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OXC-13426
COPY 3 OF 3

TDC No. 20
16 October 1967

TECHNICAL DATA CHANGE
TA-12 Trainer Flight Manual

This TDC, dated 16 October 1967, accomplished the following:

1. Revises the Abort Procedure

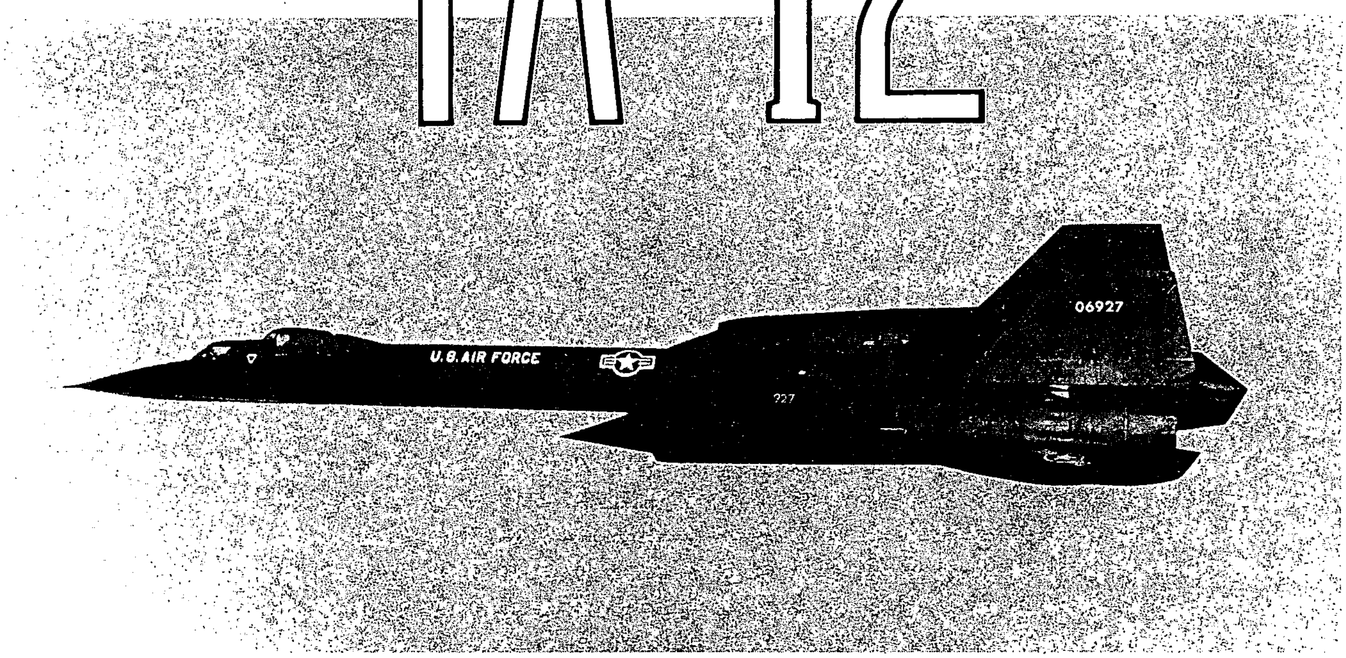
2. Revises the Brake Description and adds a maximum initial Braking Speed Chart.

3. Revises the Landing Field Length Requirements description and adds several Landing Distance performance charts.

The pilot's abbreviated checklist is supplied separately.

COPY NO. 15

TA-12



TRAINER

FLIGHT MANUAL

PUBLISHED UNDER AUTHORITY OF THE SECRETARY OF THE AIR FORCE

31 MARCH 1967
Changed 16 October 1967

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Issue Code A-1

Changed 16 October 1967

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SPECIFIC INSTRUCTIONS FOR SAFEGUARDING THIS INFORMATION

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TDC No. 19
31 March 1967

TECHNICAL DATA CHANGE
TA-12 Trainer Flight Manual

This TDC, dated 31 March 1967, is a reissue of the TA-12 Trainer Flight Manual. The flight manual has been updated to the latest configuration and replaces the TA-12 Trainer Flight Manual dated 1 May 1964.

The pilot's abbreviated checklist is supplied separately.

TDC NO. 18

15 August 1966

TECHNICAL DATA CHANGE FLIGHT MANUAL

OXC-11001-66
COPY 3 OF 3

TO BE INSERTED IN FRONT OF TA-12 Trainer Flight Manual

FLIGHT MANUAL DATED 1 May 1964, changed 15 April 1965

SECTION	PAGE	CHANGE
		This TDC, comprising the changed and/or added pages listed on pages A and B, makes the following changes: 1. Reflects installation of alternate nosewheel steering. 2. Changes cockpit illustrations to show latest instrument arrangements. 3. Adds an INS Steering Characteristics and Destination Reject Pattern illustration to Section IV. 4. Adds a Mach Hold Engagement procedure. 5. Updates Inertial Navigation System description and procedure. 6. Changes landing and penetration speeds. 7. Adds X-Band radar beacon operation to normal operating procedures. Revised checklist pages are supplied separately. Note Cancel TDC No. 17.

NOTE : The technical data information furnished herein is intended to be used as INTERIM data only. It will be replaced and superseded at the time of issue of the next revision to the flight manual.

1094

COPY NO. 12

TDC NO. 7

OXC-6289
COPY 2 OF 3

TECHNICAL DATA CHANGE FLIGHT MANUAL

TO BE INSERTED IN FRONT OF A-12 TRAINER
FLIGHT MANUAL DATED 1 November 1963 (Changed 15 Dec. 1963)

SECTION	PAGE	CHANGE
		The new pages and title page dated 15 December 1963 supplied by this TDC replace and supercede affected pages previously issued. The new A page can be used as a reference to make certain that the Flight Manual contains all effective pages. No checklist changes are necessary because of these new changed pages.

Rec'd 8 Jan 64

NOTE: The technical data information furnished herein is intended to be used as INTERIM data only. It will be replaced and superseded at the time of issue of the next revision to the flight manual.

COPY NO. 15

TECHNICAL DATA CHANGE FLIGHT MANUAL

TDC NO. 6

1 November 1963

OXC-6132

COPY 3 OF 3

TO BE INSERTED IN FRONT OF A-12 Trainer

FLIGHT MANUAL DATED 1 November 1962 (Changed 1 November 16

SECTION	PAGE	CHANGE
		1. The new pages and title page dated 1 November 1963 supplied by this TDC replace and supersede affected pages previously issued. The new "A" page can be used as a reference to make certain that the Flight Manual contains all effective pages.
		2. Changed procedures are the result of operational experience and recommendations by the using agency.
		3. Changed check list pages dated 11-1-63 are consistent with this TDC.

Rcd 21 Nov 63

NOTE: The technical data information furnished herein is intended to be used as INTERIM data only. It will be replaced and superseded at the time of issue of the next revision to the flight manual.

TDC NO. 5

TECHNICAL DATA CHANGE FLIGHT MANUAL

OXC-5916
COPY 3 OF 3

TO BE INSERTED IN FRONT OF A-12 Trainer
FLIGHT MANUAL DATED 1 November 1962 (Changed 15 August 1963

SECTION	PAGE	CHANGE
		1. The new pages and title page dated 15 August 1963 supplied by this TDC replace and supersede affected pages previously issued in the basic Flight Manual, and those pages changed per TDC's No. 1 and 2. 2. Changes to Sections II, III, and V dated 15 August 1963 have already been issued under TDC's No. 3 and 4. 3. An "A" page is provided with this change and may be used as a reference to make certain that the Flight Manual contains all of the latest changed pages.

NOTE : The technical data information furnished herein is intended to be used as INTERIM data only. It will be replaced and superseded at the time of issue of the next revision to the flight manual.

COPY NO. 12

TDC NO. 4

1 September 196

OXC-5669

COPY 2 OF 3

TECHNICAL DATA CHANGE
FLIGHT MANUAL

TO BE INSERTED IN FRONT OF A-12 Trainer

FLIGHT MANUAL DATED 1 November 1962

SECTION	PAGE	CHANGE
		New pages supplied by this TDC replace affected pages in Section II dated 15 August 1963. This new material reflects procedures developed as a result of Trainer aircraft operation which include: a. Positioning of aft cockpit battery switch during preflight check b. Redefinition of minimum airspeeds for drag chute jettison with crosswind components of 5 to 12 knots. Pages supplied by this TDC are marked "Changed 1 September 1963" at the lower inside corner of the page. List of pages supplied: Section II 2-5 2-31

NOTE : The technical data information furnished herein is intended to be used as INTERIM data only. It will be replaced and superseded at the time of issue of the next revision to the flight manual.

Rcd 18 Sep 63

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TDC NO. 3

15 August 1963

TECHNICAL DATA CHANGE
FLIGHT MANUAL

TO BE INSERTED IN FRONT OF A-12 Trainer
FLIGHT MANUAL DATED 1 November 1962

SECTION	PAGE	CHANGE
		New pages supplied by this TDC replace all original pages in Sections II and III and Section V Limitations pages 5-11 and 5-12 of A-12 Flight Manual dated 1 November 1962. Changes to affected pages authorized by TDC's No. 1 and 2 are superceded. The Pilots Abbreviated Check List dated 1 November 1962 is also superceded by this material and revised check lists will be issued as soon as possible. New material supplied by this TDC reflects procedures developed as a result of trainer aircraft operation, and equipment changes which include: a. Inverter switching rearrangement (SB 351) b. Operational anti-skid braking c. RMI needle switching rearrangement d. 4-rotor brake installation and "silver" tires Pages supplied by this TDC are marked "Changed 15 August 1963" at the lower inside corner of the page.

NOTE : The technical data information furnished herein is intended to be used as INTERIM data only. It will be replaced and superseded at the time of issue of the next revision to the flight manual.

TDC NO. 3

15 August 1963

TECHNICAL DATA CHANGE FLIGHT MANUAL

TO BE INSERTED IN FRONT OF A-12

FLIGHT MANUAL DATED 1 November 1962

SECTION	PAGE	CHANGE
		List of changed pages supplied: Section II: 2-1; 2-1 through 2-37 Section III: 3-1; 3-1 through 3-58 Section V: 5-11; 5-12

NOTE : The technical data information furnished herein is intended to be used as INTERIM data only. It will be replaced and superseded at the time of issue of the next revision to the flight manual.

TECHNICAL DATA CHANGE FLIGHT MANUAL

TO BE INSERTED IN FRONT OF A-12 Trainer
FLIGHT MANUAL DATED 1 November 1962

SECTION	PAGE	CHANGE
I ✓	1-38	Under Fuel Shutoff Switches, after the 3rd sentence add a WARNING as follows: WARNING When a fuel shutoff switch is actuated to the EMER position, a minimum of 5 seconds delay must be observed prior to moving the switch back to the ON position to allow for full travel of the shutoff valve. Attempting to recycle the valve within 5 seconds may cause the circuit breaker in Air Conditioning Bay to open.
I ✓	1-41	Under Crossfeed Switches, before the last sentence, add a CAUTION as follows: CAUTION When the crossfeed switch is depressed, a minimum of 5 seconds delay must be observed prior to depressing the switch a second time to allow for full travel of the crossfeed valve. Attempting to recycle the valve within 5 seconds may cause the circuit breaker in a Air Conditioning Bay to open.
I ✓	1-42	Under Fuel Dump Switches, after the 3rd sentence add a WARNING as follows: WARNING When the fuel dump switch is actuated to the DUMP position, a minimum of 5 seconds delay must be observed prior to moving the switch back to the OFF position to allow the full travel of the dump valves. Attempting to recycle the valves within 5 seconds may cause the circuit breakers in the Air Conditioning Bay to open.
I ✓	1-85	Under Landing Gear Warning Light and Audible Warning, revise as follows: Change the 1st sentence after step 3 to read: An audible warning is produced in the pilot's earphones when the throttles are retarded below minimum cruise setting, the landing gear is not in the down and locked position and altitude is below 10,000 (± 500) feet.

NOTE: The technical data information furnished herein is intended to be used as INTERIM data only. It will be replaced and superseded at the time of issue of the next revision to the flight manual.

TDC NO. 2

TECHNICAL DATA CHANGE FLIGHT MANUAL

TO BE INSERTED IN FRONT OF A-12 Trainer

FLIGHT MANUAL DATED 1 November 1962

SECTION	PAGE	CHANGE
I	107	Under EJECTION SEQUENCE, in the 2nd and 6th sentences change the numeral 2 to 4.
I	107	At end of Section 1 after EJECTION SEQUENCE add the following: EGRESS (Bail Out) SYSTEM An egress light system installed in the aircraft permits bailout coordination between pilots in addition to normal interphone communication or in the event that interphone communication is interrupted. With this system the aircraft commander always has the capability to issue and check compliance with a bailout signal, regardless of which cockpit he may be occupying. Power for the system is furnished by the essential dc bus. See EMERGENCY ESCAPE IN FLIGHT, Section III for further information.
I	107	Egress Lights and Switches The forward cockpit lower right instrument panel contains a guarded toggle switch labeled BAIL OUT (up) and two lights which read BAIL OUT (red) and AFT COCKPIT EJECTED (amber) when illuminated. The aft cockpit lower instrument panel contains a guarded switch labeled BAIL OUT (up) and a light which reads BAIL OUT (red) when illuminated. Both forward and aft cockpit switches are safety wired to the off (guard down) position. Actuation of a BAIL OUT switch illuminates the BAIL OUT light in the opposite cockpit. The AFT COCKPIT EJECTED light is wired directly to the aft cockpit ejection seat tracks and will illuminate when the aft seat is ejected.

NOTE: The technical data information furnished herein is intended to be used as INTERIM data only. It will be replaced and superseded at the time of issue of the next revision to the flight manual.

TDC NO. 2

TECHNICAL DATA CHANGE FLIGHT MANUAL

TO BE INSERTED IN FRONT OF A-12 Trainer

FLIGHT MANUAL DATED 1 November 1962

SECTION	PAGE	CHANGE
II	2-5	Under Instrument Panel, revise as follows: Change step 12 to read: Forward cockpit system switch - ON.
II	2-9	Under Instrument Panel, revise as follows: 1. Delete step 13. 2. Renumber steps 14 thru 39 to 13 thru 38.
II	2-20	Under PRE-TAKEOFF AIRCRAFT CHECK, revise as follows: 1. Delete steps 5 and 6. 2. Renumber steps 7 thru 12 to 5 thru 10.
II	2-26	Under AFTER TAKEOFF CLIMB, revise as follows: 1. Delete steps 5 and 6. 2. Renumber step 7 to step 5.

NOTE: The technical data information furnished herein is intended to be used as INTERIM data only. It will be replaced and superseded at the time of issue of the next revision to the flight manual.

TDC NO. 2

TECHNICAL DATA CHANGE FLIGHT MANUAL

TO BE INSERTED IN FRONT OF A-12 Trainer
FLIGHT MANUAL DATED 1 November 1962

SECTION	PAGE	CHANGE
III	3-24	Under EJECTION, in 2nd sentence under item d., change to read: There is a 0.6 second delay on seat separation below 265-300 KIAS, and a 4 second delay above 265-300 KIAS.
III	3-24	Under EMERGENCY ESCAPE IN FLIGHT, temporarily delete existing steps 1 and 2 and replace with the following: Aircraft Commander flying in forward cockpit. 1. If possible, notify aft cockpit of decision to eject. 2. Actuate bailout switch. 3. Observe AFT SEAT EJECTED light illuminated. After aft cockpit seat ejects, 4. Pull ejection "D" ring with both hands. 5. After parachute is open and before touching down, pull survival kit release handle to reduce touchdown weight and avoid leg injury on landing. Aircraft Commander flying in aft cockpit. 1. If possible, notify forward cockpit pilot of decision to eject. 2. Actuate bailout switch. 3. Observe forward cockpit seat ejection. After forward cockpit seat ejects, 4. Same as step 4 above. 5. Same as step 5 above.
III	3-39 3-39a	Under FUEL DUMPING PROCEDURE, revise as follows: 1. After step 1 add the following WARNING: WARNING • Allow a minimum of 5 seconds before moving the dump switch back to the OFF position.

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TECHNICAL DATA CHANGE FLIGHT MANUAL

TO BE INSERTED IN FRONT OF A-12 Trainer
FLIGHT MANUAL DATED 1 November 1962

SECTION	PAGE	CHANGE
III	3-39 3-39a (Cont'd)	WARNING (Cont'd) •Do not attempt to dump fuel when the fuel level in tank 3 is below 4000 lbs. indicated. If dumping has been initiated, terminate dumping when fuel level reaches 4000 lbs. 2. Revise the sentence under step 6 to read: When fuel level in tank 3 reads 4000 lbs, 3. Delete existing NOTE under step 7 and replace with the following: NOTE If a power failure should occur in the dump circuit, it is possible for the normal motor driven valves to fail in the open position; however, solenoid operated back up dump valves installed in the dump lines will close to stop fuel dumping.
III	3-39a	Under FORWARD FUEL TRANSFER AND FUEL DUMPING PROCEDURE, after step 1, add the following WARNING: WARNING •Allow a minimum of 5 seconds before moving the dump switch back to the OFF position. •Do not attempt to dump fuel when the fuel level in tank 3 is below 4000 lbs. indicated. If dumping has been initiated, terminate dumping when fuel level reaches 4000 lbs.
IV	4-8	Under NORMAL OPERATION, delete the WARNING.
V	5-10	Delete the AIR CONDITIONING SYSTEM limitation.

NOTE: The technical data information furnished herein is intended to be used as INTERIM data only. It will be replaced and superseded at the time of issue of the next revision to the flight manual.

TECHNICAL DATA CHANGE FLIGHT MANUAL

OXC-4743
COPY 2 OF 2

TO BE INSERTED IN FRONT OF A-12 Trainer
FLIGHT MANUAL DATED 1 November 1962

SECTION	PAGE	CHANGE
I	1-1	Under AIRCRAFT GROSS WEIGHT, delete both sentences and add a new sentence to read: The approximate ramp gross weight of the aircraft with fuel load for present operating restrictions, water, two pilots and equipment is 87,000 pounds.
1	1-20	Under AFTERBURNER IGNITION SYSTEM, in 1st sentence change 91% to 93%.
1	1-25	Add new paragraph after Constant Speed Drive Oil Reservoir as follows: Constant Speed Drive Oil Low Level Lights. Constant Speed Drive oil low level lights on the annunciator panel (labeled L OIL QTY LOW and R OIL QTY LOW) will illuminate when respective CSD oil level has depleted below approximately 1 quart.
1	1-31	Under Inlet Air Bypass Door Switches, change 5th sentence to read as follows: When the aft cockpit switches are placed in the OPEN or CLOSED position they will override the forward cockpit switches.
1	1-32	Under Emergency Spike Switches, in 2nd sentence delete the words, "and closes the bypass doors."
1	1-48 1-49	Under DC ELECTRICAL POWER SUPPLY, in 3rd sentence delete the words, "reverse current relay and."
1	1-79	Under MACH TRIM SYSTEM, revise 5th sentence as follows: The trim system operates between 0.2 and 1.5 Mach number on a schedule of approximately 8° per Mach number. It operates only within the $8\frac{1}{2}$° nose up and 5° nose down trim limits of the elevons.
1	1-80	Under PITOT-STATIC SYSTEM, revise 6th sentence as follows: The other set of pickups supplies the speed sensors on the ejection seats, the altimeters, IAS indicators, and vertical velocity indicators.
1	1-82	Under LANDING GEAR SYSTEM, delete entire discussion down to the paragraph on LANDING GEAR LEVERS and substitute with the following: The tricycle type landing gear and the main wheel well inboard doors are electrically controlled and hydraulically actuated. The main gear outboard doors and the nose gear doors are linked directly to the respective gear struts. Each three wheeled main gear retracts inboard into the fuselage and the dual wheel nose gear retracts forward into the fuselage. The main gear is locked up by the inboard doors and the nose gear by an uplock which engages the strut.

