALT (1,000 FT.)	SL	5	10	15	20	25
TRUE MACH	0.43	0.46	0.49	0.52	0.56	0.59
KCAS	281	278	271	264	256	246

ENDURANCE

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PURPOSE OF CHARTS

Endurance charts determine the optimum mach number and fuel required to loiter at a given altitude for a specific period of time. A correction grid to gross weight for bank angle and a temperature correction grid (hotter-than-standard conditions) to fuel flow are provided for optional use.

NOTE

The effects of temperature for colder-than-standard day conditions are considered negligible. Use standard day (baseline) for temperatures below standard day.

The altitude for maximum loiter time is defined in the charts by the drag index curves titled “optimum maximum endurance altitude” contained in the gross weight grid. The endurance chart for two-engine operation provides data for drag indices of 0 through 75. The single-engine endurance chart provides data for drag indices of 0 through 75.

USE

Enter the appropriate two-engine or single-engine chart (Figure A5-1 or Figure A5-2) with gross weight. If the loiter period requires turning flight, gross weight should be corrected for bank angle. To use the bank angle correction grid, enter with gross weight and contour the nearest guideline to the right while simultaneously entering the bank angle scale with desired degree of bank angle and projecting up. At the point of intersection of the two projections, proceed left and read gross weight corrected for bank angle.

Gross weight (corrected for bank angle, if required) is then projected right from the gross weight scale of the chart to the pressure altitude. If maximum loiter time is desired, stop momentarily at the optimum maximum endurance altitude drag index curve (interpolate, if necessary). Mark this position location on the chart for further use.

From the point of intersection with pressure altitude, proceed up to the configuration drag index in the upper left grid of the chart, then left to read the indicated mach number for loiter. Return to the plotted point intersection of the gross weight and pressure altitude and proceed down to the drag index at the lower left portion of the chart, then right to the gross weight curve. From this point proceed up to the baseline of the temperature correction grid (standard day). For hotter-than standard day condition, contour the guidelines to the temperature increase. (If no increase is required, proceed directly through.) Fuel flow can be read while proceeding up to the desired loiter time. Project right to read fuel required for loiter. If loiter is already known, project left from the fuel required scale and simultaneously intersect the vertical plot projected from the temperature grid to read loiter time.

The chase-thru lines on Figure A5-1 represent an average gross weight of 10,500 pounds, bank angle of 20 degrees, drag index of 50, loiter time of 30 minutes, and a temperature deviation of 10ºC hotter than standard. These lines show corrected gross weight of 11,200, an optimum maximum endurance altitude for a drag index of 50 of 32,000 feet, a loiter speed of 0.71 mach, a fuel flow of 1,800 lbs/hr, and 900 pounds of fuel required. For loiter times of long duration greater accuracy requires use of average gross weight during loiter to calculate the fuel required. To obtain average loiter weight, the fuel required to loiter must first be determined based on gross weight at start or end of loiter and then is recalculated based on start or end gross weight, decreased or increased, respectively, by half the calculated loiter fuel.

Figure A5-1

MAXIMUM ENDURANCE
FLAPS UP

MODEL: T-38A
DATA: 1 JULY 1978
DATA BASIS: **ESTIMATED DATA**

FUEL REQUIRED AND
MACH NUMBER
STANDARD DAY
DRAG INDEX = 0 TO 75

ENGINE: (2) J85-GE-5
FUEL: JP-4
FUEL DENSITY: 6.5 LB/US GAL

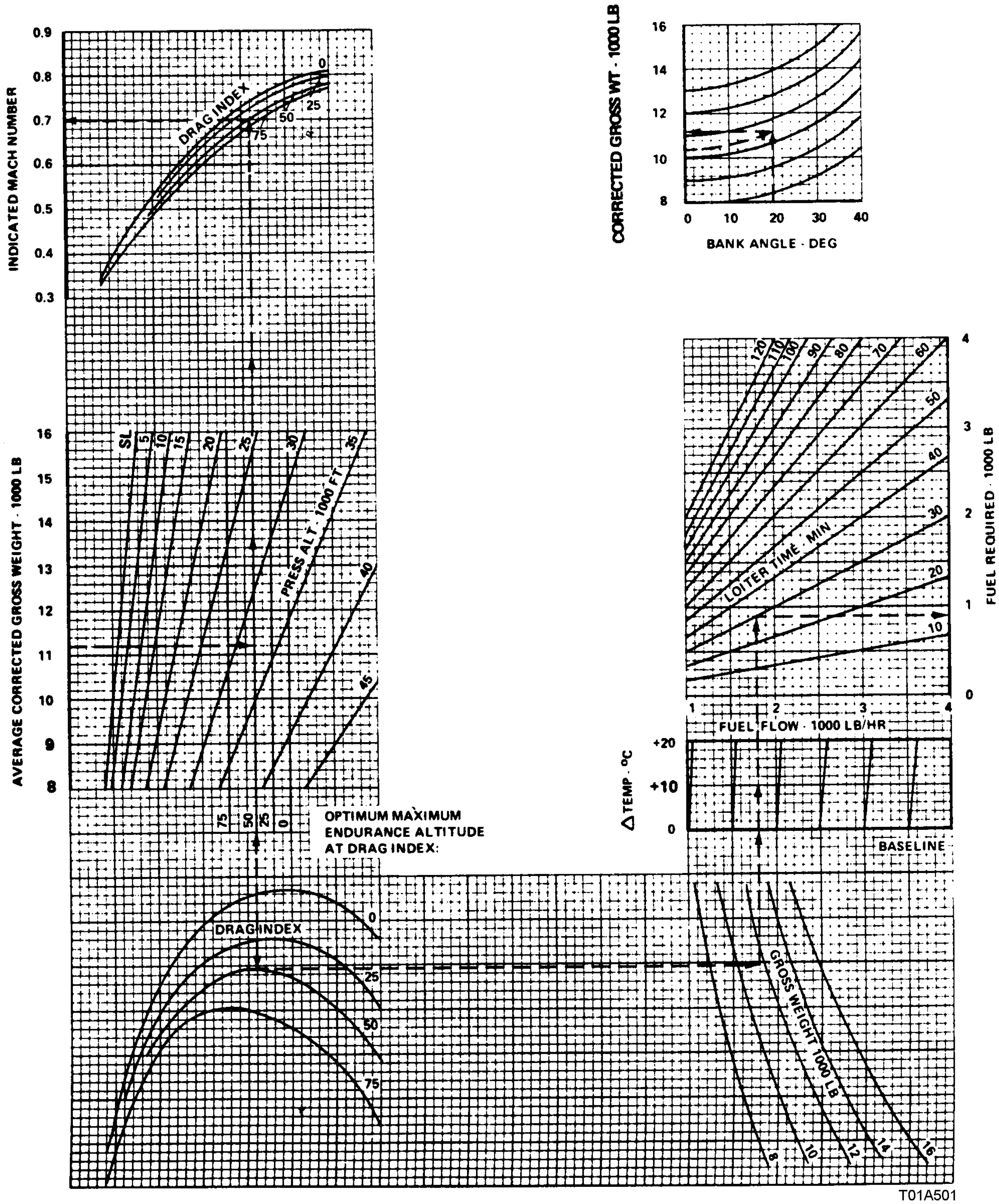


Figure A5-2

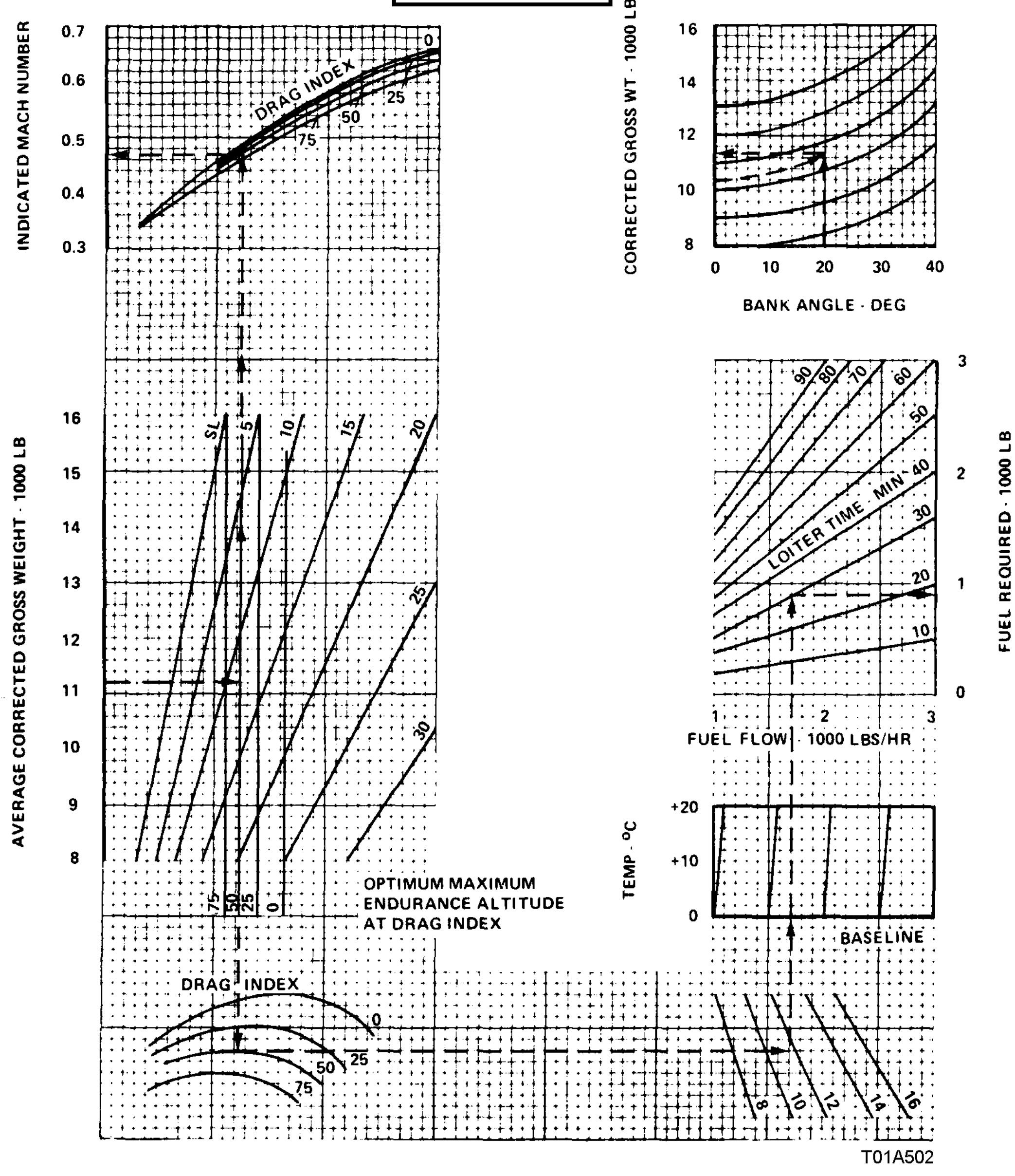
MAXIMUM ENDURANCE
FLAPS UP

MODEL: T-38A
DATA: 1 OCTOBER 1976
DATA BASIS: **ESTIMATED DATA**

FUEL REQUIRED AND
MACH NUMBER
STANDARD DAY
DRAG INDEX = 0 TO 75

ENGINE: (2) J85-GE-5
FUEL: JP-4
FUEL DENSITY: 6.5 LB/US GAL

SINGLE ENGINE



DESCENT

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PURPOSE OF CHARTS

The descent charts provide a means of determining the fuel, time, and distance required to descend from altitude with speed brake closed or open.

DESCENT CHARTS

The maximum range descent chart (Figure A6-1) shows the performance for maximum range. This range is obtained by using idle thrust and maintaining an airspeed of 240 KCAS. Figure A6-2 and Figure A6-3 give the performance for penetration descent. These charts require 80% RPM and an airspeed of 300 KCAS. The descent charts may be used for descending from one altitude to another by reading the incremental values between the initial and final altitudes.

USE OF DESCENT CHARTS

Assume that maximum range descent is desired from a pressure altitude of 40,000 feet to 10,000 feet. From Figure A6-1, the chase-thru lines show the fuel to descend is 70 pounds (98 - 28), the time is 9 minutes (12.5 - 3.5), and the distance is 54 nautical miles (70 - 16).

Figure A6-1

MAXIMUM RANGE DESCENT

IDLE THRUST 240 KCAS

MODEL: T-38A
DATA: 1 OCTOBER 1976
DATA BASIS: **ESTIMATED DATA**

STANDARD DAY
DRAG INDEX = 0 TO 75
ALL GROSS WEIGHTS
SPEED BRAKE IN

ENGINE: (2) J85-GE-5
FUEL: JP-4
FUEL DENSITY: 6.5 LB/US GAL

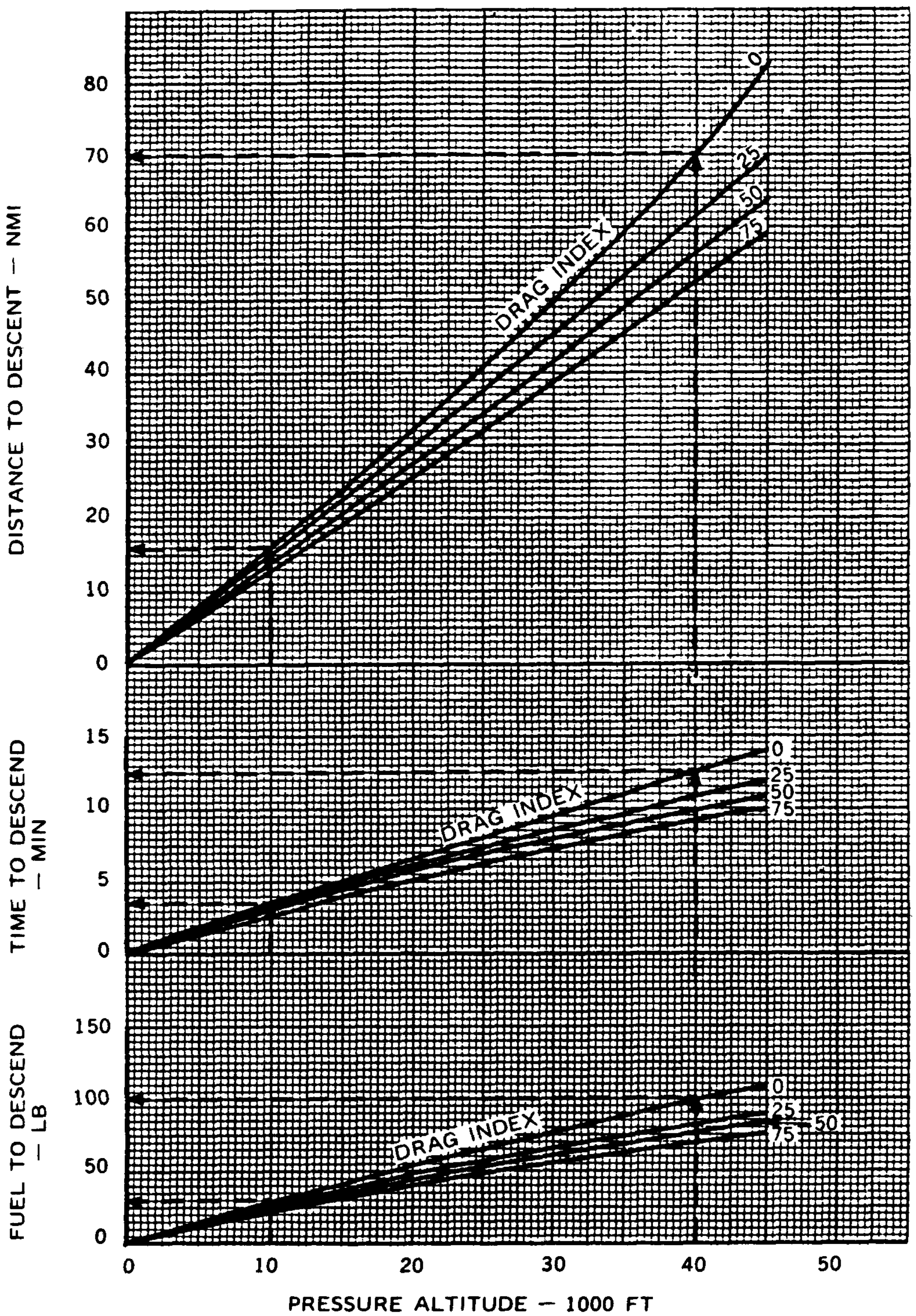

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Figure A6-2

PENETRATION DESCENT

80%RPM 300 KCAS

MODEL: T-38A	**STANDARD DAY**	ENGINE: (2) J85-GE-5
DATA: 1 OCTOBER 1976	DRAG INDEX = 0 TO 75	FUEL: JP-4
DATA BASIS: **ESTIMATED DATA**	SPEED BRAKE CLOSED	FUEL DENSITY: 6.5 LB/US GAL