NOTE: The technical data information furnished herein is intended to be used as INTERIM data only. It will be replaced and superseded at the time of issue of the next revision to the flight manual.

TECHNICAL DATA CHANGE FLIGHT MANUAL

TO BE INSERTED IN FRONT OF A-12 Trainer

FLIGHT MANUAL DATED 1 November 1962

SECTION	PAGE	CHANGE
I	1-82 (Cont'd)	There is no hydraulic pressure on the gear when it is up and locked. Down locks inside the actuating cylinders hold the gear in place in the extended position. Hydraulic pressure is on the gear in the extended position when L system pressure is available. The landing gear cylinders and doors are actuated in the proper order by two sequencing valves. Normal gear operation is powered hydraulically by the L hydraulic pump on the left engine. Should pressure drop to 1200 psi during retraction, the power source automatically becomes the R hydraulic pump. R hydraulic pressure will not extend the gear in the event of the L system failure and the manual landing gear release must be used.
I	1-84	Under Manual Landing Gear Release Handles, delete the 2nd sentence and substitute with the following: If the L hydraulic system has failed, but R hydraulic pressure is available, the landing gear lever must be in the DOWN position or the landing gear CONT circuit breaker must be pulled out before pulling the GEAR RELEASE handle. Otherwise, the R system will retract the gear. The gear extends by gravity force.
1	1-86	Under NOSE WHEEL STEERING SYSTEM, delete the words, "nose wheel" at the end of the 1st sentence and in the NOTE and substitute the words, "main gear."
1	1-87	Under WHEEL BRAKE SYSTEM, revise as follows: 1. 2nd sentence should be changed to read: Depressing the rudder pedals actuates 4-rotor brakes on each of the six main gear wheels. 2. Delete the 3rd and 4th sentences.
1	1-87 1-89	Under Brake Switches, revise as follows: 1. In the 2nd sentence, change the word SKID OFF to NORMAL. 2. In the 4th sentence, change the words EMER BRAKES to ALTERNATE. 3. Change the 5th sentence to read: When the aft cockpit switch is placed in the ANTI-SKID or ALTERNATE position it is capable of overriding the forward cockpit switch.

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TDC NO. 1

TECHNICAL DATA CHANGE FLIGHT MANUAL

TO BE INSERTED IN FRONT OF A-12 Trainer

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SECTION	PAGE	CHANGE
1	1-89	Under Anti-Skid Out Indicator Lights, in 2nd sentence change the words SKID OFF to NORMAL and EMER BRAKES to ALTERNATE.
1	1-90	Under DRAG CHUTE SYSTEM, revise 1st sentence on page to read: The chute mechanism incorporates a shear section in the yoke which ruptures if the chute is deployed above limit airspeed. Refer to Section V for further information.
1	1-90	Under Drag Chute Switches, revise as follows: 1. Change 3rd sentence to read: Deployment is accomplished by placing either switch to the DEPLOY position. 2. Add a new 6th sentence to read: The aft cockpit switch is capable of overriding the forward cockpit switch. 3. Delete the WARNING.
1	1-106	Under EJECTION SEQUENCE, after the 1st sentence add a note to read: The ejection seat cannot be fired until the canopy jettison system has fired. This design feature is necessary to prevent pilot ejection thru the metal canopy.
1		Replace the following illustrations with new attached illustrations: GENERAL ARRANGEMENT — Figure 1-1 — Page 1-2 LOWER INSTRUMENT PANEL — Figure 1-6 — Page 1-13 AFT COCKPIT - LEFT SIDE — Figure 1-9 — Page 1-16 AFT COCKPIT - RIGHT SIDE — Figure 1-10 — Page 1-17 FUEL SUPPLY SYSTEM — Figure 1-13 — Page 1-34 ELECTRICAL POWER DISTRIBUTION — Figure 1-15 — Page 1-47 CIRCUIT BREAKER PANELS — Figure 1-16 — Page 1-50 BRAKE SYSTEM — Figure 1-25 — Page 1-88 CANOPYS AND CONTROLS — Figure 1-26 — Page 1-100

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SECTION	PAGE	CHANGE
II	2-4 2-5	Under Instrument Panel, revise as follows: 1. Change step (4) [5?] to read: Brake switch - NORMAL 2. Change step 7 to read: Forward cockpit temperature rheostat - 12 o'clock position. 3. Change step 9 to read: Aft cockpit temperature rheostat - 12 o'clock position. 4. Change step 10 to read: Aft cockpit air system switch - ON 5. Change step 12 to read: Cockpit system crossover switch - ON. 6. Add a step 29 to read: Battery switch - OFF
II	2-6	Under Lower Instrument Panel, revise as follows: 1. Delete step 7. 2. Renumber step 8 to step 7.
II	2-8 2-9 2-11	Under Instrument Panel, revise as follows: 1. Delete the words "at 490°C" from step 2. 2. Change step 6 to read: Brake switch - NORMAL 3. Change step 10 to read: a. Forward cockpit - ON b. Aft cockpit - ON 4. Change step 13 to read: Cockpit system crossover switch - ON. 5. Delete step 40.
II	2-13 2-14	Under STARTING ENGINES, revise as follows: 1. Change step 2 to read: Boost pumps - Check tanks 1, 2 and 6 indicator lights (green) illuminated. 2. Delete note under step 2.

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TECHNICAL DATA CHANGE FLIGHT MANUAL

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SECTION	PAGE	CHANGE
II	2-16	Under ENGINE CHECKS, delete 1st two sentences of CAUTION.
II	2-16	Under EMERGENCY FUEL SYSTEM CHECK, revise as follows: 1. Change step 3 to read: Tachometer - Check that tachometer stabilizes at a new value. 2. Delete the 2nd sentence of NOTE.
II	2-17 2-18	Under BEFORE TAXIING, revise as follows: 1. Change step 11 to read: Inlet air bypass doors - AUTO (Ground crew will check doors open). 2. Change step 16 to read: Brake switch - NORMAL
II	2-20	Under PRE-TAKEOFF AIRCRAFT CHECK, delete the WARNING.
II	2-21	Under PRE-TAKEOFF ENGINE CHECK, change step 5 to read: Tanks 2 and 6 - Check lights ON.
II	2-27	Under CLIMB, add a new sentence after the 3rd sentence to read: Begin the rotation sufficiently in advance of reaching climb speed to avoid exceeding the recommended airspeed schedule.
II	2-30	Under DESCENT, add a NOTE after step 2 to read: The landing gear may be lowered in order to increase the rate of descent, provided that the airspeed is first reduced below 300 KEAS (gear limit speed).
II	2-30 2-31	Under BEFORE LANDING, revise as follows: 1. Add a new step 3 to read: Cross feed switch - Depress (Check light - ON) 2. Renumber existing steps 3 and 4 to 4 and 5. 3. Add a 2nd sentence to NOTE under new step 4 to read: Forward fuel flow during transfer may be increased by holding the aircraft in a moderate nose down attitude. 4. Add a new step 6 to read: Cross feed switch - Depress (Check light - OFF)

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TECHNICAL DATA CHANGE
FLIGHT MANUAL

TO BE INSERTED IN FRONT OF A-12 Trainer

FLIGHT MANUAL DATED 1 November 1962

SECTION	PAGE	CHANGE
II	2-30 2-31 (Cont'd)	5. Change new step 8 to read: Brake switch - NORMAL. 6. Renumber existing steps 5 thru 18 to 7 thru 20. 7. Under new step 17 add a sentence to read: Normal gear extension time is approximately 16 seconds.
II	2-34	Under <u>NORMAL LANDING</u>, revise as follows: 1. Delete 2nd sentence of step 4. 2. Change 3rd sentence of step 4 to read: Steering will not engage until rudder pedals align with nose wheel position (straight ahead) and weight of aircraft is on the main gear. 3. Add a step 7 to read: Drag chute - JETTISON 4. Below new step 7 add a CAUTION to read: CAUTION Whenever possible, the drag chute should be jettisoned above 20 mph. This provides sufficient pull for the socket to open and the ball to clear the aircraft. Below this speed the ball may damage the upper fuselage. If the chute is not jettisoned, the elevons should not be moved during taxiing since the shroud lines could jam between the inboard elevons and the fuselage and cause structural damage.
II	2-34	Add a new paragraph before CROSSWIND LANDING to read as follows: <u>AFT COCKPIT LANDING TECHNIQUE</u> Approach a point 1/4 to 3/8 of a mile from the end of the runway at approximately a 30 degree angle. As this point is approached, start a shallow turn to line up with the runway. Pick up each side of runway as reference points. Point of vision should be approximately 15 to 20 degrees to either side of a point dead ahead. Flare and touchdown are normal.

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TECHNICAL DATA CHANGE FLIGHT MANUAL

TO BE INSERTED IN FRONT OF A-12 Trainer

FLIGHT MANUAL DATED 1 November 1962

SECTION	PAGE	CHANGE
II	2-34	Add a new paragraph after CROSSWIND LANDING to read as follows: GCA APPROACH AND LANDING The following procedure is recommended when making a GCA approach and landing. 1. Approach the radar pickup point in a clean configuration. 2. Adjust throttles to establish 250 KIAS on base leg. 3. Lower landing gear on base leg, maintaining 250 KIAS. 4. Decrease airspeed to 230 KIAS during turn on final approach. 5. Decrease airspeed to 180 KIAS minimum on final approach. 6. Adjust throttles to maintain 1200 - 1400 feet per minute on glide slope.
II	2-38	Under AFTER LANDING, revise as follows: 1. Delete step 1. 2. Renumber steps 2 thru 6 to 1 thru 5.
II	2-38	Under ENGINE SHUTDOWN, revise as follows: 1. Delete existing steps 4 and 5. 2. Add the words "provided that the starting carts are connected" to 1st sentence of NOTE. 3. Change existing step 7 to step 4. 4. Change existing step 9 to step 5. 5. Change existing step 8 to step 7.
? II		ABBREVIATED CHECKLIST All numbered check list items changed in this section must also be changed in the pilot's abbreviated checklist.

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TECHNICAL DATA CHANGE FLIGHT MANUAL

PAGE III - 3-3 replaced for

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FLIGHT MANUAL DATED 1 November 1962

SECTION	PAGE	CHANGE
III	3-6	Under ENGINE FAILURE DURING FLIGHT, revise as follows: 1. Add a step 6 to read: Inlet air bypass doors - OPEN (To reduce buffeting) ✓ 2. After new step 6 add: If the left engine fails, ✓ 3. After above statement add a new step 7 to read: Cockpit system crossover switch - CROSSOVER ✓
III	3-7	Under IMMEDIATE AIRSTART ATTEMPT, in step 2, delete all words in the parenthesis after the word IDLE. ✓
III	3-10	Under NORMAL AIRSTART, revise as follows: 1. Renumber existing step 4 to step 5. ✓ 2. Renumber existing step 5 to step 4. ✓
III	3-13	Under LANDING WITH BOTH ENGINES INOPERATIVE, delete the words ✓ "is not recommended" and replace with "should not be attempted."
III	3-24	Under EJECTION, item d, change 2½ to 2. ✓
III	3-25	Under EMERGENCY ESCAPE IN FLIGHT, revise as follows: 1. Change step 3 to step 4. ✓ 2. Change step 4 to step 3. ✓ 3. After step 7, insert a new paragraph to read: ✓ DELAYED EJECTION If an emergency arises (smoke or fire in cockpit, etc.) which requires jettisoning the canopy with a subsequent need for the pilot to eject, proceed as follows: ✓

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TECHNICAL DATA CHANGE FLIGHT MANUAL

TO BE INSERTED IN FRONT OF A-12 Trainer
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SECTION	PAGE	CHANGE
III	3-25 (Cont'd)	1. Canopy - Jettison If the canopy does not jettison, 2. Canopy latch handle - Pull 3. Pull ejection seat "D" ring with both hands when or if necessary.
III	3-35	Under SPIKE INLET CONTROL SYSTEM MALFUNCTIONS, change the WARNING to read: If the emergency helium system is used, the spike will move forward and its position cannot be changed for the remainder of the flight.
III	3-36 3-37	Under IMPROPER FUEL SEQUENCING, revise as follows: 1. Delete 3rd sentence from WARNING. 2. Delete NOTE.
III	3-42	Under UTILITY HYDRAULIC SYSTEM FAILURE, revise as follows: 1. In 2nd sentence change 1900 psi to 1200 psi. 2. In the 4th sentence add: "the L water injection system" after "aerial refueling system." 3. In the 5th sentence add: "R water injection system" after "right inlet spike."
III	3-51	Under LANDING GEAR EMERGENCY EXTENSION, revise as follows: 1. Add a new step 1 to read: Landing gear CONT circuit breaker - Pull. 2. Renumber existing steps 1 and 2 to 2 and 3.
III	3-52	Under BRAKE SYSTEM EMERGENCY OPERATION, change step 1 to read: Brake switch - ALTERNATE.
? III	-	ABBREVIATED CHECKLIST All numbered checklist items changed in this section must also be changed in the pilot's abbreviated checklist.

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FLIGHT MANUAL

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SECTION	PAGE	CHANGE
IV	4-9	Under DEFOG SYSTEM, add the following after the NOTE: Defog Switches Defog switches are located on the left side of each instrument panel. The switches have three positions; ON (up), neutral (center), OFF (down), and are spring loaded from the neutral to the ON position. Each switch controls a motor driven shut off valve in the respective cockpit defog duct. When the switch is held in the ON position, the valve moves toward full open. Releasing the switch to the neutral position stops the valve travel. When the switch is placed in the OFF position the shut off valve travels to the full closed position. Power for the switches is furnished by the essential dc bus.
IV	4-20	Figure 4-6 (IFF and SIF CONTROL PANELS) Replace existing illustration with new attached illustration.
IV	4-22	Under Coder Group (SIF) Control Panel, change the 2nd sentence to read: The panel is installed on the forward cockpit right console.
IV	4-23	Under AN/AIC-10 INTERPHONE CONTROL PANEL, change 1st sentence to read: Both AN/AIC-10 interphone control panels are located on a shelf inside of lower hatch below the aft cockpit.
IV	4-49	Under Operation of the MA-1 Compass System, revise as follows: 1. Delete step 1. 2. Change steps 2 thru 5 to 1 thru 4.
IV	4-50	Under INERTIAL NAVIGATION SYSTEM, change last sentence of INS description to read: Power for the system is furnished by the No. 3 inverter, the LH generator and the monitored dc bus.
IV	4-63 4-64	Under Inadvertent Selection of Present Destination, revise as follows: 1. Delete last sentence on page 4-63. 2. Delete items 1, 2 and 3 on page 4-64.

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TECHNICAL DATA CHANGE FLIGHT MANUAL

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SECTION	PAGE	CHANGE
V	5-11	Under Landing, delete existing text and replace with the following: Normal Landing There is no limitation on airspeed for brake application at normal landing weights when the drag chute is used. The maximum speed for brake application without the drag chute is 125 KIAS in calm air, or 125 KIAS plus the runway wind component when headwinds exist.
V	5-11	Under Aborted Takeoff, delete existing text and replace with the following: At 85,000 pounds the maximum airspeed for brake application is approximately 100 KIAS in calm air without the drag chute. The airspeed is 135 KIAS when the drag chute is used. These airspeeds can be increased by an amount equal to the runway wind component when headwinds exist, but they will burn out before the aircraft is stopped if applied at higher speeds.

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SECTION	PAGE	CHANGE
VI	6-3	Under CLIMB, revise as follows: 1. Add the words "particularly when piloting from the aft cockpit" at the end of the 3rd sentence. 2. Add a new sentence after the 4th sentence to read: An increase in the level of wind noise may be noticed in the forward cockpit at 380 KEAS.
VI	6-6	Under SUPERSONIC ACCELERATION, revise as follows: 1. Change last sentence to read: The throttles should be retarded very slowly at the end of acceleration to avoid afterburner flameout and engine stall. 2. Add the following sentence at the end of above sentence: Yaw maneuvers should not be made at maximum speed unless the yaw damper is on. Return to neutral after rudder kick is slow with the yaw damper off.
VI	6-7 6-8	Under APPROACH AND LANDING, revise as follows: 1. Add the following sentence after the 2nd sentence: The transfer rate is substantially higher during descent than during level flight. 2. Change first sentence on page 6-8 to read: Simulated and actual single engine landings can be made using the procedures outlined in Section III. 3. Change 4th sentence on page 6-8 to read: Normally, adequate control is available, but caution should be observed and higher than normal approach speeds used when landing in extremely turbulent air where maximum control rates may be required.
VI	6-12	Under STABILITY AND CONTROL CHARACTERISTICS, change 7th sentence on page 6-12 to read: The breakout forces are considered to be exceptionally good, although they are somewhat greater than for single place aircraft.

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SECTION	PAGE	CHANGE
VI	6-13	Replace the following illustration with new attached illustration: GROSS WEIGHT-CENTER OF GRAVITY VARIATION, Figure 6-2 Page 6-13.
Appendix		Replace existing Appendix with new attached Appendix (Parts I thru IV)

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SECTION I

DESCRIPTION

TABLE OF CONTENTS

THE AIRCRAFT

The A-12 trainer is a delta-wing, two-place aircraft powered by two axial-flow turbojet engines with afterburners. The aircraft is designed to operate at high altitudes and supersonic speeds. Some notable features of the aircraft are very thin delta wings, twin canted rudders mounted on top of the engine nacelles, and a pronounced fuselage chine extending from the nose to the leading edge of the wing. The surface controls, comprising the elevons, and twin rudders, are operated by irreversible hydraulic actuators with artificial pilot control feel. A single-point pressure refueling system is installed for both ground and in-flight refueling. A drag chute is provided to reduce landing roll.

The following switches and instruments are installed in this aircraft to simulate their arrangement and location in the A-12 aircraft. They are not wired for use. Refer to the A-12 Utility Flight Manual for information regarding their operation and purpose.

Spike switches - located on the instrument panel in forward cockpit.

Dual spike indicator - located on the instrument panel in forward cockpit.

Dual nozzle position indicator - located on the instrument panel in forward cockpit.

Inlet aft bypass switches - located above the throttle quadrant in each cockpit.

Restart and forward bypass switch - located on the right throttle in each cockpit.

Dual compressor inlet pressure gage - located on the instrument panel in forward cockpit.

Quad-hydraulic quantity gage - located on the instrument panel in forward cockpit.

AIRCRAFT DIMENSIONS

The overall aircraft dimensions are as follows:

Wing span	55.62 feet
Length	98.75 feet
Height	18.45 feet
Tread	16.67 feet

AIRCRAFT GROSS WEIGHT

The approximate ramp gross weight of the aircraft, with fuel load for present operating restrictions, INS, two pilots and equipment is 85,000 pounds.

ENGINE (J-75)

The aircraft is powered by two Pratt & Whitney J-75-19W(S)A turbojet engines equipped with afterburners. This engine has a sea level standard day installed static thrust rating of approximately 19,500 pounds at Maximum thrust. The engine is a continuous-flow gas turbine, incorporating an eight-stage low pressure compressor, a seven-stage high pressure compressor, eight radially positioned combustion chambers, a split three-stage turbine, and an afterburner incorporating a two-position exhaust nozzle. The rotor systems are mechanically independent of each other. The high pressure compressor is driven by a hollow shaft from the first stage turbine wheel. The low pressure compressor is driven from the second and third-stage turbine wheels by a shaft rotating within the hollow, high-pressure compressor shaft. The throttle controls the rpm of the high pressure rotor only. The main engine accessory section is gear-driven from the high pressure rotor and provides reduction gearing and mounting pads for the engine fuel control, the fuel pump, the oil boost pump, the tachometer generator, two hydraulic pumps, and the external starter drive.

GENERAL ARRANGEMENT DIAGRAM

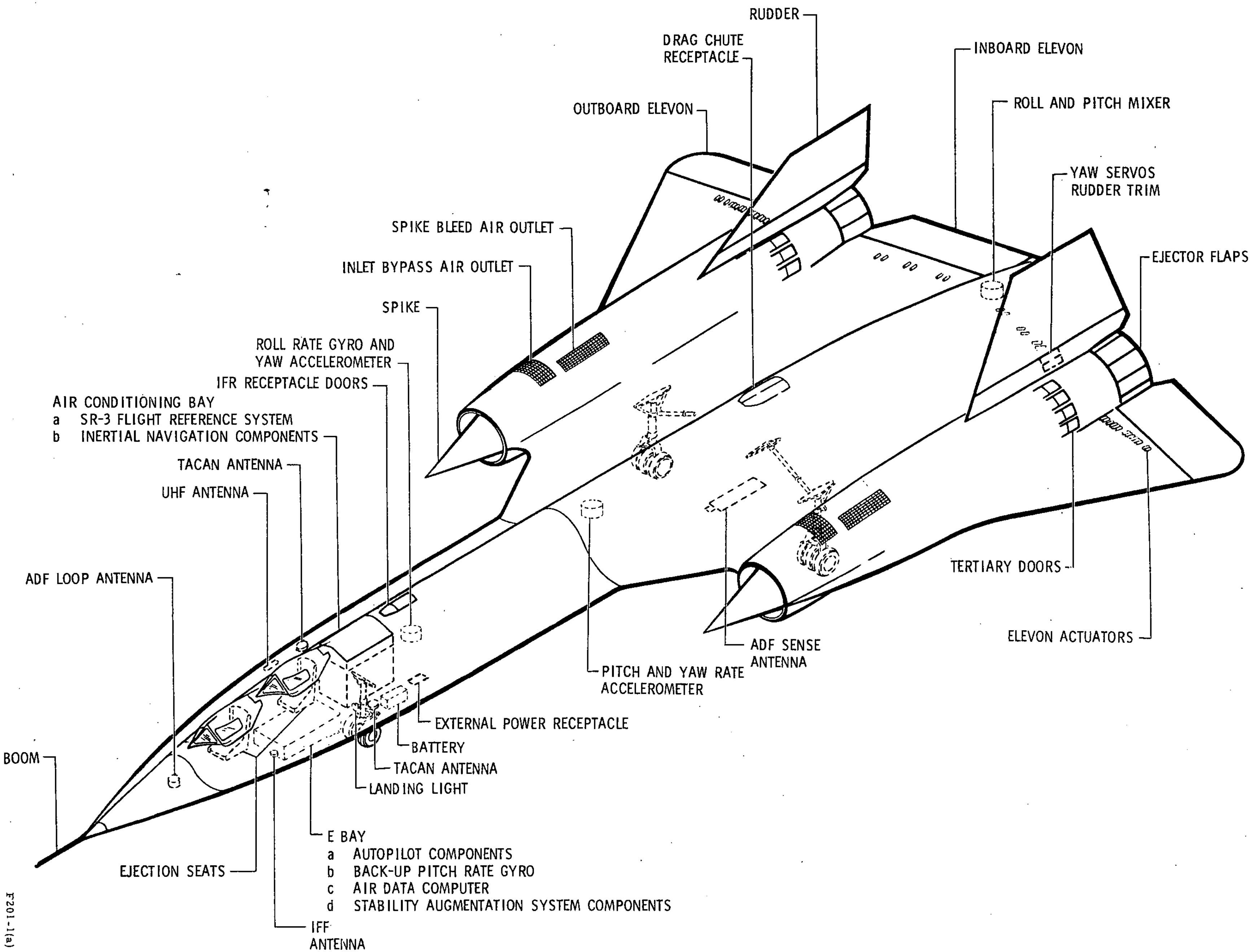


Figure 1-1

ENGINE FUEL CONTROL SYSTEM

Desired engine rpm is established by throttle movement. The fuel flow to the engine is regulated by the engine fuel control system.

Note

The engine fuel control systems are identical and completely separate for each engine.

The system includes the engine-driven fuel pump unit, the engine fuel control unit, the fuel pressurization and dump valve unit, and the afterburner fuel system.

Engine-Driven Fuel Pump Unit

The engine-driven fuel pump unit contains four pumps. It supplies fuel, at the pressure required, to the engine and afterburner systems. A centrifugal pump receives fuel from the airplane fuel system and forces it into three gear-type pumps. One gear-type pump is the engine stage fuel pump; the other two are the afterburner stage fuel pumps. The engine stage fuel pump furnishes fuel to the engine fuel control unit which regulates fuel flow to the combustion chambers. The afterburner stage fuel pumps furnish fuel to the afterburner fuel control which regulates fuel flow to the afterburner when afterburner operation is selected. When the afterburner is not operating, the output from the afterburner stage fuel pumps is returned to the discharge stream of the centrifugal pump. If the engine pump output pressure drops below approximately 50 psi, the emergency transfer valve in the engine-driven fuel pump unit automatically opens to allow fuel from the output side of one of the afterburner fuel pumps to flow to the hydromechanical fuel control unit.

Note

There is no direct indication of engine fuel pump failure.

During this condition, fuel can be supplied to both the engine and the afterburner systems, but may be insufficient for full afterburning thrust at low altitude. No thrust loss will occur in the MILITARY thrust range.

Engine Fuel Control Unit

The engine fuel control unit regulates fuel to the combustion chambers and incorporates normal and emergency fuel control systems. The normal fuel control system contains a mechanical computer, a governor, and temperature and pressure sensing elements which control the main throttle valve. The computer, in addition to sensing throttle position, senses changes in flight conditions and regulates fuel flow to insure optimum engine operation for the selected thrust setting. During rapid engine accelerations, the normal fuel control system regulates fuel flow to prevent overspeed, overtemperature, compressor stalls, and flameouts. The normal fuel control system also maintains a minimum fuel flow to prevent engine flameout at high altitudes and during rapid decelerations. When the throttles are retarded to OFF, a mechanically controlled cutoff valve in the fuel control unit cuts off all fuel to the combustion chambers. The emergency fuel control system provides an alternate system of regulating fuel flow to the combustion chambers in event of failure of components within the normal system. The emergency fuel system is capable of supplying sufficient fuel to obtain at least 95% Military thrust on a 100°F day at low altitudes and at least 80% Military thrust at altitudes up to 30,000 feet at standard, plus 40°F ambient conditions.

ENGINE FUEL AND IGNITION SYSTEM

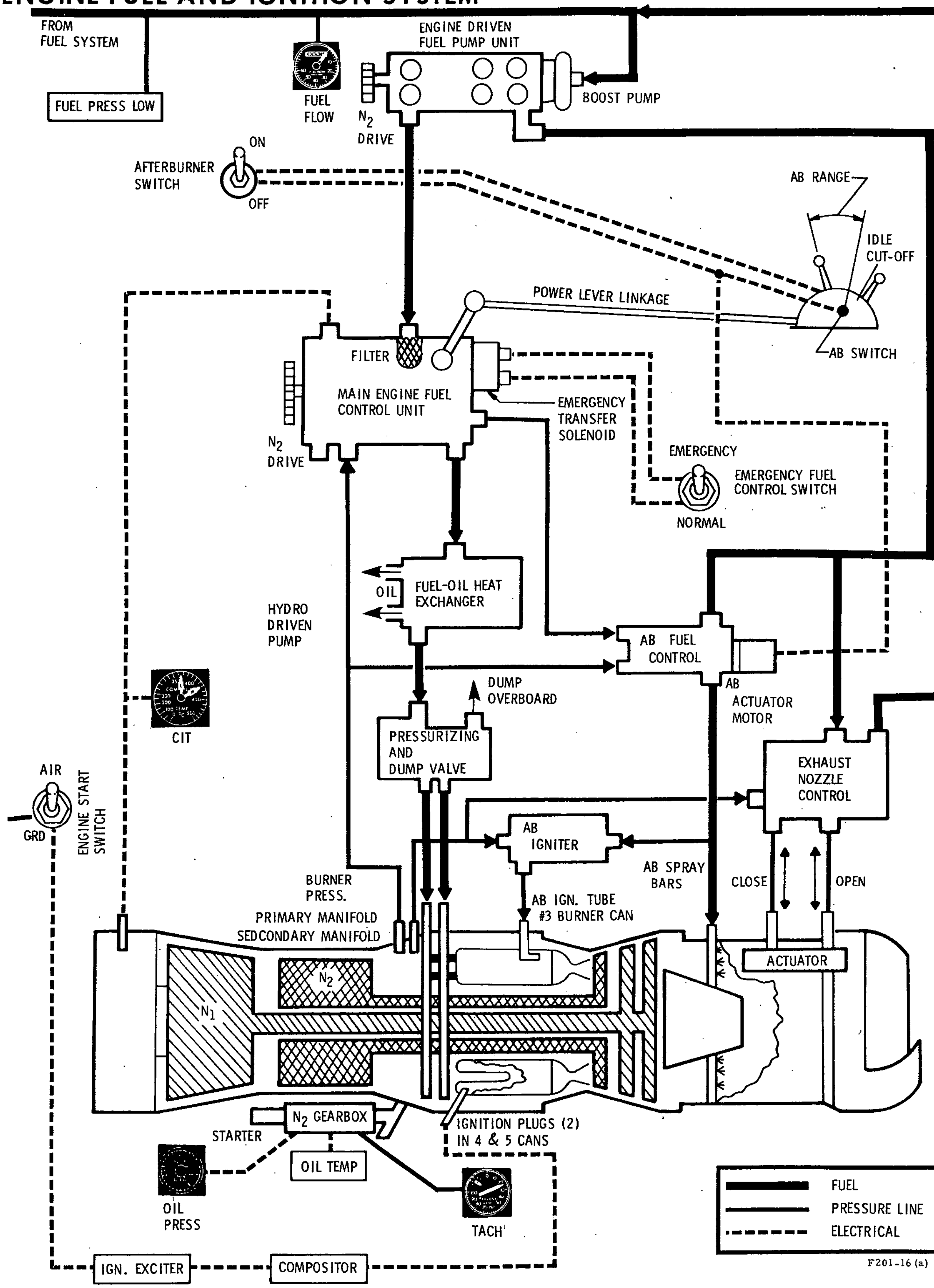


Figure 1-2

Note

When operating on the emergency fuel system, full obtainable thrust may result in lower rpm and exhaust gas temperature than that of normal fuel system operation.

The engine may be started on the emergency system, either in flight or on the ground. The afterburner may be operated normally on the emergency fuel system.

CAUTION

- The emergency fuel control system should be used only during an actual in-flight emergency or flight check.
- When operating on the emergency fuel control system, rapid throttle movements must be avoided to prevent overspeed, overtemperature, compressor stalls, and flameouts.

Fuel Pressurizing and Dump Valve

The fuel pressurizing and dump valve is located in the fuel control system between the fuel cutoff valve and the combustion chambers. The unit controls fuel flow to the primary and secondary injector nozzles in the engine combustion chambers. To facilitate starting, fuel at relatively low pressure is directed through the primary manifold, and spring tension on the pressurizing valve keeps the port to the secondary manifold closed until increasing engine speed builds up fuel pressure high enough to overcome the spring tension and open the valve. When this happens, fuel flows through both primary and secondary manifolds to the combustion chambers. When the engine is to be shut down, the cutoff valve in the fuel control unit is closed by throttle movement and the dump valve automatically opens to permit residual fuel in the manifolds of the main combustion system to drain overboard.

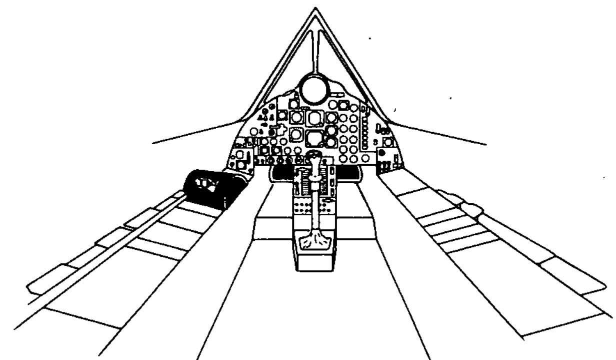
Emergency Fuel Control Switches

The two-position emergency fuel control switches are located on the left console in each cockpit. In the NORM (aft) position, the normal fuel control is in operation. The EMER (forward) position is used in the event of failure of the normal system, and fuel flow to the engine is controlled by a separate emergency throttle valve connected directly to the throttle. Power for the circuits is furnished by the essential dc bus.

THROTTLES

Two throttle levers, one for each engine, are located in a quadrant on the left forward console in each cockpit. The forward cockpit and aft cockpit throttles for each engine are interconnected and mechanically linked to the engine fuel control units, which directly govern engine thrust. The quadrant positions are labeled OFF, IDLE, and AFTERBURNER. Moving the throttles forward from OFF to IDLE mechanically opens the fuel cutoff valve. At the IDLE position, each throttle drops over a hidden ledge, which prevents inadvertent engine cutoff when the throttles are retarded to IDLE. Slow throttle movement ensures that the throttles will follow the curve of the quadrant. When returning the throttles from IDLE to OFF, the throttles must be pulled upward in order to clear the ledge. Above IDLE, forward throttle movement past a raised detent indicates that the afterburner micro-switches inside the throttle quadrant are about to close.

THROTTLE QUADRANT (Both Cockpits)



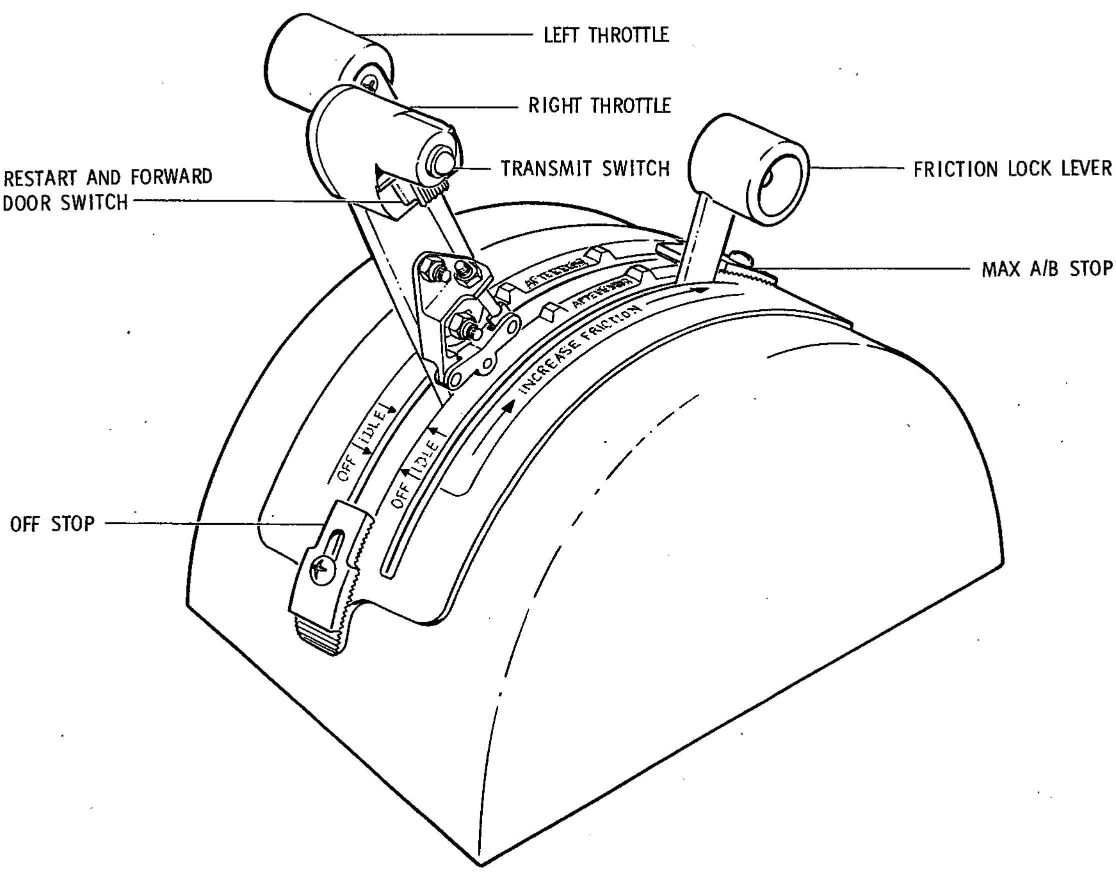


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Figure 1-3

Throttle Friction Levers

The throttles are prevented from creeping by interconnected friction levers, located on the inboard sides of the throttle quadrants. When the levers are fully aft, the throttles are free; moving the levers forward progressively increases the amount of friction to hold the throttles in position.

AFTERBURNER SYSTEM

The afterburner fuel control meters fuel flow to the afterburner spray bars on demand, as a function of engine burner pressure. The control incorporates a metering valve, shutoff valve, pressure regulator bypass valve, and a burner pressure mechanical metering linkage. Thrust with afterburner can be varied approximately 50 percent through throttle modulation between minimum and maximum afterburner position.

AFTERBURNER IGNITION SYSTEM

The afterburners are ignited electrically at engine rpm above approximately 93 percent rpm by moving the throttles through the detent to the AFTERBURNER position, and then placing the afterburner switches to the ON position. A "hot streak" igniter valve supplies a streak of burning fuel which passes through the turbines and ignites the afterburner fuel. The igniter valve also recirculates fuel when the afterburner is shut off.

Afterburner Switches

Each afterburner is actuated by individual afterburner switches located on the instrument panel in each cockpit. Either the forward or aft afterburner switches will initiate afterburner operation. In the ON (up) position, the afterburners will light when either throttle is forward of the afterburner microswitch setting on the throttle quadrant. Afterburner operation is terminated by moving the forward and aft cockpit afterburner switches to the OFF (down) position.

Note

> Both forward and aft cockpit afterburner switches must be moved to the OFF position to terminate afterburner operation.

Power for the circuit is furnished by the essential dc bus.

Afterburner Emergency Shutoff

Should either of the electrically operated afterburner switches (afterburner switch or throttle microswitch) fail to terminate afterburner operation, an afterburner shutdown may be accomplished by retarding the respective throttle to a point slightly aft of the afterburner detent. The afterburner fuel control shutoff valve is manually closed and shuts off all fuel to the afterburner.

Note

> If afterburner operation is terminated by manually closing the afterburner fuel shutoff valve in the manner described above and electrical power has been restored, the afterburner switch must be recycled after 5 seconds in order to regain afterburner operation.

EXHAUST NOZZLE SYSTEM

The engines are equipped with an iris type, two-position afterburner primary nozzle comprised of segments which are operated by a cam and roller mechanism and pneumatic actuators. The primary nozzle is enclosed by a fixed contour convergent-divergent ejector nozzle followed by free floating trailing edge flaps. Secondary air is provided by the inlet and bypasses around the engine to cool the engine and ejector. A series of free floating doors ahead of the nozzle provide tertiary air into the nozzle. The trailing edge flaps and tertiary doors open and close with varying internal nozzle pressure which is a function of Mach number and engine power. The tertiary doors will open to provide additional air which is required during low speed flight.