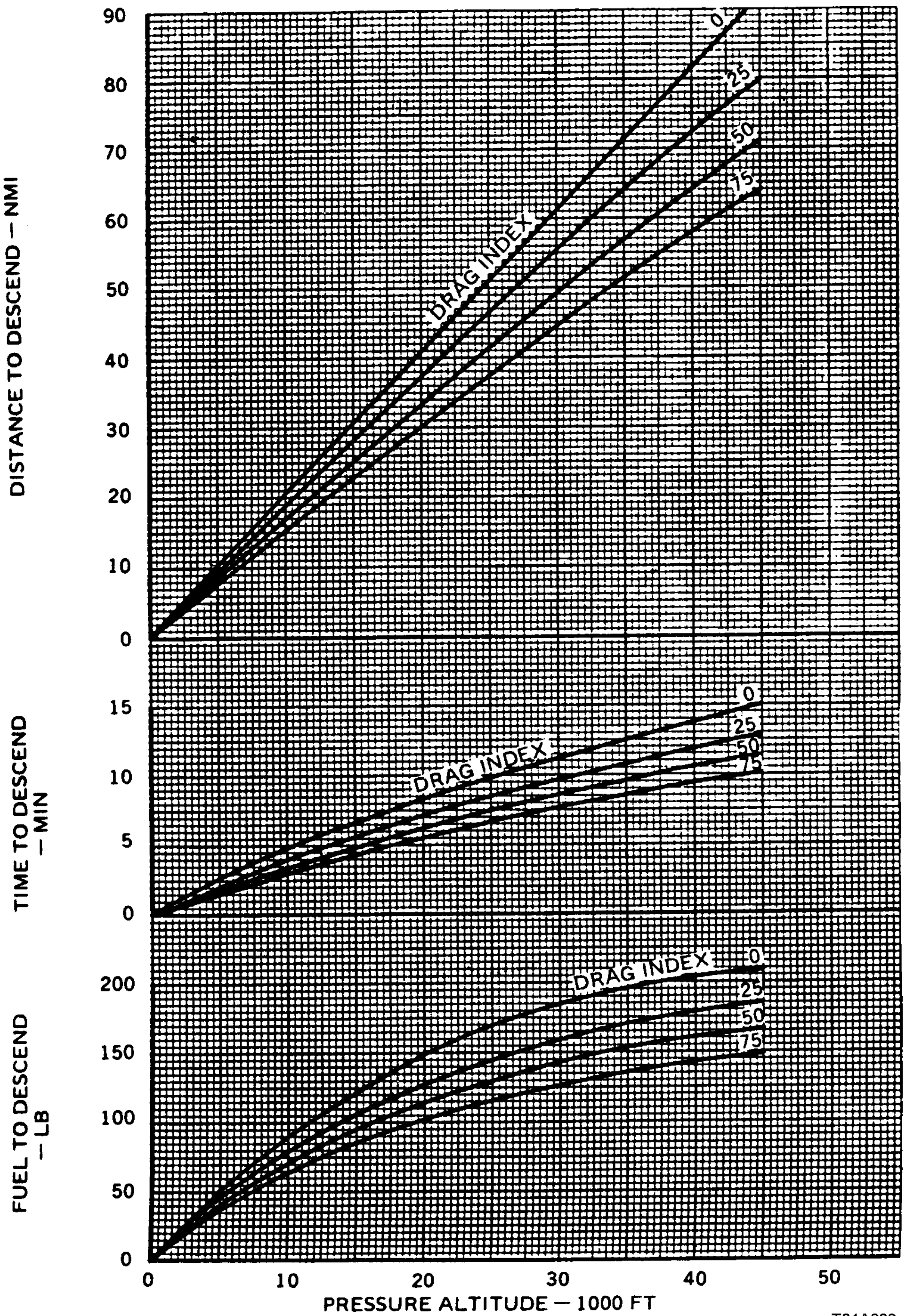

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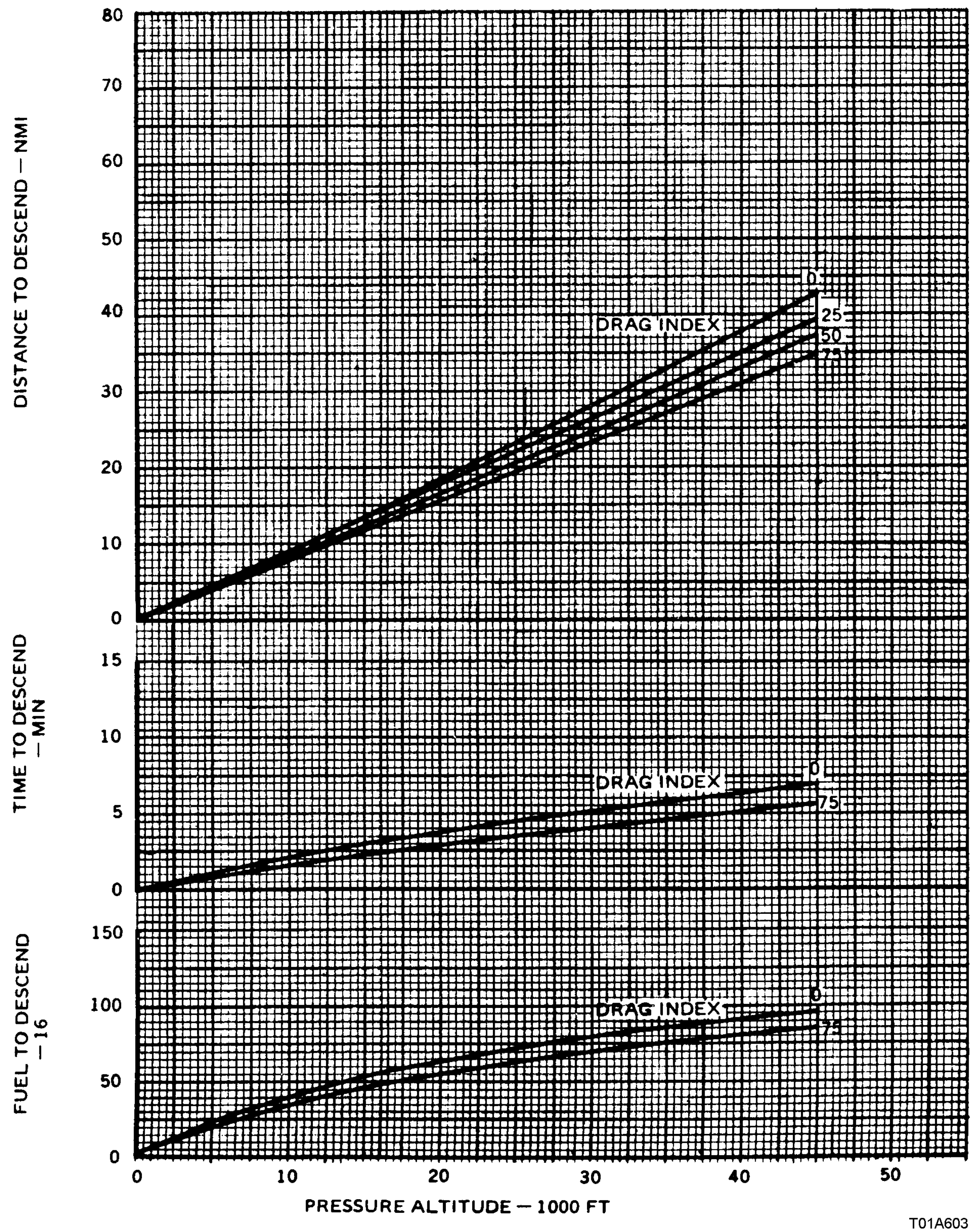
Figure A6-3

PENETRATION DESCENT

80%RPM 300 KCAS

MODEL: T-38A	**STANDARD DAY**	ENGINE: (2) J85-GE-5
DATA: 1 OCTOBER 1976	SPEED BRAKE CLOSED	FUEL: JP-4
DATA BASIS: **ESTIMATED DATA**	DRAG INDEX = 0 TO 75	FUEL DENSITY: 6.5 LB/US GAL



LANDING

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LANDING DISTANCE

The landing distance chart (Figure A7-1) shows ground distance and associated landing speeds. The ground roll distance is based on full flaps. The chart shows data for landing at the appropriate chart landing speeds, maintaining a 12º nose high attitude until just prior to loss of elevator authority, then lowering the nosewheel to the runway, and applying optimum braking. If the landing technique differs, landing distances will vary from those given in the charts. A 5 percent variation in touchdown speed causes approximately a 10 percent variation in landing distance. Insufficient aerodynamic or wheel braking could further increase the ground roll distance by as much as 50 percent.

USE OF LANDING DISTANCE CHART

The chase-thru lines in the landing distance chart (Figure A7-1) show a landing with two engines operating, with a runway air temperature of 15ºC at 2,000 feet pressure altitude, a gross weight of 9,000 pounds, and a 20-knot headwind.

LANDING SPEED

The landing speed chart (Figure A7-1) shows the normal landing final approach speed, minimum roll landing final approach speed, and touchdown speed. The landing speeds in the normal landing distance chart (Figure A7-1) are compatible with the normal landing pattern speed rule in Section II, which indicates that final turn, final approach, and touchdown speeds be increased 1 knot for each 100 pounds of fuel above 1,000 pounds of fuel remaining.

EFFECT OF RUNWAY CONDITION (RCR) ON GROUND ROLL DISTANCE

Figure A7-2 provides the means of correcting the landing ground roll distance for the effect of various runway surface conditions. The corrections are shown as a function of Runway Condition Readings (RCR), which is a number indicating the degree of braking effectiveness available during the ground roll. RCR values vary from 23 to 5 for dry to icy runways. RCR of 12 is provided for a wet runway but for conditions of heavy rain or standing water lower RCR values should be selected to determine the approximate stopping distance. When wet conditions prevail, the runway will be reported as wet (no RCR provided).

CAUTION

RCR values provide an approximation of the required stopping distance. RCR is only valid for dry or icy runways. Selection of an RCR for a wet runway does not ensure a safe landing and stopping distance. If hydroplaning occurs, it is not possible to predict the actual stopping distance.

USE OF THE CORRECTION CHART FOR RUNWAY SURFACE CONDITIONS

Using the ground roll distance of 2,700 feet for a dry, hard surfaced runway and an RCR of 12, the chase-thru lines in Figure A7-2 show 3,600 feet required for this runway condition.

SINGLE-ENGINE THRUST REQUIRED AND AVAILABLE

The single-engine thrust required and available charts (Figure A7-3 through Figure A7-5) show thrust required and available versus airspeed for go-around configuration with 0%, 60%, and 100% flaps with gear down. These charts are for several weights and temperatures from sea level to 6,000 feet and include both single-engine MAX and MIL thrusts.

USE OF SINGLE-ENGINE THRUST REQUIRED AND AVAILABLE CHART

Assume an airspeed of 160 KIAS, a weight of 11,000 pounds, and an ambient temperature of 30ºC with MAX thrust. The chase-thru lines in Figure A7-3 show the thrust required is 2,230 pounds for all altitudes, and the thrust available is 2,810 pounds at sea level. When the pressure altitude is 2,000 feet, the thrust available is 2,625 pounds.

EFFECT OF BANK ANGLE ON VERTICAL VELOCITY

The effect of bank angle on vertical velocity charts shows the climb capability of the aircraft as a function of ambient temperature, gross weight (fuel remaining), bank angle, and thrust setting. Figure A7-6 shows two and single-engine performance for MIL thrust settings and Figure A7-7 shows two and single-engine performance for MAX thrust settings. All of the charts are for landing gear extended and 60% flaps, which is the recommended flap setting for single-engine approaches. The two engine charts are for comparison purposes and are based on a 60% flap setting. The rate-of-climb determined from the charts is valid only for the recommended approach turn speed, which may be computed from the curve in the upper left corner of each chart.

USE OF EFFECT OF BANK ANGLE ON VERTICAL VELOCITY CHARTS

Assume a pattern altitude at 2,000 feet, ambient temperature of 25ºC and 1,000 pounds of fuel remaining. Entering the MIL thrust, single-engine chart, Figure A7-6 (sheet 2), the chase-thru lines show an approach turn speed of 175 KIAS. Reentering the chart at an ambient temperature of 25ºC the chase-thru lines show a climb capability of 300 fpm with a 0º bank angle. If a 30º bank angle were used in turn, the chase-thru lines show a negative climb capability of -300 fpm in the gray area. In the MAX thrust, single-engine chart Figure A7-7 (sheet 2), for the same conditions, the chase-thru lines show a 2,300 fpm climb capability at 0º bank angle and 1,700 fpm climb capability at a 30º bank angle.