ENGINE OIL SUPPLY SYSTEM

The engine oil system is a dry sump recirculating pressure type system from a 5.5 US gallon oil tank mounted on the left side of the engine compressor section. Usable oil capacity is 4.5 US gallons. Oil flows from the tank to a gear-type boost pump, then through a fuel oil cooler to the main pump which supplies pressure through the main oil strainer to the engine gears and bearings. The strainer is equipped with a full flow bypass valve. Engine main oil pressure is governed by a pressure regulating valve located downstream of the filter. An oil scavenging system with four scavenge pumps returns oil to the tank. An engine oil breather pressurizing valve (aneroid type) regulates pressure in the bearing compartments, breather system and oil tank. The valve is open at sea level and regulates to hold a constant breather system altitude of approximately 35,000 ± 4000 feet when aircraft operation is above 35,000 feet. The breather system vents overboard.

Engine Oil Temperature Lights

Two oil temperature lights, labeled L OIL TEMP and R OIL TEMP, are located on each annunciator panel. These lights will illuminate when engine oil temperature is less than $4^{\circ}C \pm 3^{\circ}C$ or greater than $282^{\circ}C \pm 11^{\circ}C$.

CONSTANT SPEED DRIVE UNIT (CSD)

A constant speed drive unit (CSD) mounted on the front of each engine is driven by the low pressure rotor. The unit converts the variable speed of the rotor to maintain constant speed rotation of the A. C. generator. The CSD consists of a hydraulic pump, separate reservoir, constant displacement hydraulic motor which turns faster or slower as the pump forces more or less oil into it, and a governing system which controls pump flow, thereby controlling the speed of the motor.

Constant Speed Drive Oil Reservoir

The CSD unit has a separate pressurized oil reservoir which supplies oil to the hydraulic pump. Reservoir capacity is 9 quarts, with a normal operating fluid level of 7.2 quarts.

Constant Speed Drive Oil Pressure Low Lights

Two CSD oil pressure low lights are installed on the annunciator panel in each cockpit. The lights are labeled L CSD OIL PRESS LOW and R CSD OIL PRESS LOW and illuminate whenever the respective CSD oil pressure is less than approximately 125 psi.

IGNITION SYSTEM

Individual ignition systems are installed on each engine. Each system has two separate exciter units and each exciter feeds an individual igniter plug. The igniter plugs are located in No. 4 and No. 5 burner cans. A single exciter is sufficient for making an air or ground start.

Engine Start Switches

The engine start switches for both engines are located on the lower left side of each instrument panel. Each toggle switch controls the ignition for one engine. The switches are momentary contact, three-position switches with a center OFF position. In the GRD (down) position, ignition power for both exciters is furnished through a single 15-ampere circuit breaker, from the essential dc bus. In the AIR (up) position, ignition power is furnished to each exciter from the battery bus through separate 10-ampere circuit breakers. The aft cockpit switches are capable of overriding the forward cockpit switches.

STARTER SYSTEM

An air turbine starter is provided for ground starts. An external air supply furnishes the necessary power. There are no aircraft controls over this system, being turned on and off by the ground-crew according to pilot signals. Air starts do not require a starter but are made by a windmilling engine.

ENGINE INSTRUMENTS AND INDICATOR LIGHTS

Exhaust Gas Temperature Gages

Two exhaust gas temperature (EGT) gages, one for each engine, are mounted on the right side of each instrument panel. They are calibrated from 0° to 1200°C and indicate the temperature sensed by the turbine discharge thermocouples. The four digital windows at the top of the gages indicate the exhaust gas temperature to the nearest degree. An ON-OFF window at the bottom of each dial indicates instrument operational status. Power is furnished by the No. 1 inverter.

Fuel Flow Indicators

Fuel flow indicators, one for each engine, are mounted on both instrument panels. The indicator dial is calibrated in increments of 2000 pounds per hour to 76,000 pph. A digital indication is also provided by each indicator in a center window which shows fuel flow to the nearest 100 pph. Power for the indicators is supplied from the No. 1 inverter.

Tachometers

Two tachometers, one for each engine, are mounted on the right side of each instrument panel. The tachometers indicate percentage of high pressure rotor rpm based on 8732 rpm as 100 percent. The main pointer is calibrated to 100 percent rpm and the subpointer makes one complete revolution for each 10 percent change in rotor rpm. By using the subpointer, up to 110 percent rpm can be read. The tachometers are self-energized and operate independently of the aircraft electrical system.

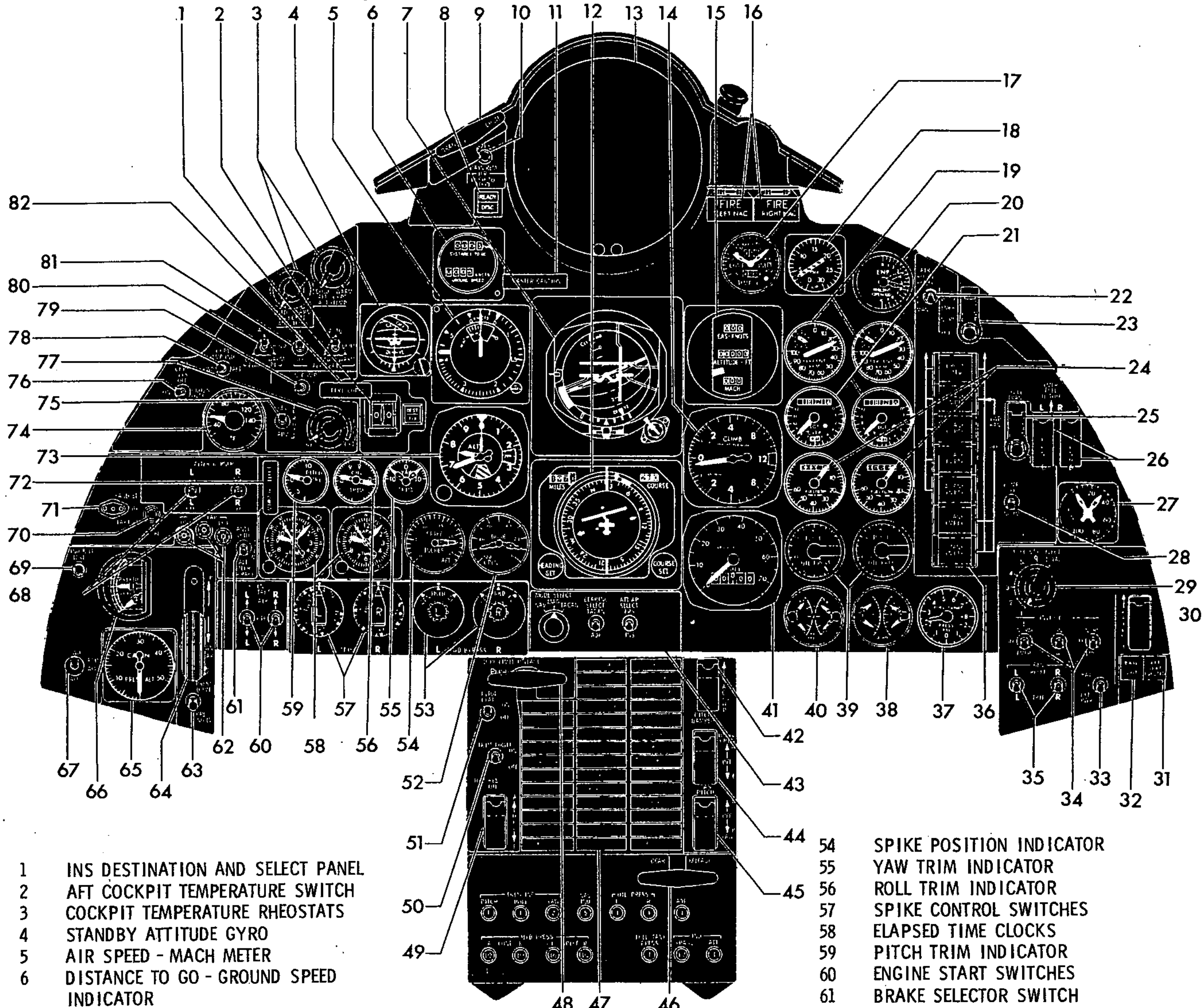
Engine Oil Pressure Gages

Two oil pressure gages are provided, one for each engine, on the right side of each instrument panel. The gages indicate output pressure of the respective engine oil pump. The gages are calibrated from 0 to 100 psi in 5-psi increments. Power for the gages is furnished by the inverter No. 3 bus through the 26-volt auto-transformer.

Compressor Inlet Temperature Gages

A dual-indicating compressor inlet temperature gage is located on the right side of each instrument panel. The forward and aft cockpit indicators are independent of each other. The gages are calibrated in 10° increments from -50° to +50° and from

INSTRUMENT PANEL (Forward Cockpit)

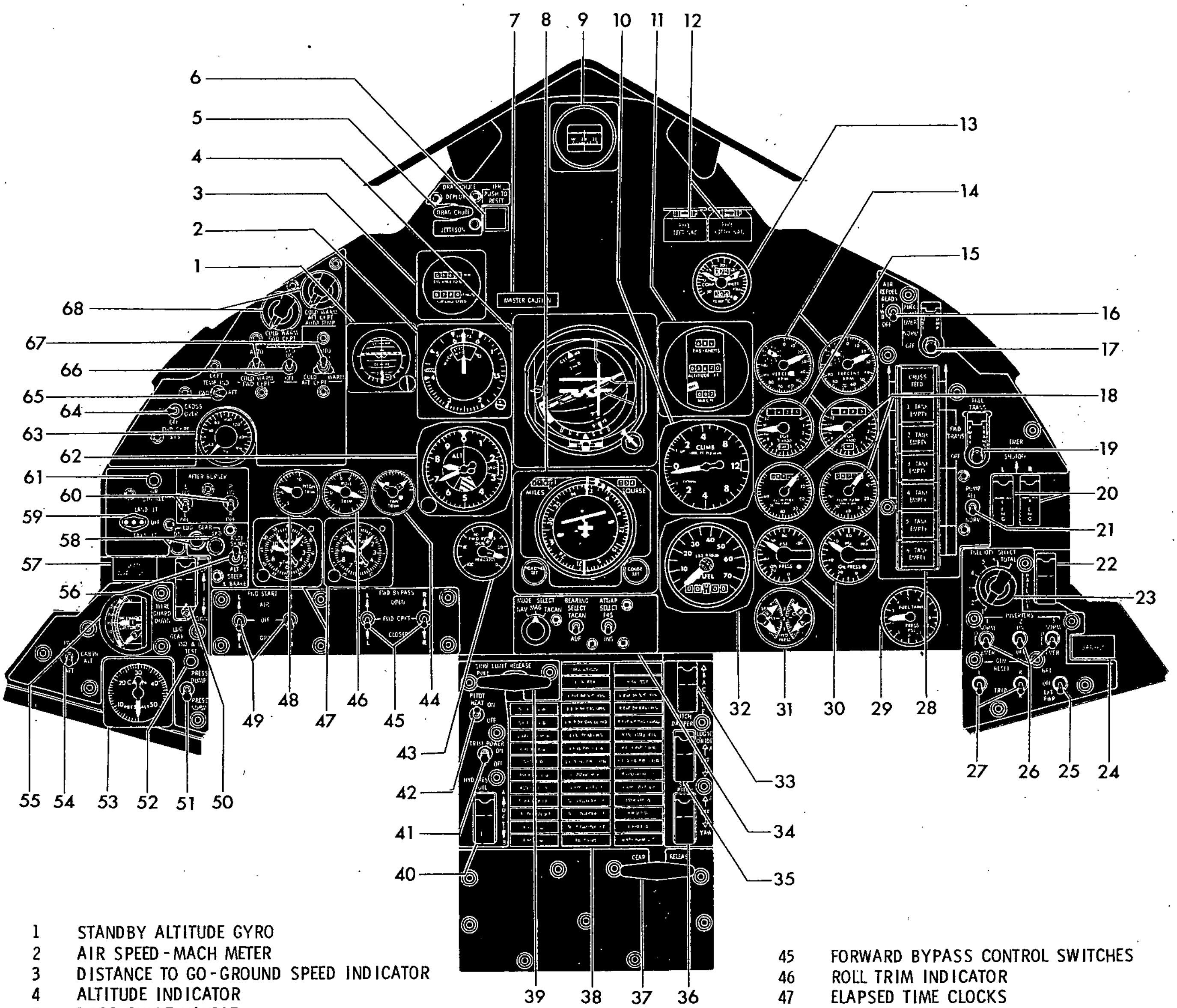


1. INS DESTINATION AND SELECT PANEL
2. AFT COCKPIT TEMPERATURE SWITCH
3. COCKPIT TEMPERATURE RHEOSTATS
4. STANDBY ATTITUDE GYRO
5. AIR SPEED - MACH METER
6. DISTANCE TO GO - GROUND SPEED INDICATOR
7. ATTITUDE INDICATOR
8. AIR REFUEL READY - DISCONNECT LIGHT AND SWITCH
9. DRAG CHUTE HANDLE
10. RAIN REMOVAL SPRAY BUTTON
11. MASTER CAUTION LIGHT
12. HORIZONTAL SITUATION INDICATOR
13. PERISCOPE VIEWING SCREEN
14. RATE OF CLIMB INDICATOR
15. TRIPLE DISPLAY INDICATOR
16. FIRE WARNING LIGHTS
17. COMPRESSOR INLET TEMPERATURE GAGE
18. COMPRESSOR INLET PRESSURE GAGE
19. TACHOMETERS
20. EXHAUST NOZZLE POSITION INDICATOR
21. EXHAUST GAS TEMPERATURE GAGES
22. AIR REFUEL READY SWITCH
23. FUEL DUMP SWITCH
24. FUEL FLOW METERS
25. FUEL TRANSFER SWITCH
26. EMERGENCY FUEL SHUTOFF SWITCHES
27. LIQUID NITROGEN QUANTITY GAGE
28. PUMP RELEASE SWITCH
29. FUEL QUANTITY SELECTOR SWITCH
30. BAILOUT SWITCH
31. AFT SEAT EJECTED LIGHT
32. BAILOUT LIGHT
33. BATTERY SWITCH
34. INVERTER SWITCHES
35. GENERATOR SWITCHES
36. FUEL BOOST PUMP SWITCHES
37. FUEL TANK PRESSURE GAGE
38. HYDRAULIC QUANTITY GAGE
39. ENGINE OIL PRESSURE GAGES
40. HYDRAULIC PRESSURE GAGES
41. FUEL QUANTITY INDICATOR
42. BACKUP PITCH-DAMPER SWITCH
43. FLIGHT INSTRUMENT CONTROL PANEL
44. PITCH LOGIC O'RIDE SWITCH
45. YAW LOGIC O'RIDE SWITCH
46. LANDING GEAR RELEASE HANDLE
47. ANNUNCIATOR PANEL
48. SURFACE LIMITER HANDLE
49. HYDRAULIC RESERVE OIL SELECTOR SWITCH
50. TRIM POWER SWITCH
51. PITOT HEAT SWITCH
52. FORWARD BYPASS POSITION INDICATOR
53. FORWARD BYPASS CONTROL SWITCHES
54. SPIKE POSITION INDICATOR
55. YAW TRIM INDICATOR
56. ROLL TRIM INDICATOR
57. SPIKE CONTROL SWITCHES
58. ELAPSED TIME CLOCKS
59. PITCH TRIM INDICATOR
60. ENGINE START SWITCHES
61. BRAKE SELECTOR SWITCH
62. LANDING GEAR DOWN LIGHTS
63. COCKPIT PRESSURE DUMP SWITCH
64. LANDING GEAR SELECTOR HANDLE
65. COCKPIT PRESSURE ALTITUDE GAGE
66. OXYGEN CYLINDER PRESSURE GAGE
67. CABIN ALTIMETER SELECTOR SWITCH
68. AFTERBURNER SWITCHES
69. INDICATOR AND LIGHTS TEST SWITCH
70. LANDING GEAR WARNING CUTOUT BUTTON
71. LANDING AND TAXI LIGHT SWITCH
72. PERISCOPE MIRROR SELECT HANDLE
73. ALTIMETER
74. COCKPIT TEMPERATURE INDICATOR
75. PERISCOPE PROJECTOR FILM LIGHT
76. FORWARD COCKPIT AIR SYSTEM SWITCH
77. PERISCOPE PROJECTOR LIGHT RHEOSTAT
78. COCKPIT TEMPERATURE INDICATOR SWITCH
79. SUN COMPASS SWITCH
80. FWD COCKPIT TEMPERATURE SWITCH
81. AFT COCKPIT AIR SYSTEM SWITCH
82. PERISCOPE MAGNIFICATION CONTROL HANDLE

F201-15(d)

Figure 1-4

INSTRUMENT PANEL (Aft Cockpit)

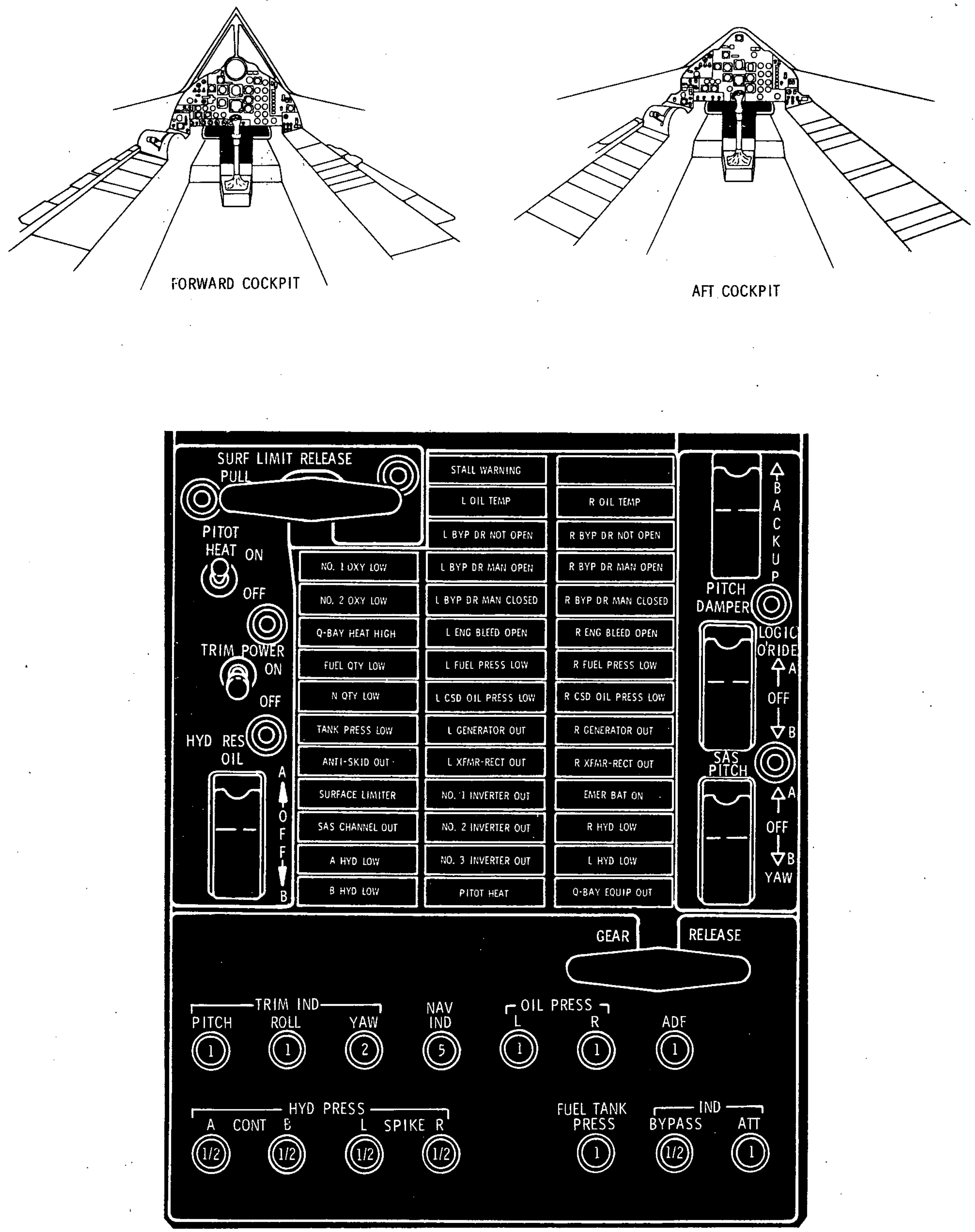


1 STANDBY ALTITUDE GYRO
2 AIR SPEED-MACH METER
3 DISTANCE TO GO-GROUND SPEED INDICATOR
4 ALTITUDE INDICATOR
5 DRAG CHUTE HANDLE
6 AIR REFUEL READY-DISCONNECT LIGHT AND SWITCH
7 MASTER CAUTION LIGHT
8 HORIZONTAL SITUATION INDICATOR
9 STANDBY COMPASS
10 RATE OF CLIMB INDICATOR
11 TRIPLE DISPLAY INDICATOR
12 FIRE WARNING LIGHTS
13 COMPRESSOR INLET TEMPERATURE GAGE
14 TACHOMETERS
15 EXHAUST GAS TEMPERATURE GAGES
16 AIR REFUEL READY SWITCH
17 FUEL DUMP SWITCH
18 FUEL FLOW METERS
19 FUEL TRANSFER SWITCH
20 EMERGENCY FUEL SHUTOFF SWITCHES
21 PUMP RELEASE SWITCH
22 BAILOUT SWITCH
23 FUEL QUANTITY SELECTOR SWITCH
24 BAILOUT LIGHT
25 BATTERY SWITCH
26 INVERTER SWITCHES
27 GENERATOR SWITCHES
28 FUEL BOOST PUMP SWITCHES
29 FUEL TANK PRESSURE GAGE
30 ENGINE OIL PRESSURE GAGES
31 HYDRAULIC PRESSURE GAGE
32 FUEL QUANTITY INDICATOR
33 BACKUP PITCH DAMPER SWITCH
34 FLIGHT INSTRUMENT CONTROL PANEL
35 PITCH LOGIC O'RIDE SWITCH
36 YAW LOGIC O'RIDE SWITCH
37 LANDING GEAR RELEASE HANDLE
38 ANNUNCIATOR PANEL
39 SURFACE LIMITER HANDLE
40 HYDRAULIC RESERVE OIL SEL SWITCH
41 TRIM POWER SWITCH
42 PITOT HEAT SWITCH
43 FORWARD BYPASS POS INDICATOR
44 YAW TRIM INDICATOR
45 FORWARD BYPASS CONTROL SWITCHES
46 ROLL TRIM INDICATOR
47 ELAPSED TIME CLOCKS
48 PITCH TRIM INDICATOR
49 ENGINE START SWITCHES
50 LANDING GEAR BYPASS SWITCH
51 COCKPIT PRESSURE DUMP SWITCH
52 INDICATOR AND LIGHT TEST SWITCH
53 COCKPIT PRESSURE ALTITUDE GAGE
54 CABIN ALTIMETER SELECTOR SWITCH
55 OXYGEN CYLINDER PRESSURE GAGE
56 BRAKE SELECTOR SWITCH
57 LANDING GEAR LOCK WARNING LIGHT
58 LANDING GEAR DOWN LIGHTS
59 LANDING AND TAXI LIGHT SWITCH
60 AFTERBURNER SWITCHES
61 LANDING GEAR WARNING CUTOUT BUTTON
62 ALTIMETER
63 COCKPIT TEMPERATURE INDICATOR
64 FORWARD COCKPIT AIR SYSTEM SWITCH
65 COCKPIT TEMPERATURE INDICATOR SWITCH
66 AFT COCKPIT AIR SYSTEM SWITCH
67 FWD AND AFT COCKPIT TEMPERATURE SWITCHES
68 COCKPIT TEMPERATURE RHEOSTATS

F201-14(d)

Figure 1-5

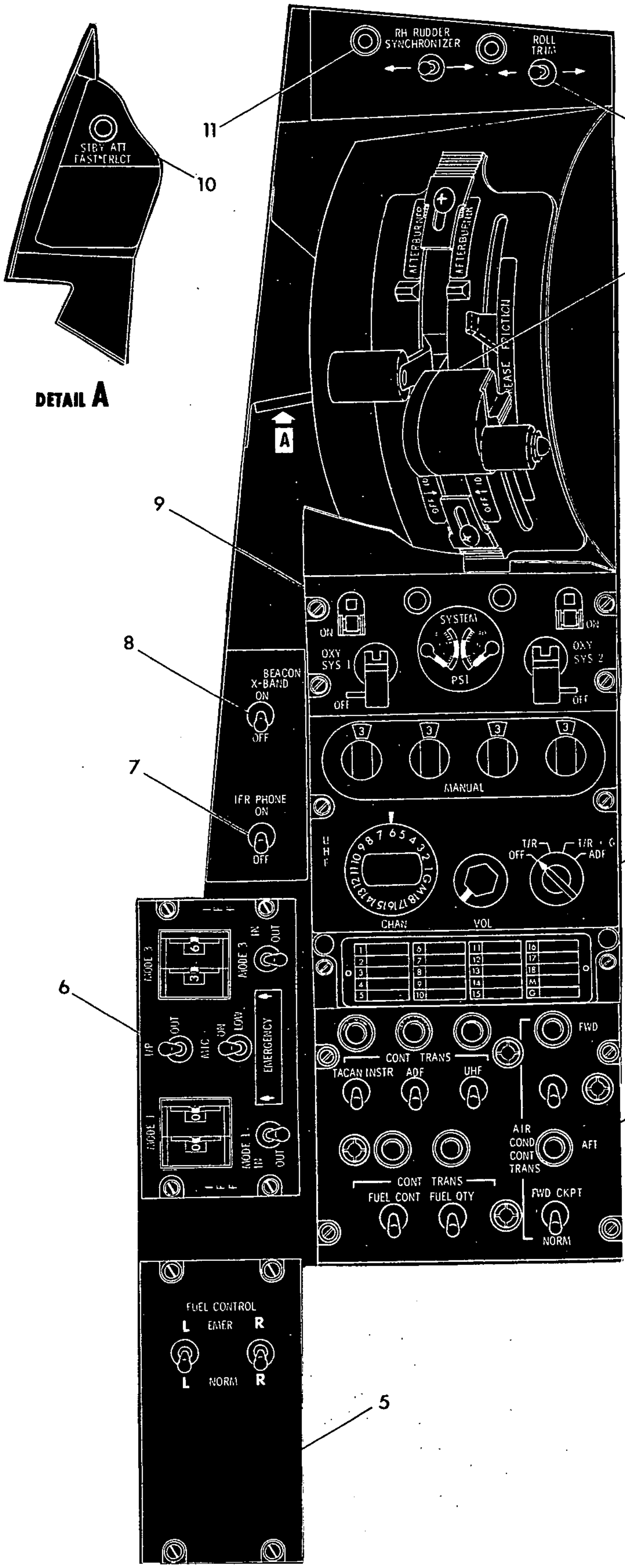
ANNUNCIATOR PANEL (Typical)

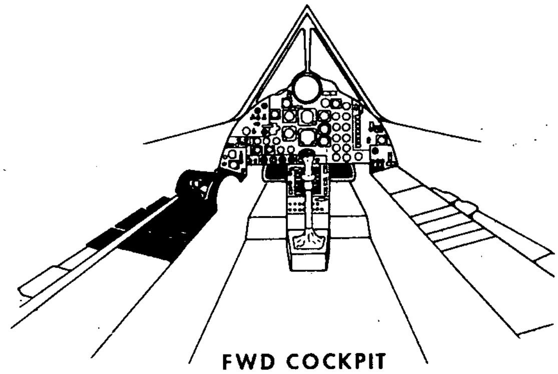


F201-10(c)

Figure 1-6

FORWARD COCKPIT (Left Side)



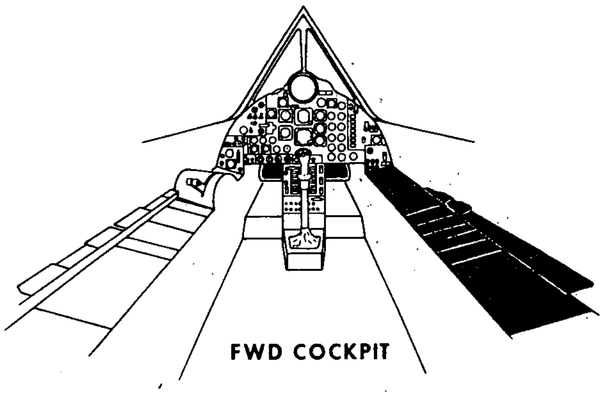


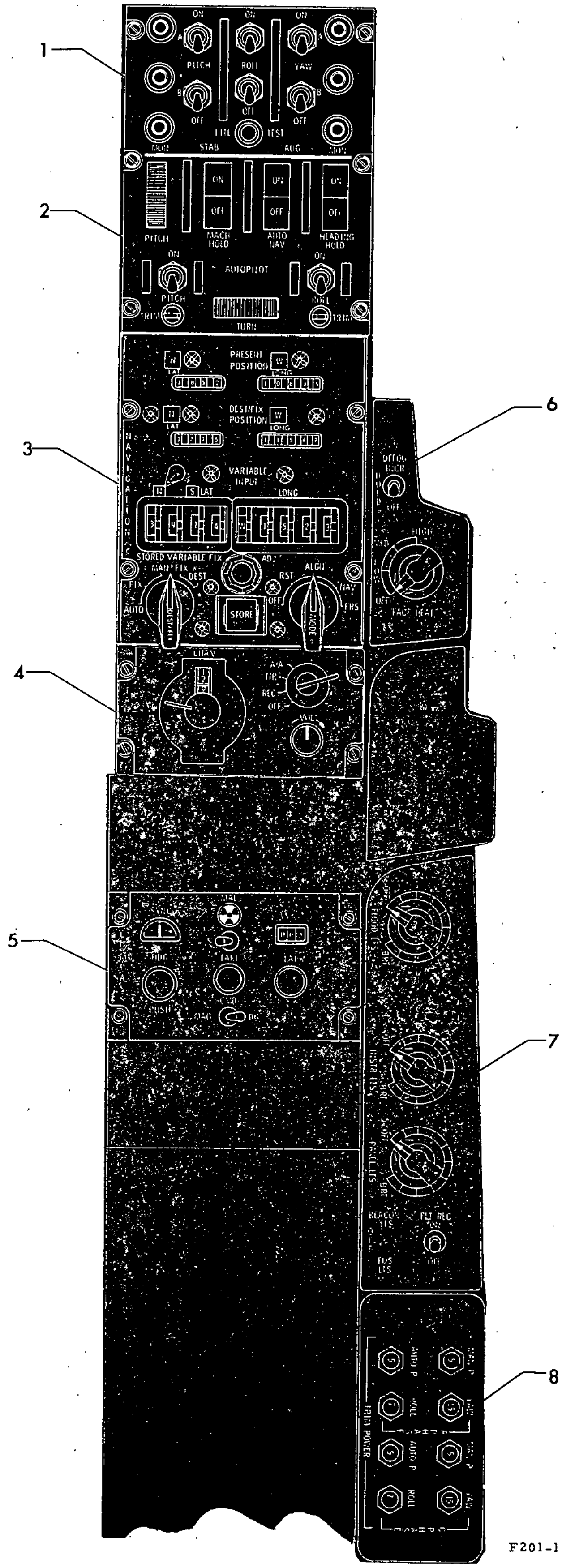
1 ROLL TRIM SWITCH
2 THROTTLE QUADRANT
3 UHF CONTROL PANEL
4 CONTROL TRANSFER PANEL
5 EMERGENCY FUEL CONTROL SWITCHES
6 IFF CONTROL PANEL
7 IFR INTERPHONE SWITCH
8 RADAR BEACON SWITCH
9 OXYGEN CONTROL PANEL
10 STANDBY ATTITUDE FAST ERECT SWITCH
11 RIGHT HAND RUDDER SYNCHRONIZER SWITCH

F201-12 (d)

Figure 1-7

FORWARD COCKPIT (Right Side)



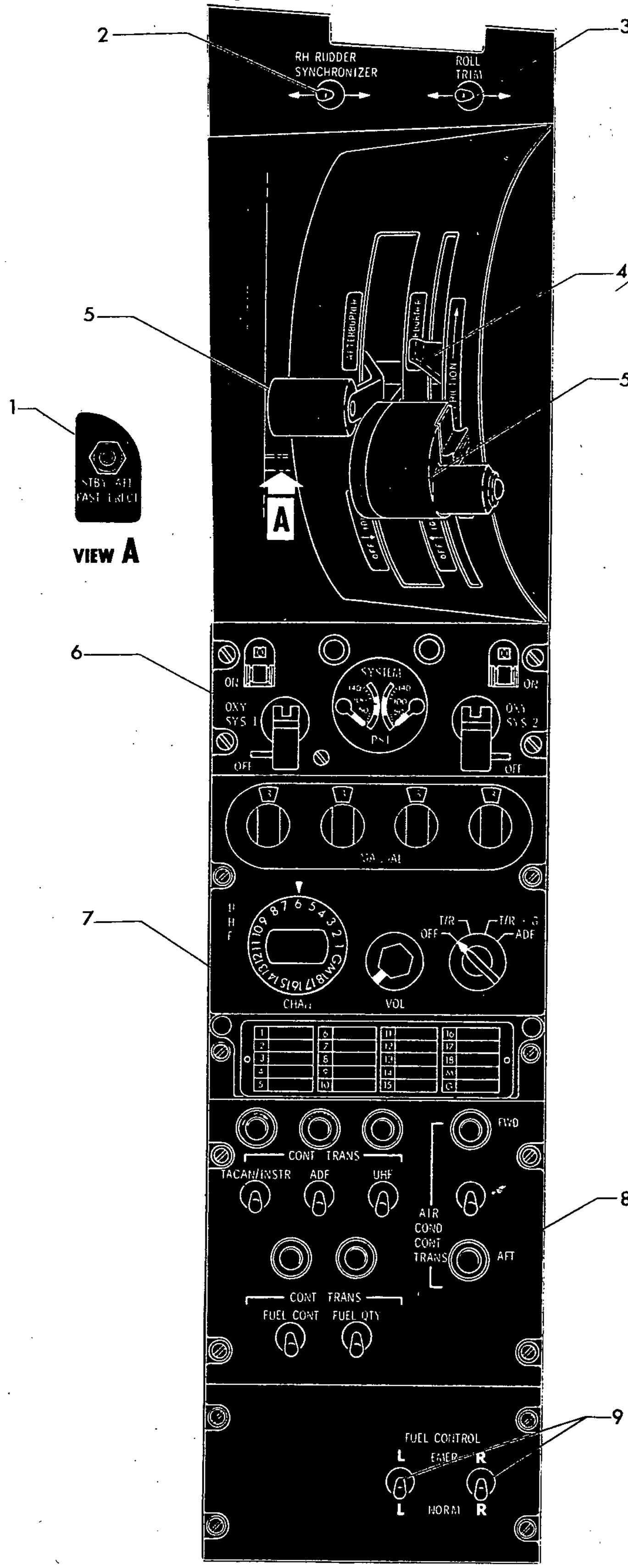


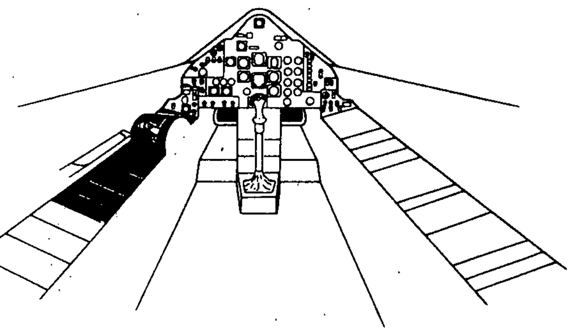
1 SAS CONTROL PANEL
2 AUTOPILOT CONTROL PANEL
3 INERTIAL NAVIGATION CONTROL PANEL
4 TACAN CONTROL PANEL
5 FRS CONTROL PANEL
6 DEFOG AND FACE HEAT CONTROL PANEL
7 LIGHTING CONTROL PANEL
8 TRIM POWER CIRCUIT BREAKER PANEL

F201-11(c)

Figure 1-8

AFT COCKPIT (Left Side)





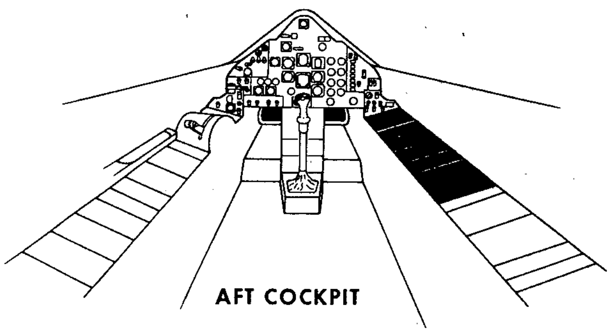
AFT COCKPIT

1. FAST ERECT BUTTON FOR STANDBY ATTITUDE INDICATOR
2. RUDDER SYNCHRONIZATION SWITCH
3. ROLL TRIM SWITCH
4. THROTTLE FRICTION LOCK
5. THROTTLES
6. OXYGEN CONTROL PANEL
7. UHF CONTROL PANEL
8. CONTROL TRANSFER PANEL
9. EMERGENCY FUEL CONTROL SWITCHES