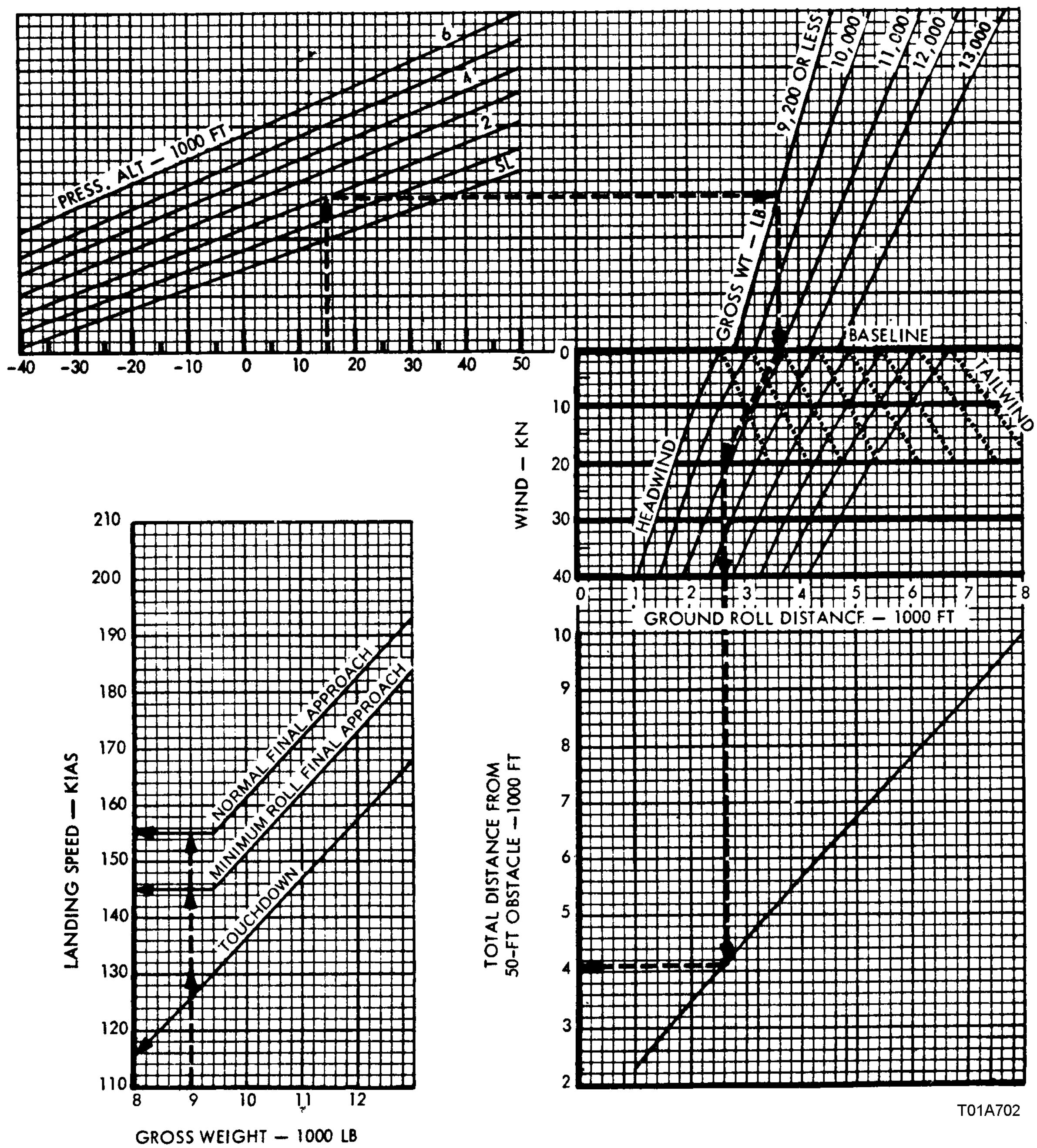
Figure A7-1

LANDING DISTANCE

DRY, HARD SURFACED RUNWAY
FULL FLAPS

MODEL: T-38A
DATA: 1 JULY 1978
DATA BASIS: **ESTIMATED DATA**

ENGINE: (2) J85-GE-5
FUEL: JP-4
FUEL DENSITY: 6.5 LB/US GAL



Verify that this is the correct version before use.

Figure A7-2

EFFECT OF RUNWAY CONDITION (RCR)

ON GROUND ROLL DISTANCE

FULL FLAPS

MODEL: T-38A
DATA: 1 AUGUST 1965
DATA BASIS: **FLIGHT TEST**

ENGINE: (2) J85-GE-5
FUEL: JP-4
FUEL DENSITY: 6.5 LB/US GAL

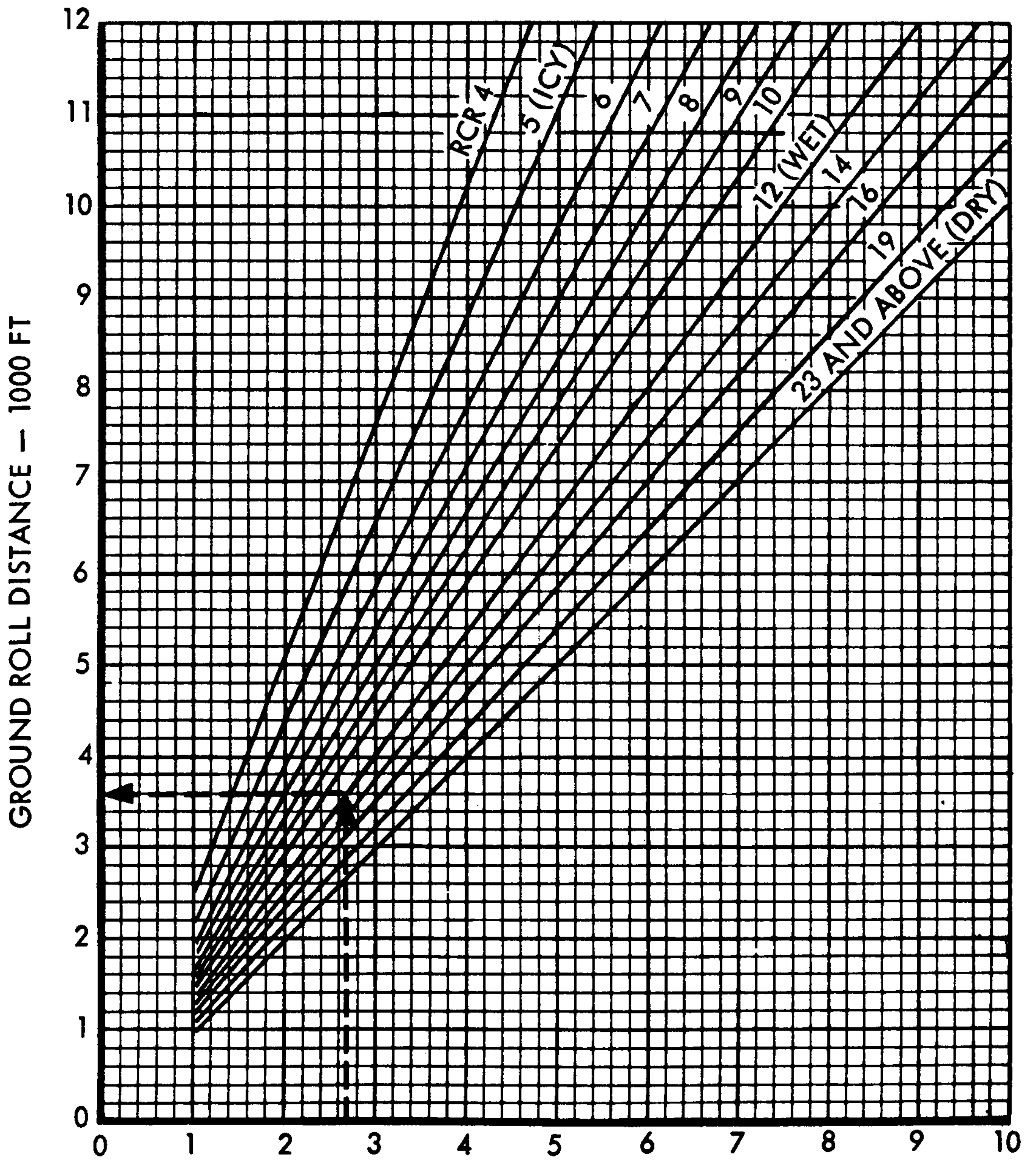


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Figure A7-3

SINGLE-ENGINE THRUST REQUIRED AND AVAILABLE

WITH 60% FLAPS AND GEAR DOWN
SEA LEVEL TO 6,000 FEET

MODEL: T-38A
DATA: 1 JULY 1978
DATA BASIS: **ESTIMATED DATA**

ENGINE: (2) J85-GE-5
FUEL: JP-4
FUEL DENSITY: 6.5 LB/US GAL

NOTE
Decrease sea level thrust available by 3.3% for each 1,000 feet increase in pressure altitude.

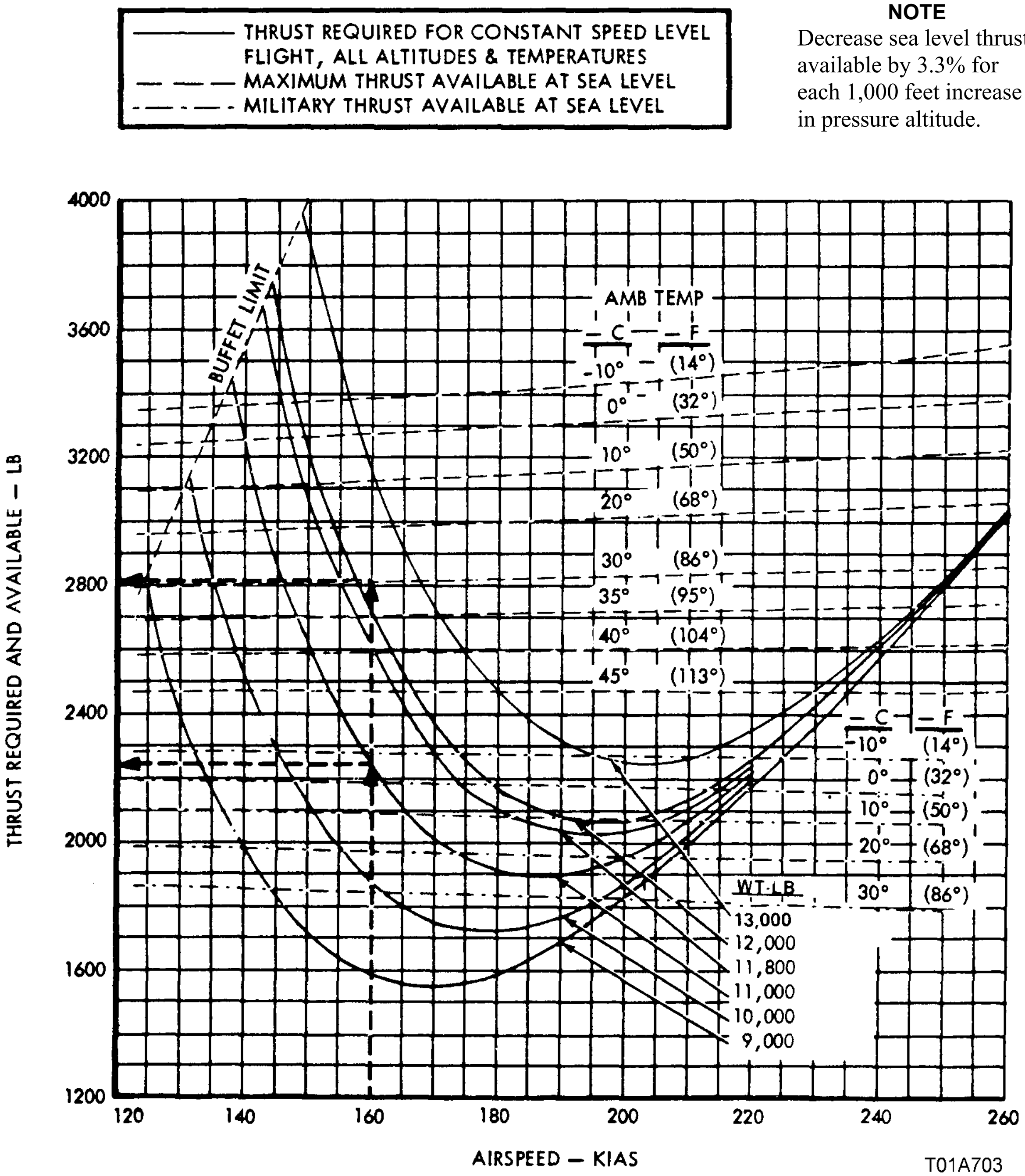

Figure A7-4

SINGLE-ENGINE THRUST REQUIRED AND AVAILABLE

0% FLAPS, GEAR DOWN
SEA LEVEL TO 6,000 FEET

MODEL: T-38A
DATA: 1 JULY 1978
DATA BASIS: **ESTIMATED DATA**

ENGINE: (2) J85-GE-5
FUEL: JP-4
FUEL DENSITY: 6.5 LB/US GAL

NOTE
Decrease sea level thrust available by 3.3% for each 1,000 feet increase in pressure altitude.