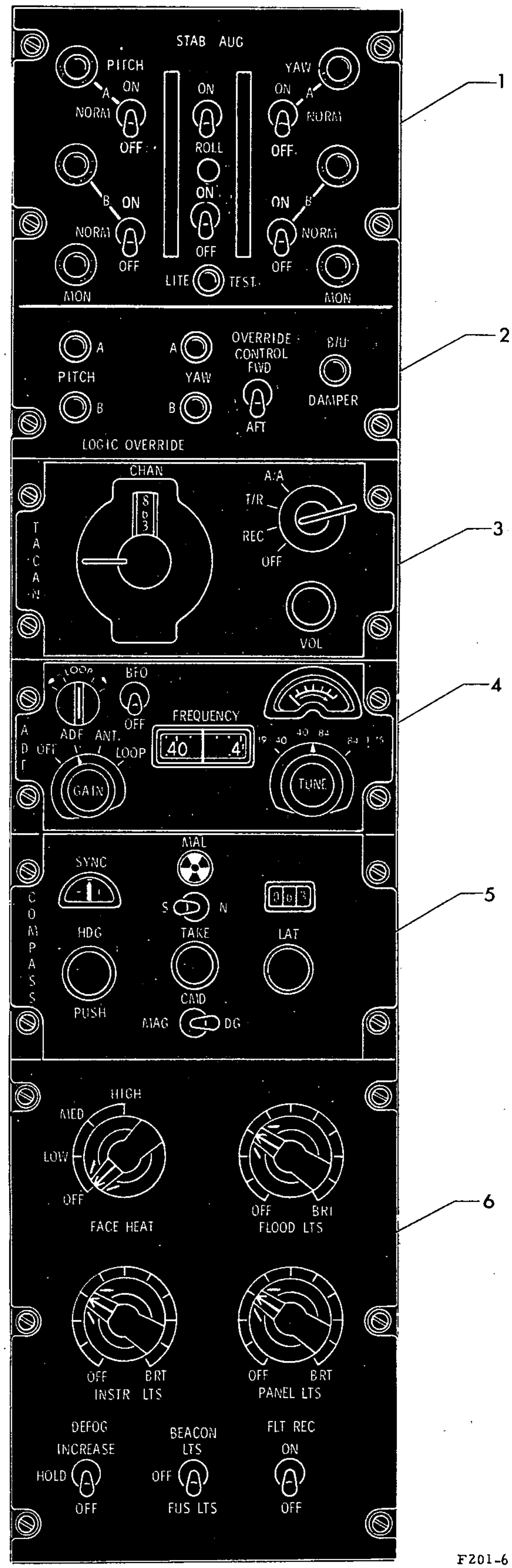
F201-7 (b)

Figure 1-9

AFT COCKPIT (Right Side)



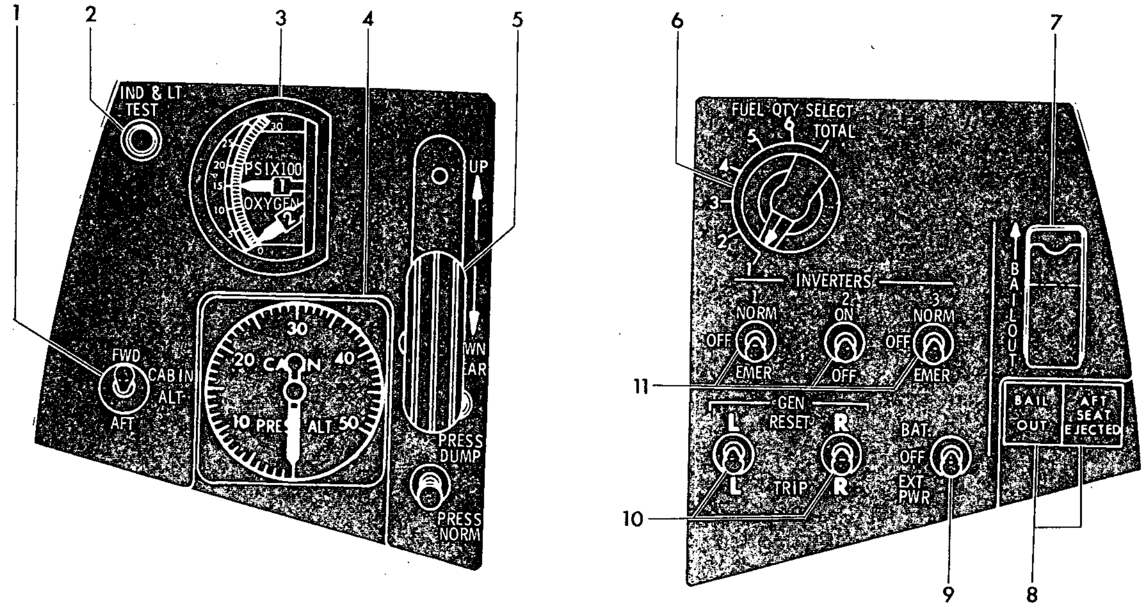
1 SAS CONTROL PANEL
2 LOGIC OVERRIDE PANEL
3 TACAN CONTROL PANEL
4 ADF CONTROL PANEL
5 FRS CONTROL PANEL
6 LIGHTING CONTROL PANEL



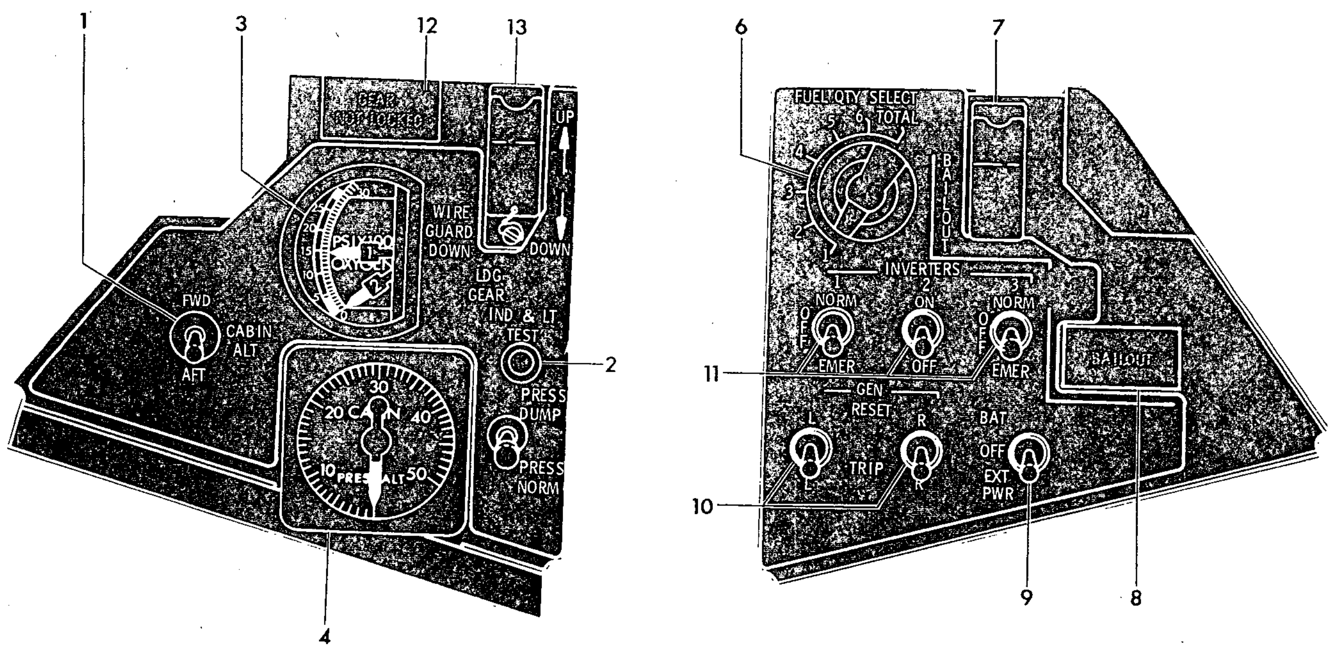
F201-6 (d)

Figure 1-10

LEFT AND RIGHT FORWARD PANELS



FORWARD COCKPIT



AFT COCKPIT

1 CABIN ALTIMETER SELECTOR SWITCH
2 INDICATOR AND WARNING LIGHTS TEST BUTTON
3 OXYGEN CYLINDER PRESSURE GAUGE
4 CABIN ALTIMETER
5 LANDING GEAR LEVER
6 FUEL QUANTITY INDICATOR SELECTOR SWITCH
7 BAILOUT SWITCH
8 BAILOUT LIGHT
9 BATTERY-EXTERNAL POWER SWITCH
10 GENERATOR SWITCHES
11 INVERTER SWITCHES
12 GEAR NOT LOCKED LIGHT
13 LANDING GEAR SWITCH

F201-8(c)

Figure 1-11

400° to 460°C. Each gage also has two digital readout windows for the compressor inlet temperature. Power is furnished by the No. 1 inverter.

ENGINE AIR INLET SYSTEM

The engine air inlets are canted inward and downward to align with the local airflow pattern. Air is bled from the spike and cowl to prevent boundary layer separation. The porous bleed on the spike centerbody exhausts overboard through the supporting struts and louvres. The cowl bleed supplies ejector secondary air for cooling the engine and ejector. Ground cooling suck-in doors are also provided in the aft nacelle area. Inlet airflow is controlled by the inlet bypass, a rotating basket which opens ports in the duct a short distance downstream of the inlet throat. On the ground, the bypass is open and the spike is full forward.

Note

The spikes are locked forward in this aircraft for all operations.

BYPASS CONTROLS AND INDICATORS

Inlet Bypass Switches

Two three-position toggle switches (aft cockpit) and two rotary switches (forward cockpit) are located on the lower left side of the instrument panel. The switches provide manual control of the inlet air bypasses. The aft cockpit switches are labeled OPEN (up), FWD CKPT (center) and CLOSED (down). The FWD CKPT position allows the forward cockpit control of the inlet air bypasses. When the switches are in the OPEN or CLOSED position the forward cockpit bypass controls are overridden. The forward cockpit rotary switches are labeled OPN, HOLD, and CL. The rotary switches are turned either clockwise or counterclockwise for the desired positioning of the bypasses.

Inlet Bypass Position Indicators

A dual inlet bypass position indicator is located on the lower left side of each instrument panel. The pointers indicate the amount of inlet bypass opening that has been selected with the inlet bypass switches, and do not indicate actual door position. The indication is in 10 percent increments and the labeled positions are 20, 40, 60, 80, and 100 percent.

Inlet Bypass Not Open Indicator Lights

Two indicator lights, one labeled L BYP DR NOT OPEN and the other R BYP DR NOT OPEN, are located on each annunciator panel. The light, when illuminated, indicates that the bypass is not open when the landing gear is down. Power for the lights is furnished by the essential dc bus.

Inlet Bypass Manually Open Indicator Lights

Two indicator lights, one labeled L BYP DR MAN OPEN and the other R BYP DR MAN OPEN, are located on each annunciator

AIR FLOW PATTERNS

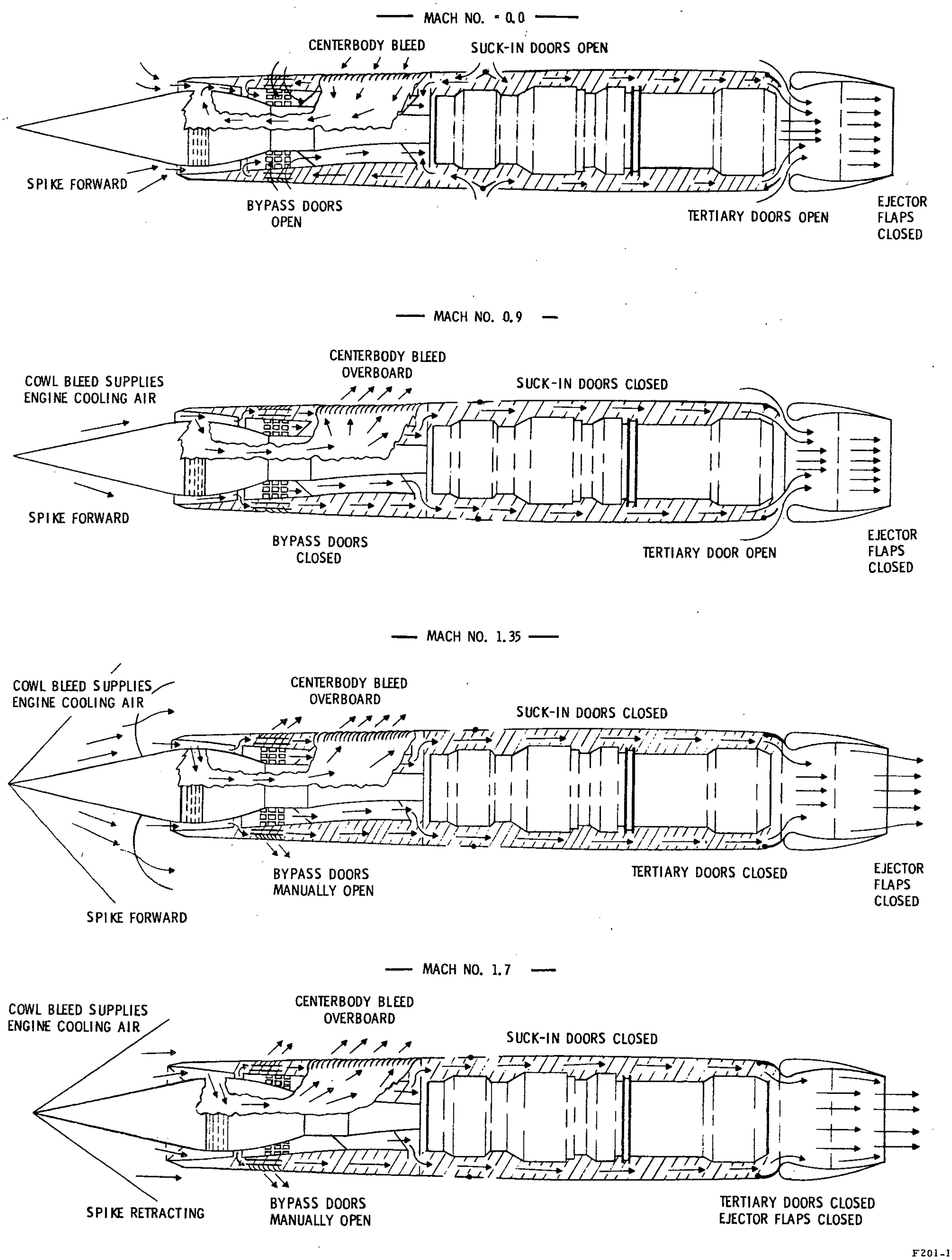


Figure 1-12

panel. The lights, when illuminated, indicate that the bypass has reached the full-open position. Power for the lights is furnished by the essential dc bus.

Inlet Bypass Manually Closed Indicator Lights

Two indicator lights, one labeled L BYP DR MAN CLOSED and the other R BYP DR MAN CLOSED, are located on each annunciator panel. The lights, when illuminated, indicate that the bypass has reached the fully closed position. Power for the lights is furnished by the essential dc bus.

FUEL SUPPLY SYSTEM

The aircraft fuel supply system consists of six integral fuel tanks with interconnecting plumbing and electrically actuated boost pumps for fuel feed, transfer, and dumping. Other components of the system include nitrogen inerting, pressurization and venting, single-point refueling, and fuel quantity indication. In addition to furnishing fuel for the engine, automatic fuel management provides center-of-gravity and trim drag control at cruise speed. The fuel is also used as a heat sink to cool cockpit air, engine oil, CSD oil, and hydraulic fluid.

FUEL TANKS

The six integral, internally sealed fuel tanks are contained in the fuselage and wing stub extensions. The tanks are numbered 1 through 6, fore to aft, and are interconnected by right and left fuel manifolds and a single vent line. Electrically actuated, submerged boost pumps are contained in all tanks, two each in tanks 2, 4, 5, and 6 and four each in tanks 1 and 3. Fuel manifolds, fed by the fuel boost pumps, route fuel to the engines, transfer fuel to tank 1 for cg control, or to the fuel dump valves where it can be dumped overboard in an emergency. Normal sequence of tank usage is controlled by a float switch for each pump to automatically maintain an optimum center of gravity for cruise. The left engine normally uses fuel in a sequence of tanks 1, 2, 4, and 3; the right engine uses fuel in a sequence of tanks 1, 6, 5, and 3. Normal automatic tank sequencing is as follows:

L ENGINE	R ENGINE
Tanks 1 & 2	Tanks 1 & 6
Tank 2	Tank 6
Tank 4	Tank 6
Tank 4	Tank 5
Tank 3	Tank 5
Tank 3	

Use of an electrically operated crossfeed valve and the boost pump switches makes it possible for any tank to feed any engine.

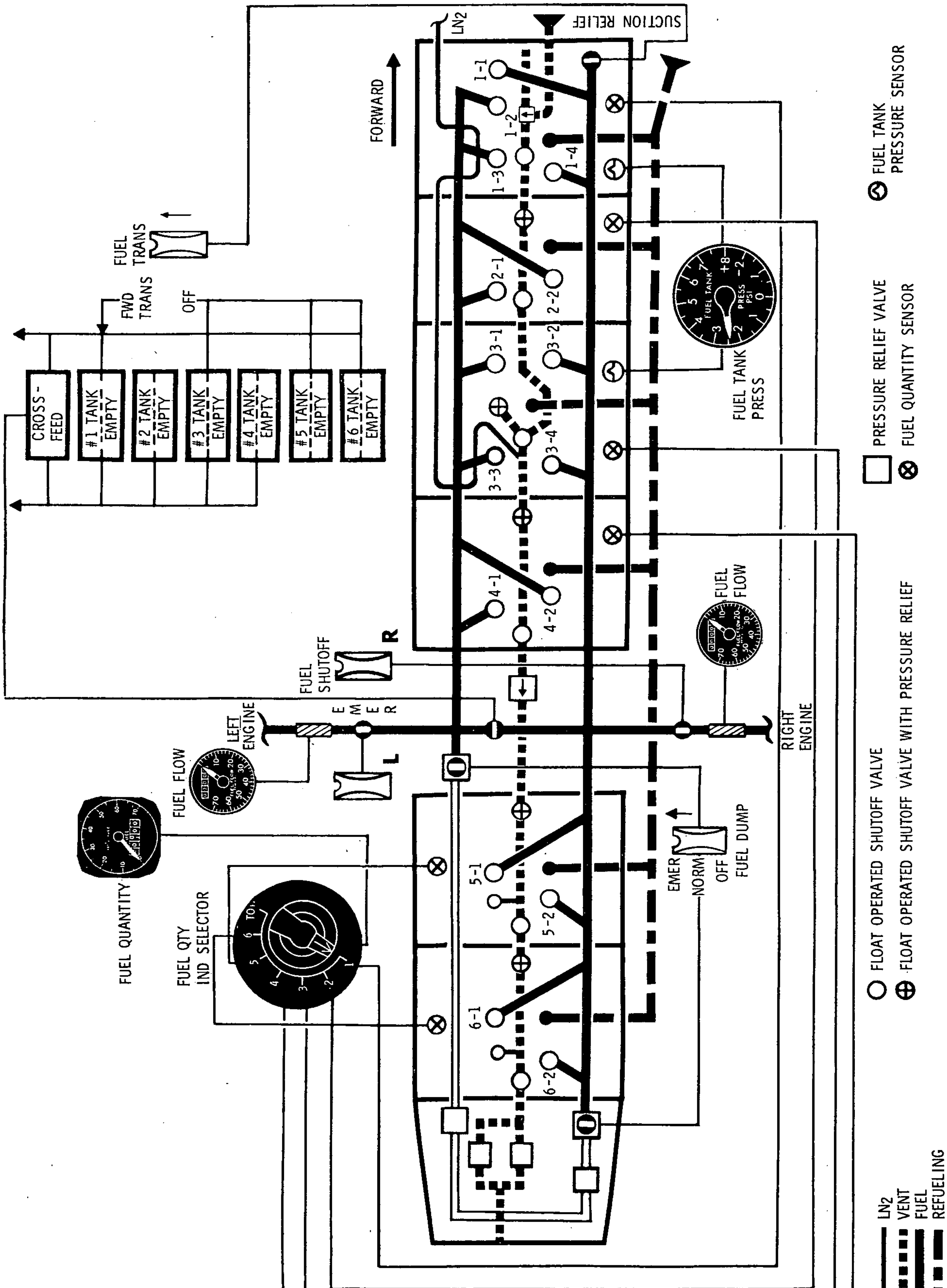
REFUELING AND DEFUELING

A single-point refueling receptacle, installed on top of the fuselage just aft of the rear cockpit, is used for both ground and air refueling. Ground refueling is accomplished by use of a probe especially modified to utilize a hand-operated locking device so that refueling may be done without hydraulic power. Fuel from the receptacle flows through the fueling manifold to each tank. The use of a different size orifice for each tank allows all tanks to be filled simultaneously in approximately 12 minutes, with a refueling pressure of 50 psi. Dual shutoff valves in each tank shut off fuel flow when the tank is full. A defueling fitting is installed on the right fuel-feed manifold in the lower right side of tank 4. Tanks 2 and 4, which feed the left manifold, are defueled by opening the crossfeed valve.