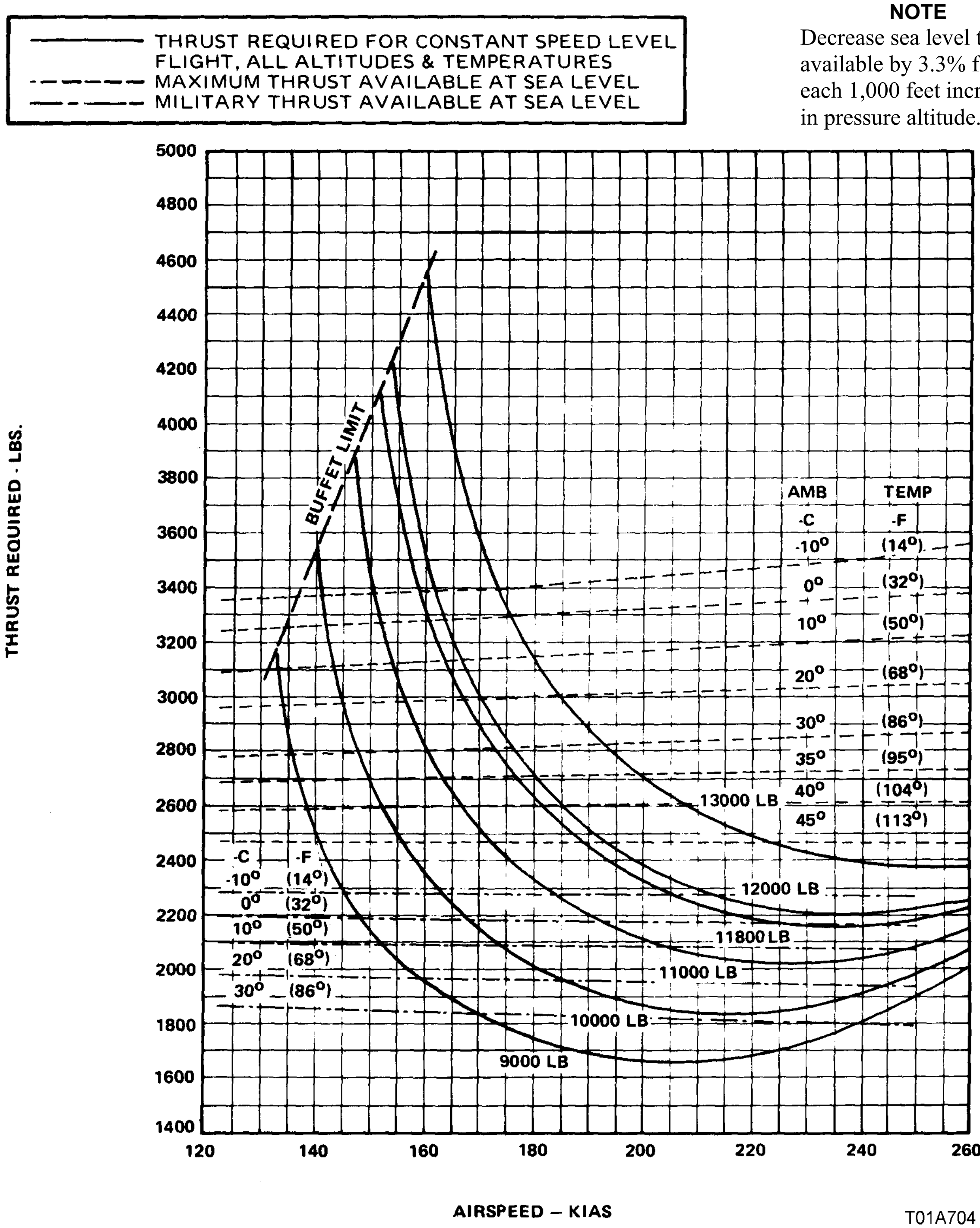

Figure A7-5

SINGLE-ENGINE THRUST REQUIRED AND AVAILABLE

100% FLAPS, GEAR DOWN
SEA LEVEL TO 6,000 FEET

MODEL: T-38A
DATA: 1 JULY 1978
DATA BASIS: **ESTIMATED DATA**

ENGINE: (2) J85-GE-5
FUEL: JP-4
FUEL DENSITY: 6.5 LB/US GAL

NOTE
Decrease sea level thrust available by 3.3% for each 1,000 feet increase in pressure altitude.

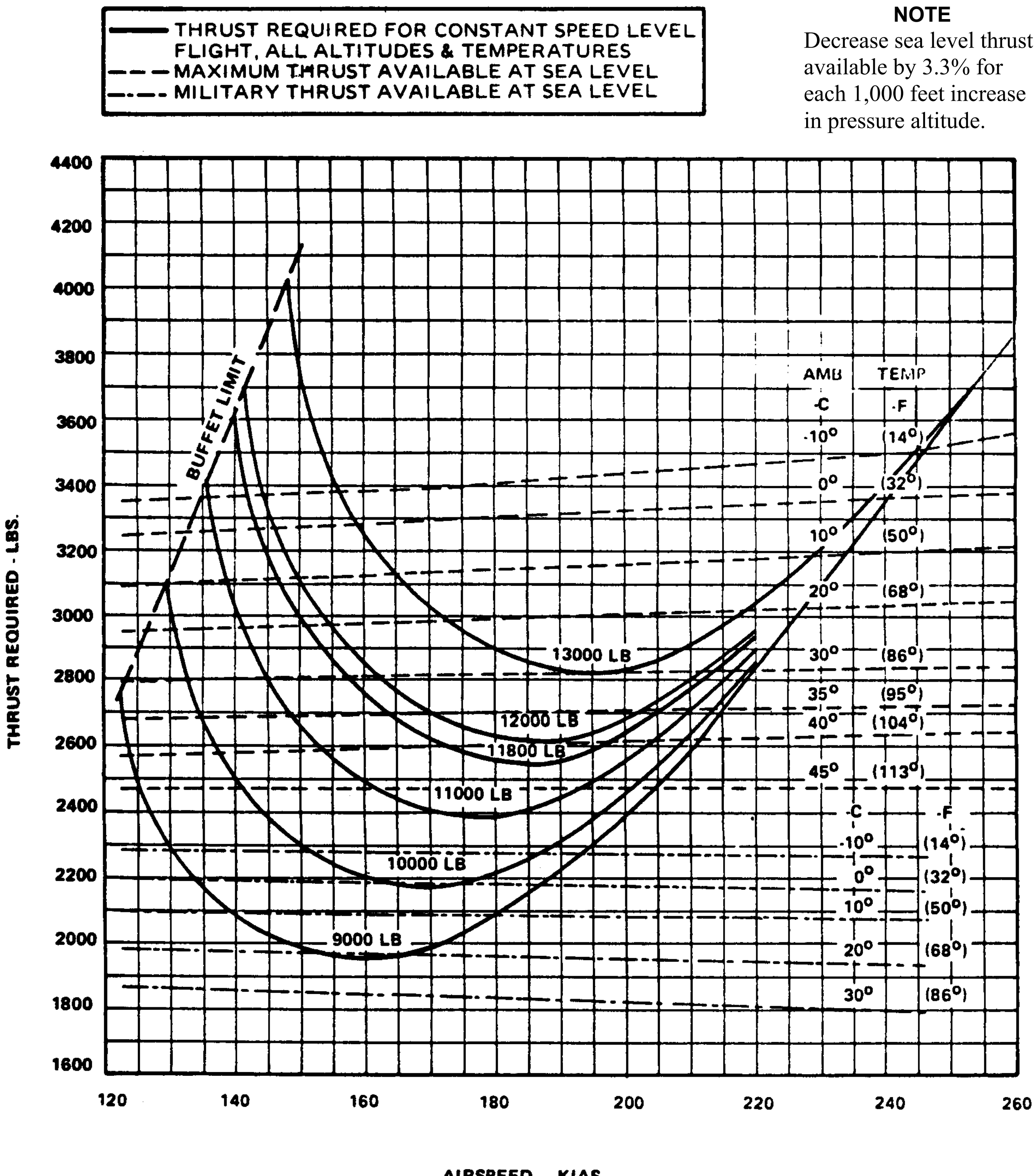

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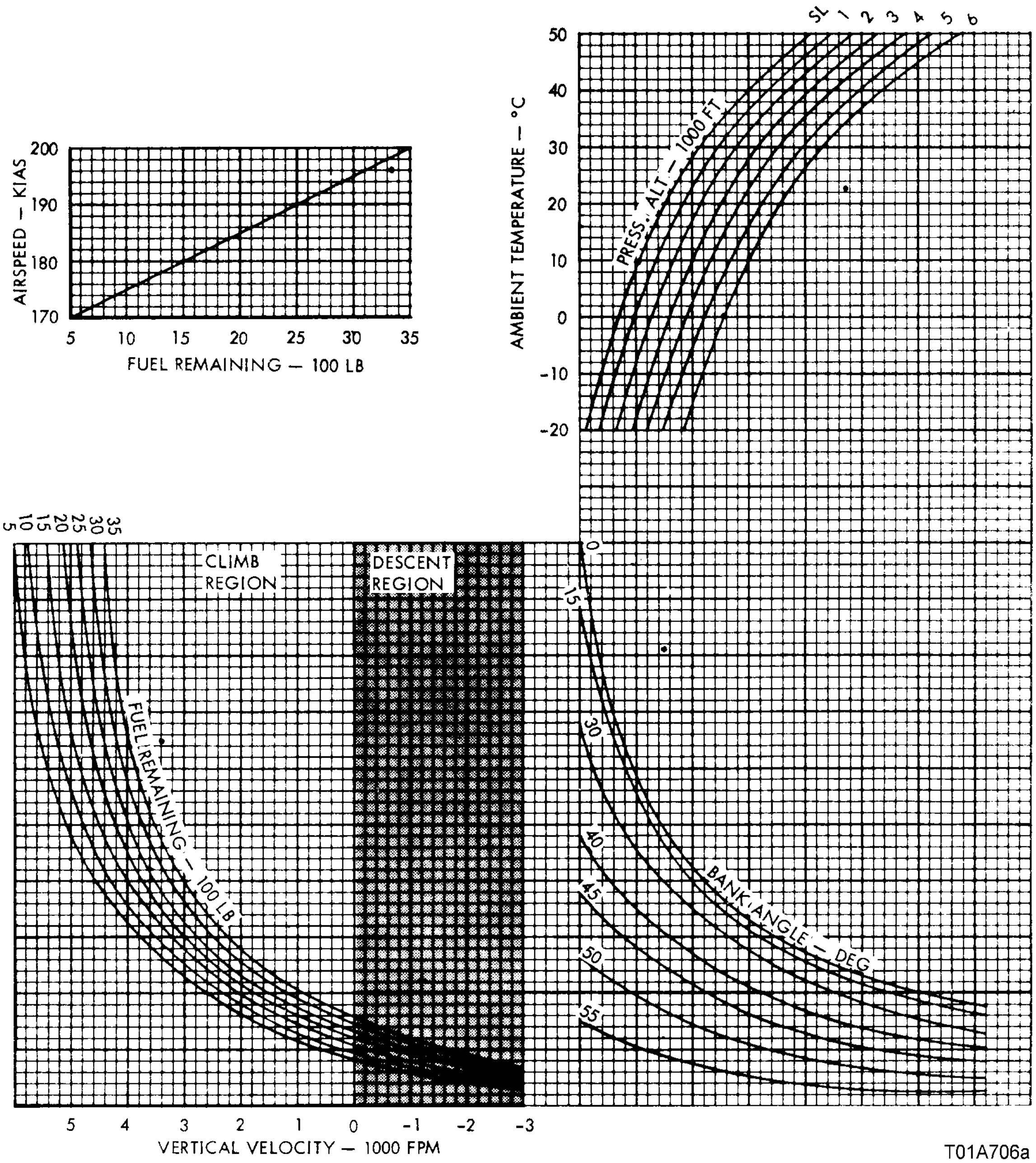
Figure A7-6 (Sheet 1 of 2)

EFFECT OF BANK ANGLE ON VERTICAL VELOCITY

MIL THRUST
WITH 60% FLAPS AND GEAR DOWN

MODEL: T-38A
DATA: 1 APRIL 1969
DATA BASIS: **FLIGHT TEST**

ENGINE: (2) J85-GE-5
FUEL: JP-4
FUEL DENSITY: 6.5 LB/US GAL



Verify that this is the correct version before use.

Figure A7-6 (Sheet 2 of 2)

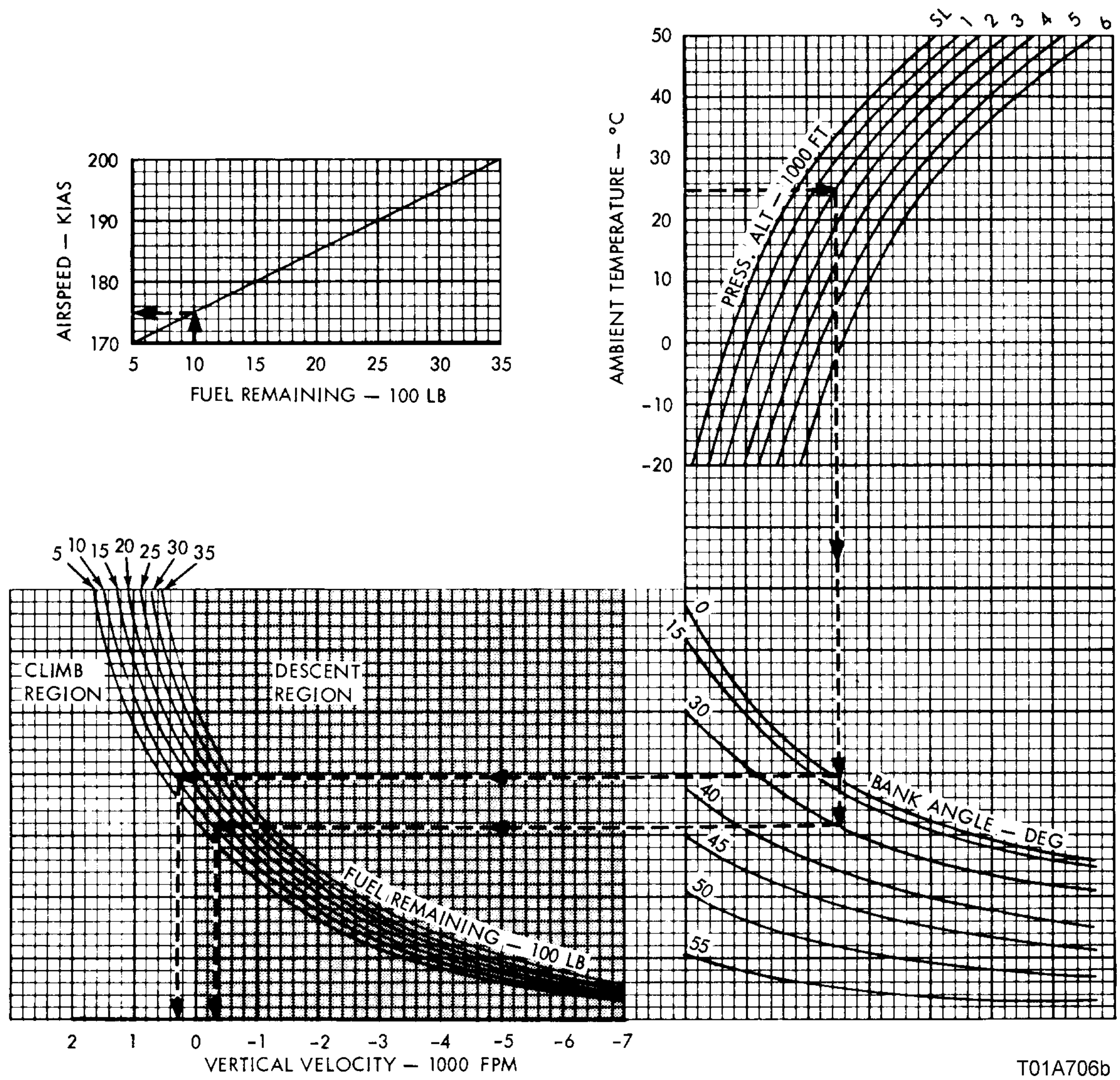
EFFECT OF BANK ANGLE ON VERTICAL VELOCITY

MIL THRUST
WITH 60% FLAPS AND GEAR DOWN

MODEL: T-38A
DATA: 1 APRIL 1969
DATA BASIS: **FLIGHT TEST**

SINGLE ENGINE

ENGINE: (2) J85-GE-5
FUEL: JP-4
FUEL DENSITY: 6.5 LB/US GAL



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Verify that this is the correct version before use.

Figure A7-7 (Sheet 1 of 2)