CAUTION

Any fuel in tanks 5 and 6 must be balanced with a like amount of fuel in the other tanks when fueling or defueling to prevent the aircraft from rocking down on the tail.

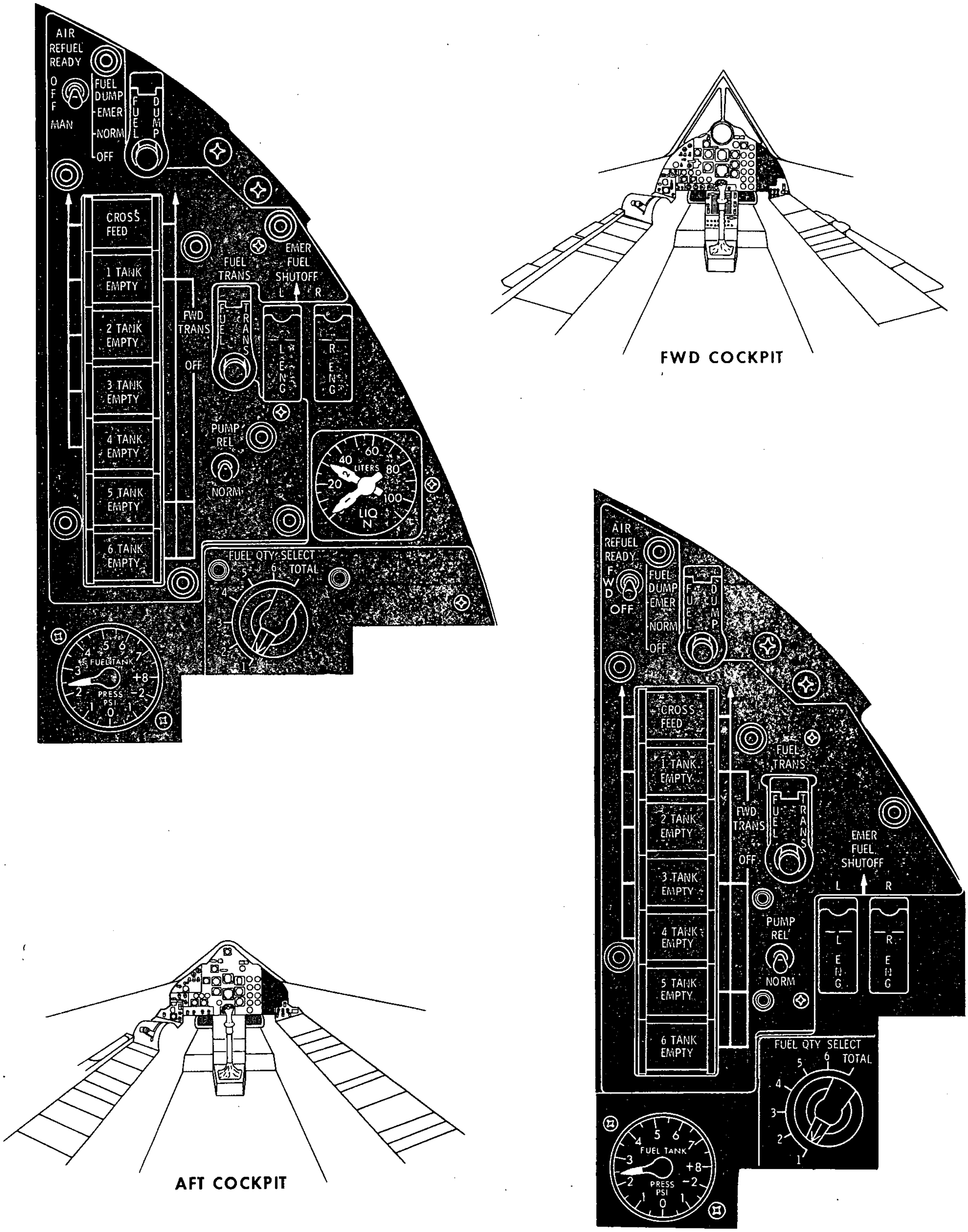
FUEL SUPPLY SYSTEM



F201-30(1)(a)

Figure 1-13

FUEL CONTROL PANEL (Both Cockpits)



F201-5(a)

Figure 1-14

Fuel Tank Capacities

Tank	Capacity	Fuel Loading Limit*
1	1,125 gal.	3,000 lbs
2	1,580	6,000
3	1,571	10,200 (full)
4	2,125	3,300
5	2,150	3,700
6	1,945	8,600
Total	10,496 gal	34,800 lbs**

* Automatic shutoff float switches set to restrict maximum weight.

** At 6.45 lb/gal fuel density.

FUEL BOOST PUMPS

Sixteen single-stage, centrifugal ac-powered fuel boost pumps are used to feed the fuel manifolds. Tanks 1 and 3, which normally feed both right and left engines, are equipped with four boost pumps, and tanks 2, 4, 5, and 6 have two pumps each. A single pump in each tank is capable of supplying fuel to the engine in the event of failure of the other pump. The pumps in each tank may be operated out of the normal sequence by actuating the individual tank boost pumps switches, located on the right side of each instrument panel. These switches supplement automatic tank sequencing if a tank fails to feed in the proper sequence. It is necessary to actuate the pump release switch to terminate any manually actuated pump when the tank is empty. Normally, each pump (except pumps 1-1 and 1-2, which are protected by a common float switch) is protected by a float switch that deactivates the pump when the tank is emptied in sequence. One of the float switches in each tank illuminates the yellow tank-empty light contained in the respective boost pump tank switch. The boost pumps that feed the left-hand manifold are normally powered from the left generator bus and the pumps that feed the right-hand manifold are normally powered from the right generator bus. Individual circuit breakers for each pump are located in a compartment behind the aft cockpit and are not accessible in flight.

Emergency Fuel Shutoff Switches

A guarded fuel shutoff switch for each engine is installed on the right side of each instrument panel. The switches are guarded in the open, or ON, position. When the switches (forward or aft cockpit) are moved to the EMER (up) position, power from the ac generator bus closes motor-driven valves in the engine feed lines. Each switch in the forward cockpit is safety-wired to the ON position for dual flight.

Fuel Boost Pump Switches and Indicator Lights

Six fuel boost pump switches are installed in a vertical line on the right side of each instrument panel. These switches are plastic, self-illuminated pushbutton-type, and control manual operation of the fuel boost pumps in each tank. The switches read out 1 TANK through 6 TANK when the respective tank boost pumps are operating.

Note

Manual operation supplements but does not terminate the normal automatic fuel tank sequencing.

The switches have an electrical hold and bail arrangement that allows manual selection of only one tank of tank group 1, 2, and 4 and one tank of tank group 3, 5, and 6 at the same time. This feature is intended to prevent more than eight boost pumps from operating simultaneously if one engine generator is inoperative.

Note

It is possible to operate more than eight boost pumps at once by a combination of automatic sequencing and manual actuation; this condition will not overload the electrical system except when operating on a single generator.

When a set of boost pumps is actuated, either automatically or manually, a green light will illuminate the pushbutton and the number of the tank involved. When a tank is empty, a yellow light in the pushbutton illuminates EMPTY. When depressed, a boost pump switch will hold down electrically until released by the pump release switch. Power for the boost pump switch circuits and lights is furnished by the essential dc bus. (Refer to description of forward and aft cockpit control transfer panels in Section IV for further information.)

Pump Release Switches

A momentary pump release toggle switch is installed on each instrument panel below the fuel boost pump switches. The switch has two positions, PUMP REL (up) and NORM (down). When placed in the PUMP REL position, any boost pump switch that has been depressed manually will be released and automatic tank sequencing will resume. Power for the circuit is furnished by the essential dc bus.

CAUTION

A manually selected boost pump should be released when a tank indicates empty so that the pumps in that tank will be shutoff.

Crossfeed Switches

A pushbutton-type crossfeed switch is installed at the top of the column of boost pump switches on each instrument panel. When depressed, it illuminates a green light in the switch, opens a motor-operated valve between the left and right fuel manifolds, allowing the right manifold to feed the left engine and the left manifold to feed the right engine. The switch must be depressed a second time to stop crossfeeding. Power for the circuit is furnished by the essential dc bus.

Fuel Transfer Switches

A guarded fuel transfer switch is installed to the right of the boost pump switches on each instrument panel. When the switch is in the FWD TRANS (up) position, a valve is opened in the forward end of the right-hand fuel supply manifold, the boost pumps in tank 1 are inactivated, and fuel will transfer forward from tank 3, 5, or 6. Transfer is automatically terminated by a float switch when the quantity in tank 1 reaches approximately 3000 pounds. This setting precludes the possibility of encountering gusts with more than the limit fuel quantity in tank 1. Tank 1 boost pumps will remain inactivated until 800 pounds of fuel remaining in tank 3, or the transfer switch is moved to the OFF (down) position. Power for the circuit is furnished by the essential dc bus.

Fuel Dump Switches

A guarded three-position lift-lock fuel dump switch is installed on the right side of each instrument panel. The three positions are EMER (up), NORM (center) and OFF (down). When the switch is moved to the NORM position, the pumps in tank 1 are inactivated to maintain a forward cg and all other tanks will dump in normal usage sequence. Fuel dumping will stop when the fuel level in tank 3 reaches 5000 lbs remaining. If there is any fuel remaining in tank 1, the boost pumps in tank 1 will start when tank 3 is down to 5000 lbs or dumping is terminated. When the switch is moved to the EMER position, the stop dump switch in tank 3 is bypassed and fuel dumping continues until all tanks, except tank 1, are empty. Power for the circuit is furnished by the essential dc bus.

WARNING

> Emergency fuel dumping must be terminated by moving the fuel dump switch to either the NORM or OFF position; otherwise, all fuel, except fuel in tank 1, will be dumped.

Fuel Quantity Selector Switch and Quantity Indicator

A quantity indicator and a rotary fuel quantity selector switch is located on the right side of the instrument panel in each cockpit. Positions on the selector switch are marked for each of the six tanks, and TOTAL position. The switch is rotated to the individual tank or TOTAL position for the desired reading on the fuel quantity indicator. The indicator is calibrated in 1000 pound increments from zero to 75,000 pounds. It also has a digital readout window indicating to the nearest 100 pounds the amount of fuel remaining. Power for the circuit is furnished by the No. 1 inverter.

Fuel-Quantity-Low Lights

Fuel-quantity-low lights, labeled FUEL QTY LOW, are located on each annunciator panel. The lights are illuminated by the closing of a low level (5000 pound) float switch in tank 3. Power for the lights is furnished by the essential dc bus.

Fuel Pressure Low Warning Lights

Fuel pressure low warning lights labeled L FUEL PRESS LOW and R FUEL PRESS LOW, are located on the annunciator panel in each cockpit. Illumination of a light indicates that engine fuel inlet pressure has fallen below approximately 7 $\pm$ 0.5 psi. The light is extinguished by restoring fuel pressure above approximately 10 psi. Power is furnished by the essential dc bus.

Note

> It is possible for a fuel pressure low warning light to illuminate when only two fuel pumps are feeding an engine during high fuel flows, especially with forward transfer and/or fuel dump selected.

FUEL PRESSURIZATION AND VENT SYSTEM

The fuel pressurization system consists of two liquid-nitrogen-filled Dewar flasks, located in the nosewheel well, and associated valves and plumbing to the fuel tanks and indicators. The Dewar flasks supply nitrogen gas to the fuel tanks at 1.5 (± 0.25) psi above ambient pressure, which inerts the ullage space above the fuel and provides pressure to ensure fuel flow to the engine-driven pump in case of boost pump failure. When Dewar flasks are full, the nitrogen supply is sufficient for approximately 9 hours of flight, including two refueling operations. The liquid nitrogen from the bottom of the flasks is routed through submerged heat exchangers in tanks 1 and 3 to ensure that the nitrogen has become gaseous. The nitrogen gas is then ported to the common vent line and to the top of all tanks. The venting system consists of a common vent line through all tanks with two vent valves in each tank except tank 1. Tank 1 has only one vent valve and the open forward end of the vent line. The forward vent valves in tanks 2, 3, 4, 5 and 6 are equipped with a relief valve to relieve tank pressure at 1.5 psi, and a float valve that closes the vent valve when the tank is full. The float shutoff is provided to keep fuel from entering the vent line. The aft vent valve is similar to the forward except that it has no relief valve. The common vent line tees into two lines in tank 6 and both go through the rear bulkhead. In the tail-cone area is a relief valve in each vent line with the left valve set to relieve pressure at 3 (± 0.25) psi above ambient pressure. In the event of failure of this valve, the right valve will relieve pressure at 3.5 (± 0.25) psi. A suction relief line and valve connects to the common vent line in tank 1 and terminates in a bell-mouth fitting in the aft end of the nosewheel well. Two valves are provided in the vent system to prevent fuel from surging forward in the vent line when the aircraft is decelerated. A check valve prevents fuel, that is coming forward from tank 6, from going beyond tank 5. A valve, located in tank 3, prevents fuel coming from tank 4 from going beyond tank 3. This float-actuated valve closes the vent when fuel is moving forward in the vent line and diverts it into tank 3. Tank 2 fuel can go forward into tank 1. Acceleration presents no problem of fuel shift between tanks.

Liquid Nitrogen Quantity Indicators

A dual liquid nitrogen quantity indicator is installed on the right side of the forward cockpit instrument panel. The indicator displays the quantity of liquid nitrogen remaining in each of the two Dewar flasks. The indicator is marked in 5-liter increments from 0 to 110 liters. Power for the indicator is furnished by the essential dc bus and the No. 1 inverter bus.

N2 Quantity Low Indicating Light

An indicator light labeled N QTY LOW is located on the annunciator panel in each cockpit. The light will illuminate when either liquid nitrogen quantity gage reaches 1 liter remaining. Power for the light is furnished by the essential dc bus.

Fuel Tank Pressure Indicators

A fuel tank pressure indicator is installed on the right side of each instrument panel. The indicators read the amount of gaseous nitrogen pressure existing in fuel tank 1, and are marked from -2 to +8 in increments of 1/2 psi. Power for the indicators is normally furnished by the No. 2 26-volt instrument transformer.

Tank Pressure Low Indicating Light

This light labeled TANK PRESSURE LOW is located on the annunciator panel in each cockpit and will illuminate when the tank pressure reduces to +.25 to +.10 psi. Power for the light is furnished by the essential dc bus.

AIR REFUELING SYSTEM

The aircraft is equipped with an air refueling system capable of receiving fuel at a flow rate of approximately 5000 pounds per minute from a KC-135 boom type tanker aircraft. The system consists of a boom receptacle, receptacle doors, hydraulic valves, hydraulic actuators, a signal amplifier, control switches and indicator lights. Hydraulic power for the system is normally supplied from the L hydraulic system. If the L system is inoperative the refueling system can be operated by R hydraulic pressure by selecting ALT STEER & BRAKE. Electrical power is supplied by the essential dc bus.

Air Refuel Switches

An AIR REFUEL switch is located at the top of the right instrument panel in each cockpit. The switch in the aft cockpit has three positions labeled READY, FWD, and OFF. When the switch is in the READY position the refueling doors are hydraulically actuated open, the boom latches are armed, the fueling receptacle lights are illuminated, the green READY portion of the air refuel reset light in each cockpit is illuminated, and the forward cockpit AIR REFUEL switch is made inoperative. When the AIR REFUEL switch in the aft cockpit is placed in the FWD position, the forward cockpit AIR REFUEL switch is operative, and when placed in the OFF position the forward cockpit switch is inoperative.

The AIR REFUEL switch in the forward cockpit has three positions labeled READY, OFF, and MANUAL. In the READY position the system is readied for automatic latching. In the OFF position the doors are closed and electrical power is removed from the system. In the MANUAL position the doors are open, the green READY portion of the reset switch is illuminated, and the fueling receptacle latches are closed. The latches may be opened to accept the probe by holding the A/R DISC trigger switch on the control stick grip. When the A/R DISC disconnect trigger is released the latches will close and hold the boom. The latches will open to release the boom when the A/R DISC trigger is depressed. MANUAL position is used in the event of a malfunctioning amplifier.

Air Refuel Reset Switches and Indicator Lights

A square dual indicator light and reset button is located on the top of each instrument panel on the left side. The top half is labeled READY and will illuminate green when an air refuel switch is in the READY or MANUAL position, and the refueling receptacle is open and ready to accept the refueling boom. The lights will extinguish after the boom is engaged. If the boom disconnects from the fueling receptacle for any reason when automatically latched, the lower half of the switches will illuminate amber and show DISC. The light may then be pressed to reset the system amplifier for another engagement. The DISC lights do not illuminate if a disconnect occurs while manually latched. Power for the system is supplied by the dc essential bus.

Disconnect Trigger Switches

A momentary contact, trigger-type switch, marked A/R DISC, is installed on the forward side of each control stick. Depressing either trigger switch will initiate a boom disconnect. The trigger is also depressed to open the receptacle latches when the air refuel switch is in the MANUAL position; releasing the trigger will close the latches.

Disconnect

A refueling disconnect may be accomplished in one of the following ways:

1. Automatically.
   a. If boom envelope limits are exceeded.
   b. When manifold pressure reaches 85-90 psi.
2. Manually.
   a. By the boom operator.
   b. By depressing the A/R DISC trigger on the control stick grip.

Pilot Director Lights (On Tanker)

Pilot director lights are located on the bottom of the tanker fuselage, between the nose gear and the main gear. They consist of two rows of lights, the left row for elevation, and the right row for boom telescoping. The elevation lights consist of five colored panels with green strips, green triangles, and red triangles to indicate relative position. Two illuminated letters, D and U for down and up, respectively, indicate elevation correction. Background lights are located behind the panels. The colored panels are illuminated by lights controlled by boom elevation during contact. The colored panels which indicate boom telescoping are not illuminated by background lights. An illuminated white panel between each colored panel serves as a reference. The letters A for aft and F for forward are visible at the ends of the boom telescoping panel. Figure 4-16 shows the panel illumination at various boom nozzle positions within the boom envelope. There are no lights to indicate azimuth; however, a yellow line is visible on the tanker to indicate the centerline. When the contact is made, the panels automatically reflect the correction required by the pilot to maintain position.

ELECTRICAL SUPPLY SYSTEM

The basic ac electrical system consists of a 30-KVA, constant-speed ac generator on each engine, furnishing 3-phase power to two ac buses through an automatic bus transfer and protection system. DC power is obtained by two 200-amp transformer-rectifiers, one from each ac bus. The parallel output from these transformer-rectifiers supplies the essential dc bus and a monitored dc bus. Three 600-VA inverters, powered by the essential dc bus, furnish fixed-frequency ac power to three separate ac buses. Three instrument transformers furnish 26-volt ac power; one is powered from inverter 1, the other two from inverter 3. A battery bus is furnished to provide power for air starting.

AC GENERATOR POWER SUPPLY

Each engine drives a 30-KVA generator through a constant-speed drive. This is the primary source of ac electrical power for the aircraft. The generators supply 115/200 V, 3-phase, constant-frequency power to the aircraft electrical system. Either generator will provide through the automatic bus transfer system in the event one generator fails. Conventional switches are provided for manual control of the generators.