EFFECT OF BANK ANGLE ON VERTICAL VELOCITY

MAX THRUST
WITH 60% FLAPS AND GEAR DOWN

MODEL: T-38A
DATA: 1 APRIL 1969
DATA BASIS: **FLIGHT TEST**

ENGINE: (2) J85-GE-5
FUEL: JP-4
FUEL DENSITY: 6.5 LB/US GAL

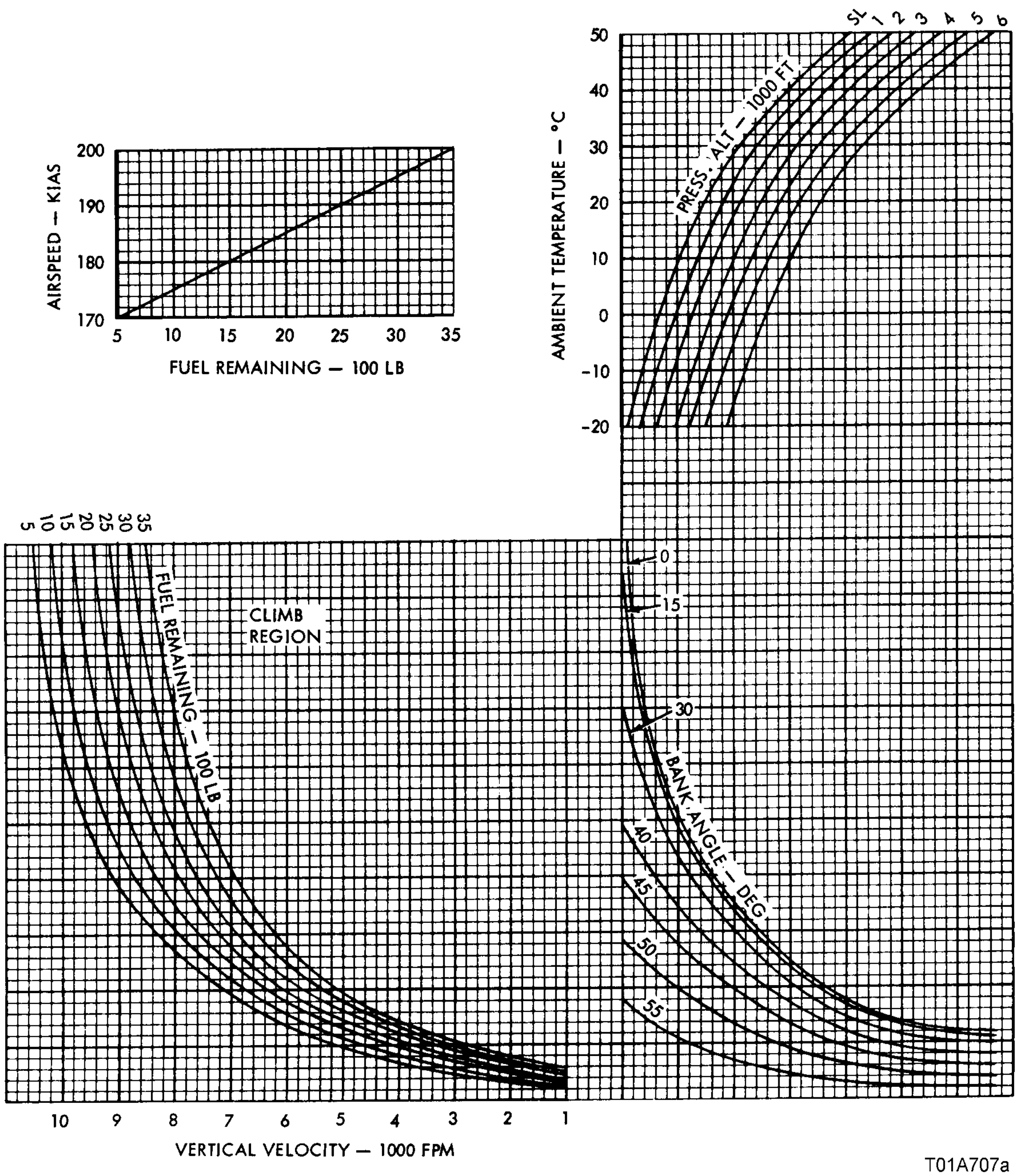


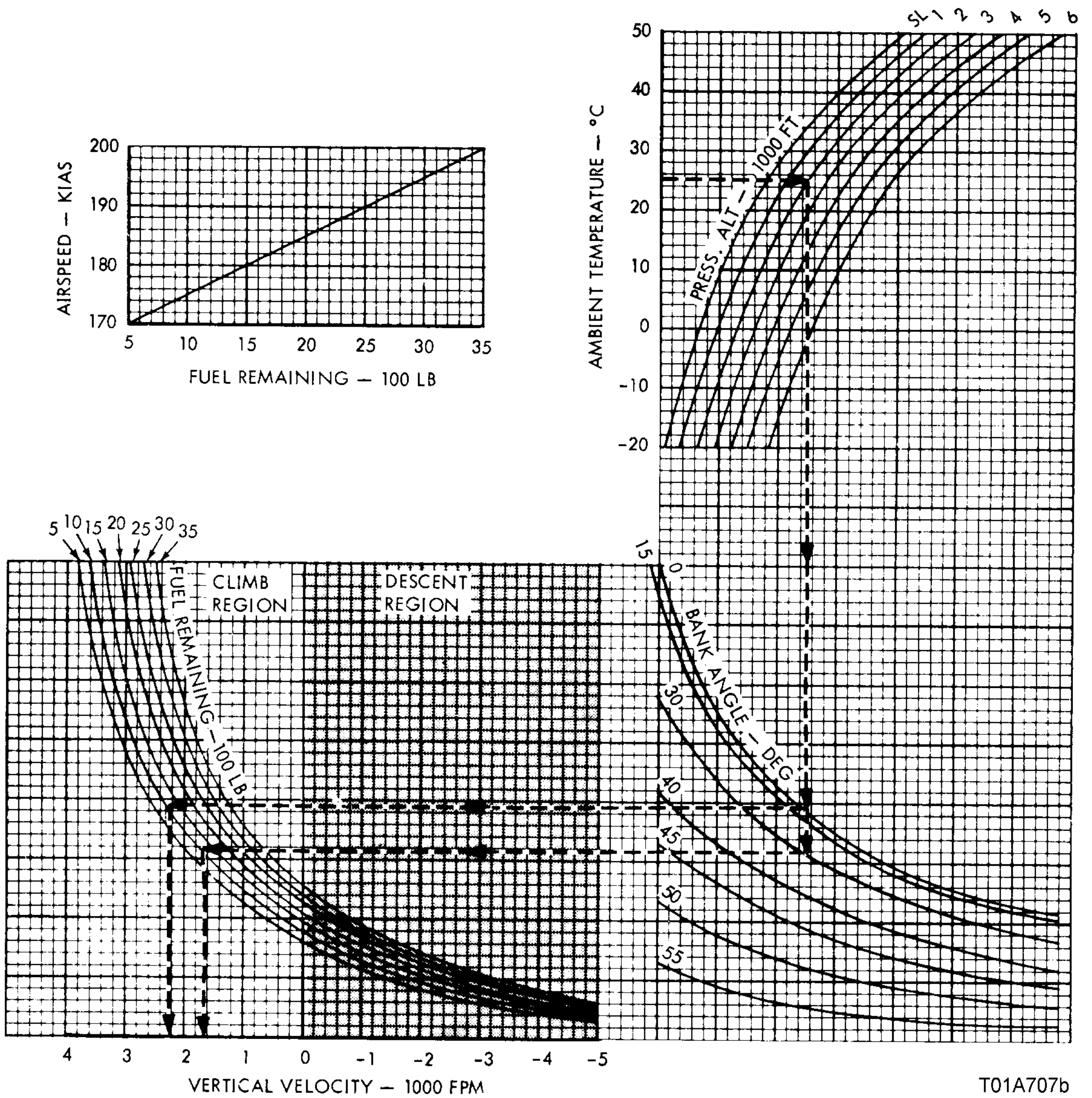
Figure A7-7 (Sheet 2 of 2)

EFFECT OF BANK ANGLE ON VERTICAL VELOCITY

MAX THRUST
WITH 60% FLAPS AND GEAR DOWN

MODEL: T-38A
DATA: 1 APRIL 1969
DATA BASIS: **FLIGHT TEST**

ENGINE: (2) J85-GE-5
FUEL: JP-4
FUEL DENSITY: 6.5 LB/US GAL



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MISSION PLANNING

PART 8

TABLE OF CONTENTS

PURPOSE OF MISSION PLANNING

Mission planning can be termed preflight planning. The purpose of preflight planning is to obtain optimum performance from the aircraft for any specific mission. Optimum performance will vary, for example, from maximum time on station to maximum radius with no time on station. Exact requirements will vary, depending upon the types of missions to be flown.

MISSION PLANNING SAMPLE PROBLEM

The following problem is an exercise in the use of the performance charts. It is not intended to reflect actual or proposed missions employing this aircraft on a typical cross country flight.

FLIGHT PLAN DATA

A mission profile is to be flown, assuming the following conditions:

1. Takeoff data.
   a. Takeoff weight (solo) ... 11,800 lb.
   b. Wind ....10-knot headwind.
   c. Runway temperature.............15ºC.
   d. Pressure altitude............... 4,000 ft.
   e. Runway............................ 7,000 ft.
   f. RCR ....12.
2. Climb data to 35,000 ft.
   a. Temperature deviation from standard +10ºC.
   b. Wind 15-knot headwind.
3. 35,000 ft. cruise data.
   a. Temperature..........................46ºC.
   b. Wind ....50-knot headwind.
   c. Speed .... Optimum.
4. Descent data to 3,000 ft.
   a. Temperature deviation from standard.................................Zero.
   b. Wind .... 15-knot tailwind.
5. Enter pattern 1,000 ft. above terrain with 1,000 lb. fuel reserve.
6. Landing data.
   a. Landing weight............... 9,000 lb.
   b. Wind ....20-knot headwind.
   c. Temperature..........................15ºC.
   d. Pressure altitude............... 2,000 ft.
   e. Runway length................. 7,000 ft.
   f. RCR ....12.

TAKEOFF

1. MAX thrust takeoff factor (Figure A2-2) ....3.45.
2. Takeoff speed (Figure A2-3) .... 154 KIAS
3. Takeoff distance (Figure A2-4) .... 3,050 ft.
4. Critical field length (Figure A2-6).
   a. RCR = 23 .... 5,800 ft.
   b. RCR = 12 .... 6,500 ft.
5. Critical engine failure speed (Figure A2-7).
   a. RCR = 23 .... 132 KIAS
   b. RCR = 12 .... 112 KIAS
6. Acceleration check speed at 1,500 feet from brake release.
   a. Normal (Figure A2-10) .... 110 KIAS.
   b. Minimum (7,000 – 6,500) = 500,
   $110 - \left(\frac{500}{1{,}000} \text{ X } 3\right)$ .... 108 KIAS.
7. Single-engine takeoff speed (Figure A2-3) (154 + 8) ... 162 KIAS.
8. Refusal speed (Figure A2-7).
   a. RCR = 23 .... 143 KIAS.
   b. RCR = 12 .... 116 KIAS.

INITIAL CLIMB FROM 4,000 FT TO FLIGHT LEVEL 350

(Using MIL Thrust Climb Chart Figure A3-1)

1. Aircraft weight at start of climb is 11,800 lb minus the allowance for taxi, takeoff, and acceleration to climb speed (11,800 - 300) .... 11,500 lb.
2. Obtain time to climb, fuel to climb, and climb range.
   Time (8.2 – 0.6) .... 7.6 min.
   Fuel (565 – 55)....................... 510 lb.
   Range (67 – 3) .... 64 nmi.
3. Compute distance lost due to headwind (15 X 7.6/60)........................... 2 nmi.
4. Adjusted climb range (64-2) .... 62 nmi.
5. Weight at level-off (11,500 – 510).................. 10,990 lb.

PENETRATION DESCENT TO 3000 FT, SPEED BRAKE OPENED (280 KCAS, 80% RPM)

1. Obtain time, fuel, and no wind range from Figure A6-3.
   Fuel (85 – 15)........................... 70 lb.
   Time (5.6 – 0.6) .... 5.0 min.
   Range (32 – 2) .... 30 nmi.
2. Compute distance gained due to tailwind (15 X 5.0/60)........................... 1 nmi.
3. Compute ground range (30 + 1) .... 31 nmi.
4. Weight at end of descent (8,010 + 1,000) .... 9,010 lb.

AVERAGE GROSS WEIGHT

1. Weight at beginning of cruise................................ 10,990 lb.
2. Weight at end of cruise (9,010 + 70) .... 9,080 lb.
3. Compute fuel for cruise (10,990 – 9,080).................. 1,910 lb.
4. Average weight (10,990 – 1/2 X 1,910)...... 10,035 lb.

CRUISE AT FLIGHT LEVEL 350

(Using Cruise chart Figure A4-1)

1. Maximum range mach number ...0.83
2. Basic reference number 4
3. Nautical miles per pound 0.338
4. True airspeed..........................485 kn.

5. Fuel flow lb/hr/eng......................715
6. Groundspeed (485 – 50) ....435 kn.
7. Time $\left(\frac{1,980x60}{715x2}\right)$ .... 83 min.
8. Ground Distance $\left(83x\frac{435}{60}\right)$ ...602 nmi.

CRUISE AT FLIGHT LEVEL 350

(Using Constant Altitude Cruise chart Figure A4-3)

1. True mach number......................0.83
2. True airspeed..........................485 kn.
3. True groundspeed ....435 kn.
4. Fuel flow lb/hr/eng................715 kn.
5. Time $\left(\frac{1,980x60}{715x2}\right)$ .... 83 min.
6. Ground Distance $\left(83x\frac{435}{60}\right)$ ...602 nmi.

LANDING

(Using Normal Landing Distance chart Figure A7-1)

1. Final speed turn................ 175 KIAS.
2. Normal landing final approach speed................. 155 KIAS.
3. Minimum roll landing final approach speed................. 145 KIAS.
4. Touchdown speed .... 125 KIAS.
5. Ground roll distance
   a. RCR = 23......................... 2,700 ft.
   b. RCR = 12 (Figure A7-2) . 3,600 ft.

MISSION SUMMARY

1. Total time........................... 95.6 min.
2. Total range .... 695 nmi.

TAKEOFF AND LANDING DATA CARD

The takeoff and landing data card is included in the Flight Crew Checklist normal procedures. The takeoff and landing data was computed during mission planning from Part 2 and Part 7 respectively. The landing weight for immediately after takeoff is the takeoff gross weight less an average fuel allowance of 300 lb for takeoff and go-around. Landing immediately after takeoff for the conditions stated in the mission planning takeoff data is computed as follows:

LANDING (Immediately After Takeoff)

1. Landing gross weight........ 11,500 lb.
2. Final turn speed................ 198 KIAS.
3. Normal landing final approach speed (Figure A7-1)................... 178 KIAS.
4. Touchdown speed (Figure A7-1)................... 153 KIAS.
5. Ground roll distance.
   a. RCR = 23 (Figure A7-1) . 5,100 ft.
   b. RCR = 12 (Figure A7-2) . 6,800 ft.

The takeoff and landing information for mission planning is entered on the data card as a ready reference for review prior to takeoff and landing as shown in Figure A8-1.

CONDITIONS

RUNWAY LENGTH			7,000	FT
WIND COMPONENT			10HW	KN
RUNWAY TEMPERATURE			15	C°
PRESSURE ALTITUDE			4,000	FT

TAKEOFF

ACCELERATION CHECK	108	KIAS	1,500	FT
CRITICAL ENGINE FAILURE SPEED			112	KIAS
REFUSAL SPEED			116	KIAS
SINGLE-ENGINE TAKEOFF SPEED			162	KIAS
TAKEOFF DISTANCE			3,050	FT

LANDING

		IMMEDIATELY AFTER TAKEOFF		FINAL	
FINAL TURN SPEED		198	KIAS	175	KIAS
FINAL APPROACH SPEED		178	KIAS	155	KIAS
TOUCHDOWN SPEED		153	KIAS	125	KIAS
GROUND ROLL:	DRY	5,100	FT	2,700	FT
	WET	6,800	FT	3,600	FT

Figure A8-1. Takeoff and Landing Data Card

APPENDIX B ACRONYMS AND ABBREVIATIONS

A/A	Air to Air
ABS	Absolute
ABU	Automatic Back-Up
AC	Alternating Current
ACARS	Aircraft Communications Addressing and Reporting System
ADC	Air Data Computer
ADI	Attitude Director Indicator
ADS	Air Data Sensor
ADU	Automatic Deployment Unit
AFCS	Automatic Flight Control System
AFIS	Airborne Flight Information Systems
A/G	Air to Ground
AGL	Above Ground Level
ALTERR	Altitude Error
ANP	Actual Navigational Performance
ANT	Antenna
AOA	Angle of Attack
AOD	Aircraft Operations Division
APPR	Approach
ARPT	Airport
ARTU	ARINC Radio Tune Unit
ASU	Antenna Switching Unit
ATC	Air Traffic Control
BC	Back Course
BCD	Binary Coded Decimal
BCP	Best Computed Position
BTRU	Barostatic Time Release Unit
C	Celsius
CCU	Cockpit Control Unit
CDI	Course Deviation Indicator
CDU	Control Display Unit
CEP	Circular Error Probable
CG	Center of Gravity
CHP	Course Heading Panel
CIT	Compressor Inlet Temperatures
CNI	Communications, Navigation, and Identification
COMM	Communication
CPU	Central Processing Unit
CRS	Course

CRT	Cathode Ray Tube
CSDB	Commercial Standard Data Bus
DA	Drift Angle
DADC	Digital Air Data Computer
DB	Data Base
DC	Direct Current
DDA	Double-Density ARINC board
DDU	Disk Drive Unit
DEV	Deviation
DEXP	Date of Expiration
DG	Directional Gyro
DGPS	Differential GPS
DME	Distance Measuring Equipment
DME/P	Precision Distance Measuring Equipment
DMU	Data Management Unit
DOD	Department of Defense
dP	Pressure Differential
DTK	Desired Track
DTG	Distance to Ground
DTO	Direct-To
DTU	Data Transfer Unit
DZH	Drop Zone Heading
DZL	Drop Zone Length
EADI	Electronic Attitude Director Indicator
EFIS	Electronic Flight Instrumentation System
EFIS/MFD	Electronic Flight Information System Multifunction Display
EGT	Exhaust Gas Temperature
EHSI	Electronic Horizontal Situation Indicator
EMI	Electromagnetic Interference
EOA	End of Approach
ERP	EFIS Radar Panel
ESAD	Equivalent Still Air Distance
ETA	Estimated Time of Arrival
ETE	Estimated Time Enroute
FAA	Federal Aviation Administration
FACF	Final Approach Course Fix
FAF	Final Approach Fix
FAP	Final Approach Point
FCF	Functional Check Flight
FGS	Flight Guidance System
FMS	Flight Management System
FOD	Foreign Object Damage
FPA	Flight Path Angle
FPCDU	Flat Panel Control Display Unit
FSS	Flight Service Station
G.C.	Grid Course
GCA	Ground Controlled Approach
GCS	Ground Clutter Suppression
GDC	General Data Center
GDOP	Geometric Dilution of Position
GPIRS	Global Positioning and Inertial Reference System
GPS	Global Positioning System

GPWS	Ground Proximity Warning System
GRI	Group Repetition Interval
G/S	Glide Slope
HDOP	Horizontal Dilution of Position
HIL	Horizontal Integrity Limits
HPRU	Harness Power Retraction Unit
HUD	Heads-Up Display
HSI	Horizontal Situation Indicator
IAF	Initial Approach Fix
ICAO	International Civil Aircraft Organization
ICS	Internal Communications System
IFF	Identification Friend or Foe
IFR	Instrument Flight Rules
ILS	Instrument Landing System
IMN	Indicated Mach Number
INS	Inertial Navigation System
IRS	Inertial Reference System
ISA	International Standard Atmosphere
ISS	Inertial Sensor System Inter-seat Sequencing System
KCAS	Knots Calibrated Air Speed
KEAS	Knots Effective Air Speed
KIAS	Knots Indicated Air Speed
KTAS	Knots True Air Speed
LCC	Loran C Navigational Charts
LCS	Loran C Sensor System
LDA	Localizer-type Directional Air
LOA	Loran C Operating Area
LOP	Line of Position
LSK	Line Select Key
MADC	Mini Air Data Computer
MAP	Missed Approach Point
MCU	Modular Concept Unit
MDA	Minimum Descent Altitude
MFD	Multi-Function Display
MLS	Microwave Landing System
MMMS	Multi-Mission Management System
MNPS	Minimum Navigational Performance Specifications
MNVR	Maneuver
MOR	Manual Override
MOT	Mark on Target
MPP	Most Probable Position
MSB	Modified Speed Brake
MSG	Message
MSU	Mode Selector Unit
NAS	National Airspace System
NASA	National Aeronautics and Space Administration
NAT OTS	North Atlantic Organized Track System
NCU	Navigation Computer Unit
NDB	Non-Directional Beacon
NM	Nautical Mile
NMI	Nautical Mile
NMU	Navigation Management Unit
NOS	National Oceanic Service

NPU	Navigation Processor Unit
NVG	Night Vision Goggles
NVIS	Night Vision
NVRAM	Non-Volatile RAM
OAT	Outside Air Temperature
ONC	Operational Navigation Chart
P	Precision
PAR	Precision Approach Radar
PBI	Push Button Indicators
PCA	Polar Cap Anomaly
PFT	Pre-Flight Test
PGS	Pseudo-Glide Slope
PIO	Pilot Indicated Oscillation
PLOC	Pseudo Localizer
PNR	Point of No Return
PPOS	Present Position
PREV	Previous
PT	Procedure Turn
PVOR	Pseudo-VOR
Q	Azimuth Quality Factor
QC	Quality Control
RAIM	Receiver Autonomous Integrity Monitoring
RAM	Random Access Memory
RCR	Runway Condition Reading
RFI	Radio Frequency Interference
RIS	Radio Interface Simulator
RMS	Radio Management System
R-Nav	Area Navigation
RNP	Required Navigational Performance
RP	Release Point
RPM	Rotations Per Minute
RPU	Receiver/Processor Unit
RRS	Radio Reference Sensor
RSU	Radio Select Unit
RTU	Radio Tune Unit
SAR	Search and Rescue
SAS	Stability Augmentation System
SAT	Static Air Temperature
SCN	Software Control Number
SEP	Spherical Error Probable
SETOS	Single-Engine Take-off Speed
SID	Standard Instrument Departure
SMC	Special Mission Computer
SNR	Signal to Noise Ratio
SPS	Standard Positioning Service
SQ	Squelch
SSK	Seat Survival Kit
SSU	Signal Switching Unit
STAR	Standard Terminal Arrival Routes
S/W	Software
SXTK	Selected Crosstrack
TACAN	Tactical Air Command and Navigation
TAS	True Airspeed
TERPS	Terminal Instrument Procedures
TKE	Track Angle Error
TOD	Top-of-Descent
TOF	Take-Off Factor

TRDRP	Teardrop
TRK	Track
TSO	Technical Standard Order
TTG	Time to Go
UNS	Universal Navigation System
USRM	Underseat Rocket Motor
UTC	Coordinated Universal Time
VAC	Volts AC
VDC	Volts DC
VDOP	Vertical Dilution of Position
VFR	Visual Flight Rules
VHF	Very High Frequency
VIP	Video Integrated Processor
VLF	Very Low Frequency
VMC	Visual Meteorological Conditions
VNAV	Vertical Navigation
VOR	VHF Omnidirectional Radio Range
VOX	Voice Operated Transmitter
VPU	VORTAC position unit
VSR	Vertical Speed Required
VTO	Vertical Direct-To
WCA	Wind Correctional Angle
WSSP	Weapon System Support Pod
WX	Weather
WXA	Weather Alert
XFILL	Crossfill
XTK	Crosstrack
XTK DEVITATION	Track Deviation
XWIND	Crosswind

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APPENDIX C
ALPHABETICAL INDEX