INVERTER POWER SUPPLY

Three 600-VA, solid-state inverters furnish constant-frequency ac power to individual buses. Inverter 1 and 3 buses supply power for the entire inverter load except for the B SAS channel and one standby attitude gyro which is supplied by the inverter 2 bus. In the event that either inverter 1 or 3 fails, its load can be transferred to bus 2 and full operation continued. If inverter 2 fails, the B SAS channels and standby attitude gyro will be inoperative and inverter 1 or 3 load cannot be transferred. Should inverters 1 and 3 fail simultaneously,

ELECTRICAL POWER DISTRIBUTION

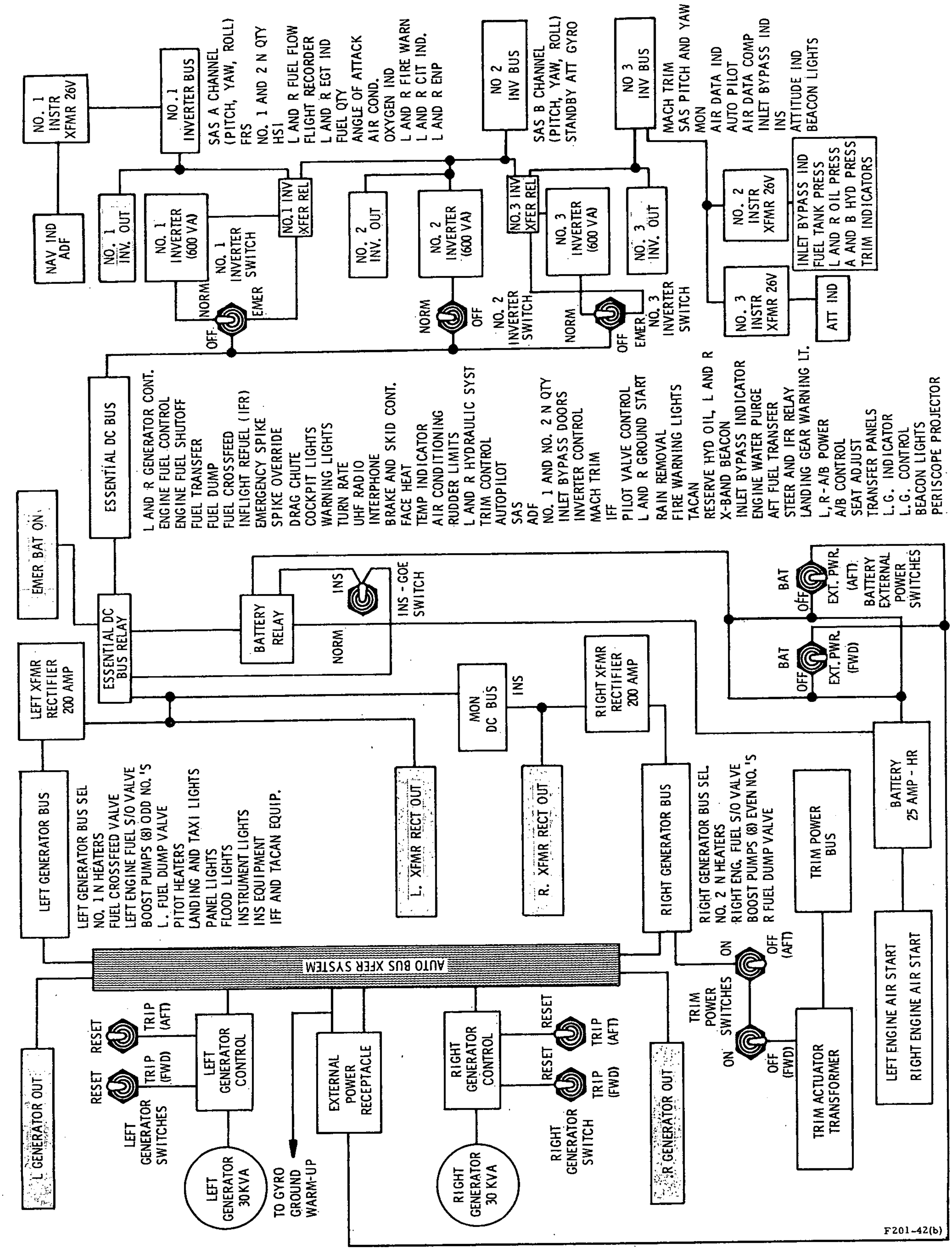


Figure 1-15

the load of only one of the inverters can be transferred to the No. 2 inverter. (See figure 1-15, Electrical Power Distribution diagram.)

EXTERNAL POWER SUPPLY

The aircraft is equipped with a receptacle for connecting an external ac power source to the aircraft electrical system. This receptacle is located in the nosewheel well. When the external power source is connected to the aircraft and the BAT-EXT PWR switch is in the EXT PWR position, the generators are automatically disconnected from their respective buses and both buses receive power from the ground power unit.

DC ELECTRICAL POWER SUPPLY

DC electrical power for the dc essential bus and the dc monitored bus is supplied from a 200-amp transformer-rectifier from each ac bus. The two transformer rectifiers are in parallel to supply the essential dc bus and the monitored dc bus. The 25-ampere-hour battery for emergency use will only supply current to the essential dc bus when both transformer-rectifiers are inoperative and the battery switch is ON.

CIRCUIT BREAKERS

The circuit breaker panels in the cockpit are located on the right and left consoles and below the annunciator panel, and contain push-to-reset, pullout-type breakers for certain ac and dc circuits. Circuit breaker panels which are not accessible during flight, but which should be inspected before flight, are located in the air conditioning bay and in the electrical load center (left-hand side of nosewheel well).

Generator Switches

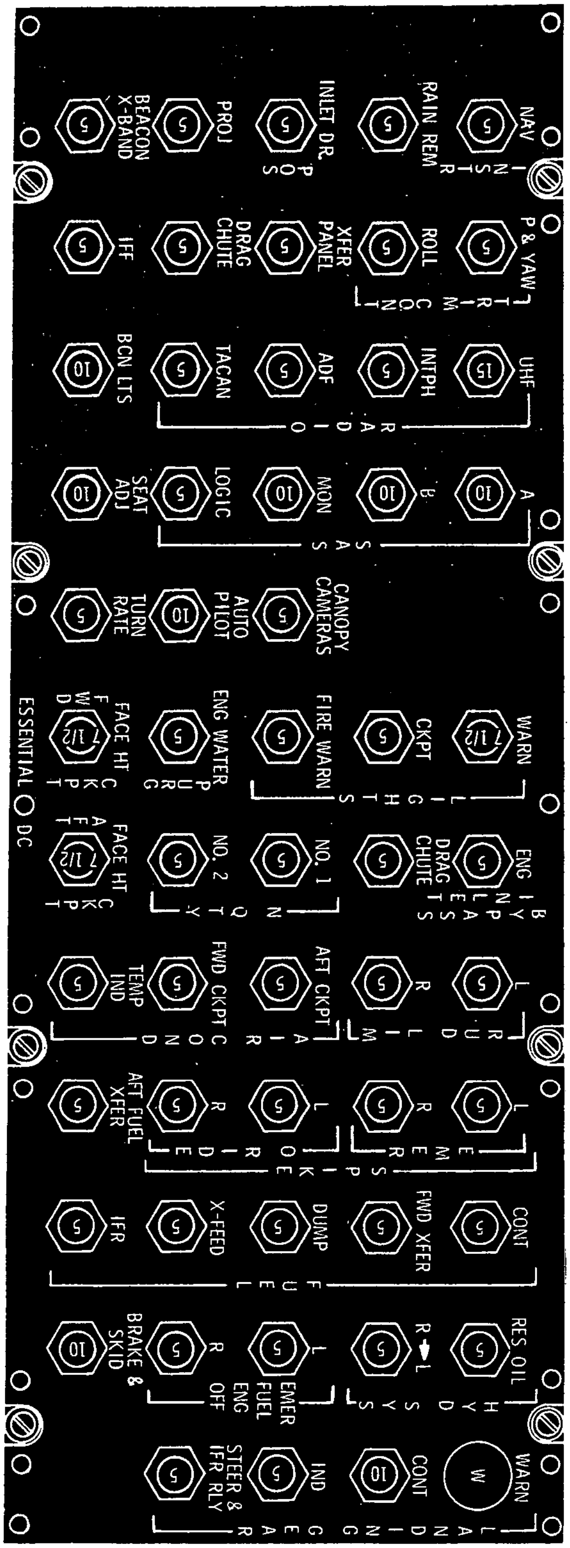
A generator switch for each generator system is located on the right side of each instrument panel and is powered from the essential dc bus. Each switch has three positions, GEN RESET, TRIP, and center (neutral). The switches are spring loaded to the center neutral position. Placing either switch up to the GEN RESET position will return the respective generator to normal operation if it has been removed from the bus for any reason other than complete generator failure. In the down, TRIP, position the automatic bus transfer system will supply that bus from the other generator if it is operating.

> The generators must be reset and connected to the bus after the engines are started and before the ground power is removed. The BAT-EXT PWR switches must be moved to the OFF position within 5 seconds after the generator is reset or the generator will trip.

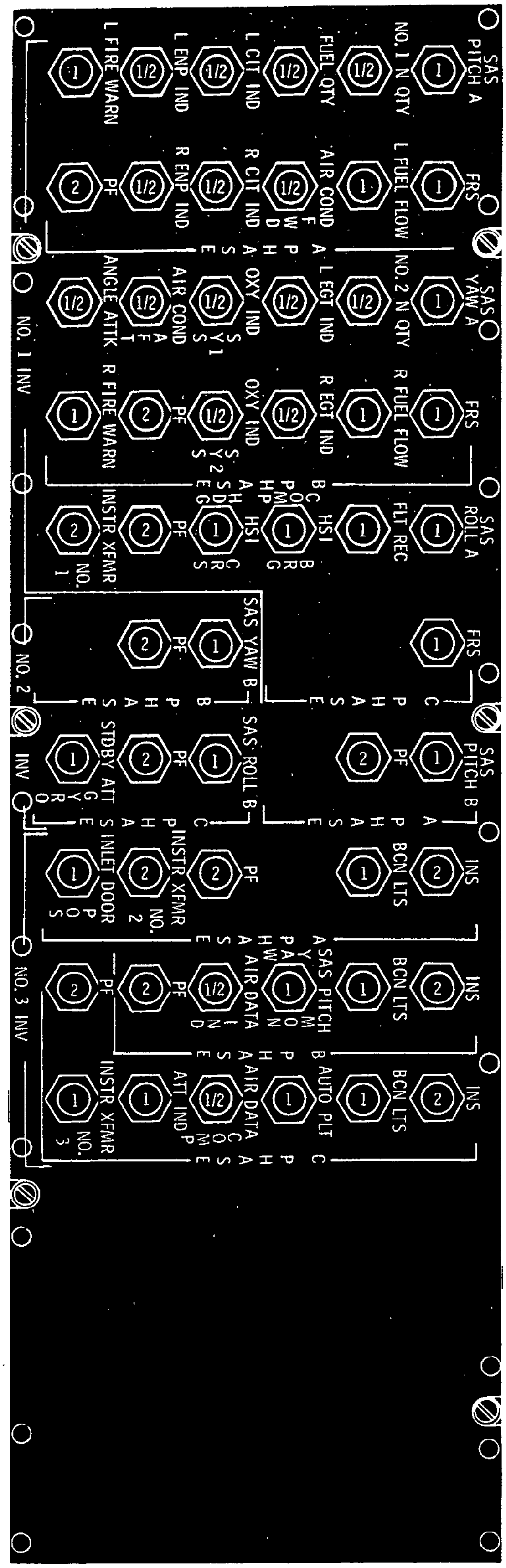
Battery-External Power Switches

A three-position, center-off, battery-external power switch is located on the right side of each instrument panel. In the BAT (up) position the 25-ampere-hour battery is connected to the essential dc bus if neither 200-amp transformer-rectifier is furnishing power to the essential dc bus. The BAT-EXT PWR switch should be in the BAT position during flight so that the battery will be automatically connected to the essential dc bus if both transformer-rectifiers fail. In the EXT PWR position, the external power source, if connected and operating, furnishes power for the entire electrical system. In the center OFF position, neither external nor battery power is supplied.

CIRCUIT BREAKER PANELS



CIRCUIT BREAKER LH FWD COCKPIT



CIRCUIT BREAKER RH FWD COCKPIT

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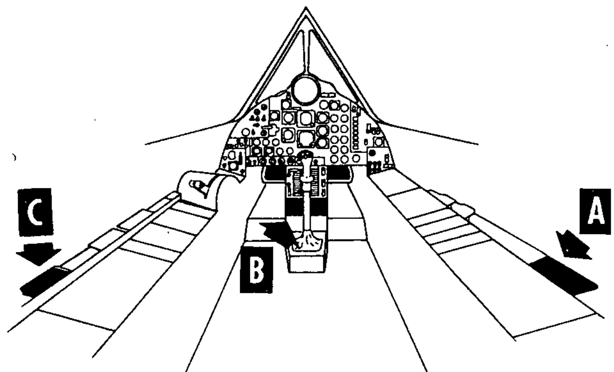
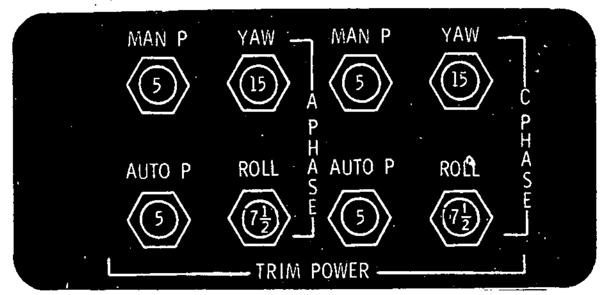
Figure 1-16 (Sheet 1 of 2)

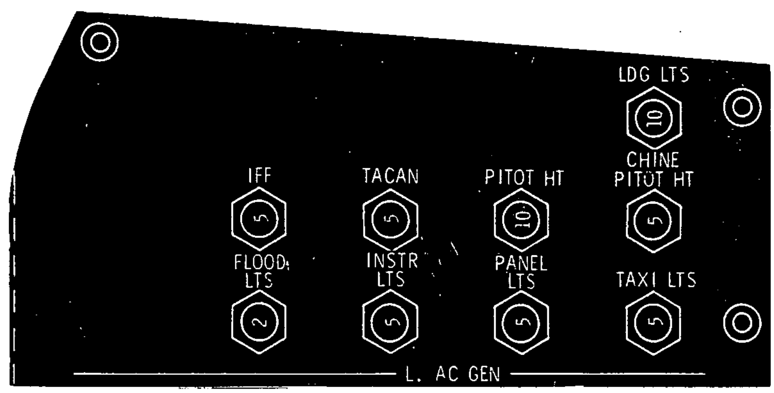
CIRCUIT BREAKER PANELS



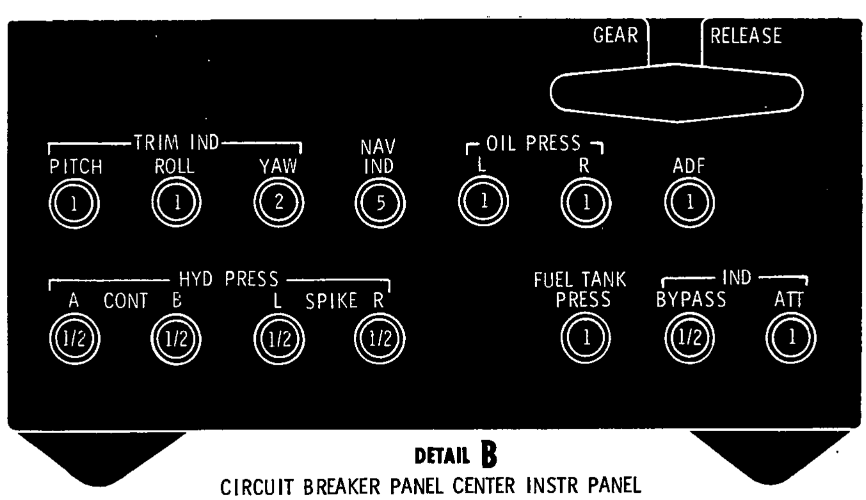
FWD COCKPIT



DETAIL A
CIRCUIT BREAKER PANEL TRIM POWER RH CONSOLE



DETAIL C
CIRCUIT BREAKER LH CONSOLE F/S 318



DETAIL B
CIRCUIT BREAKER PANEL CENTER INSTR PANEL

F201-9(2)(d)

Figure 1-16 (Sheet 2 of 2)

Inverter Switches

A switch for each of the three inverters is located on the right side of each instrument panel. The No. 1 and No. 3 inverter switches have three positions: NORM, OFF, and EMER. For normal operation the inverter switches are placed in the NORM position. The No. 2 inverter switch is placed in the ON position for normal operation. When either the No. 1 or No. 3 inverter switch is placed in the EMER position, the respective inverter load is transferred to the No. 2 inverter. If both the No. 1 and No. 3 inverter switches are placed in the EMER position the No. 1 inverter load only will transfer to the No. 2 inverter. When the aft cockpit switches are placed in the EMER position they will override the forward cockpit switches.

Indicator and Light Test Pushbutton Switch

A pushbutton switch, labeled IND & LT TEST is located on the left forward panel in each cockpit. The pushbutton switch, when depressed, illuminates the landing gear lever red light, all annunciator panel lights, the right and left nacelle fire warning lights, fuel boost pump lights, and actuates the gear warning tone in the headsets. This switch is also used to test the operation of the dual liquid nitrogen indicator which is located in the forward cockpit. When the aircraft is airborne, depressing the pushbutton switch illuminates the three green landing gear position lights for test.

Generator Out Indicator Lights

The L GENERATOR OUT and R GENERATOR OUT indicator lights are located on the annunciator panels and illuminate when the respective generator is not furnishing power to the respective generator bus.

Transformer-Rectifier-Out Indicator Lights

The L XFMR-RECT OUT and R XFMR-RECT OUT indicator lights are located on the annunciator panels and illuminate to indicate that the respective transformer-rectifier is not furnishing dc power to the dc buses.

Inverter Out Indicator Lights

Three inverter out lights, labeled NO. 1 INVERTER OUT, NO. 2 INVERTER OUT and NO. 3 INVERTER OUT, are installed on the annunciator panel in each cockpit. When illuminated, the respective light indicates that the inverter bus voltage is below minimum. When NO. 1 INVERTER OUT or NO. 3 INVERTER OUT light illuminates, the inverter load may be transferred to the No. 2 inverter if operative, by placing the respective failed inverter switch to the EMER position. The light will extinguish after load transfer is accomplished. If both NO. 1 INVERTER OUT and NO. 3 INVERTER OUT lights illuminate, one inverter load only can be transferred to the No. 2 inverter.

Emergency-Battery-On Indicator Lights

The emergency-battery on lights, labeled EMER BAT ON, are located on the annunciator panels. The lights illuminate when the battery is furnishing power to the essential bus.

HYDRAULIC POWER SUPPLY SYSTEMS

Four separate hydraulic systems are installed on the aircraft, each with its own pressurized reservoir and engine-driven pump. Hydraulic fluid is cooled by fuel-oil heat exchangers, using the aircraft fuel supply as the cooling agent. The A and B hydraulic systems provide power for operating the flight controls. The L and R

A & B HYDRAULIC POWER SUPPLY SYSTEM

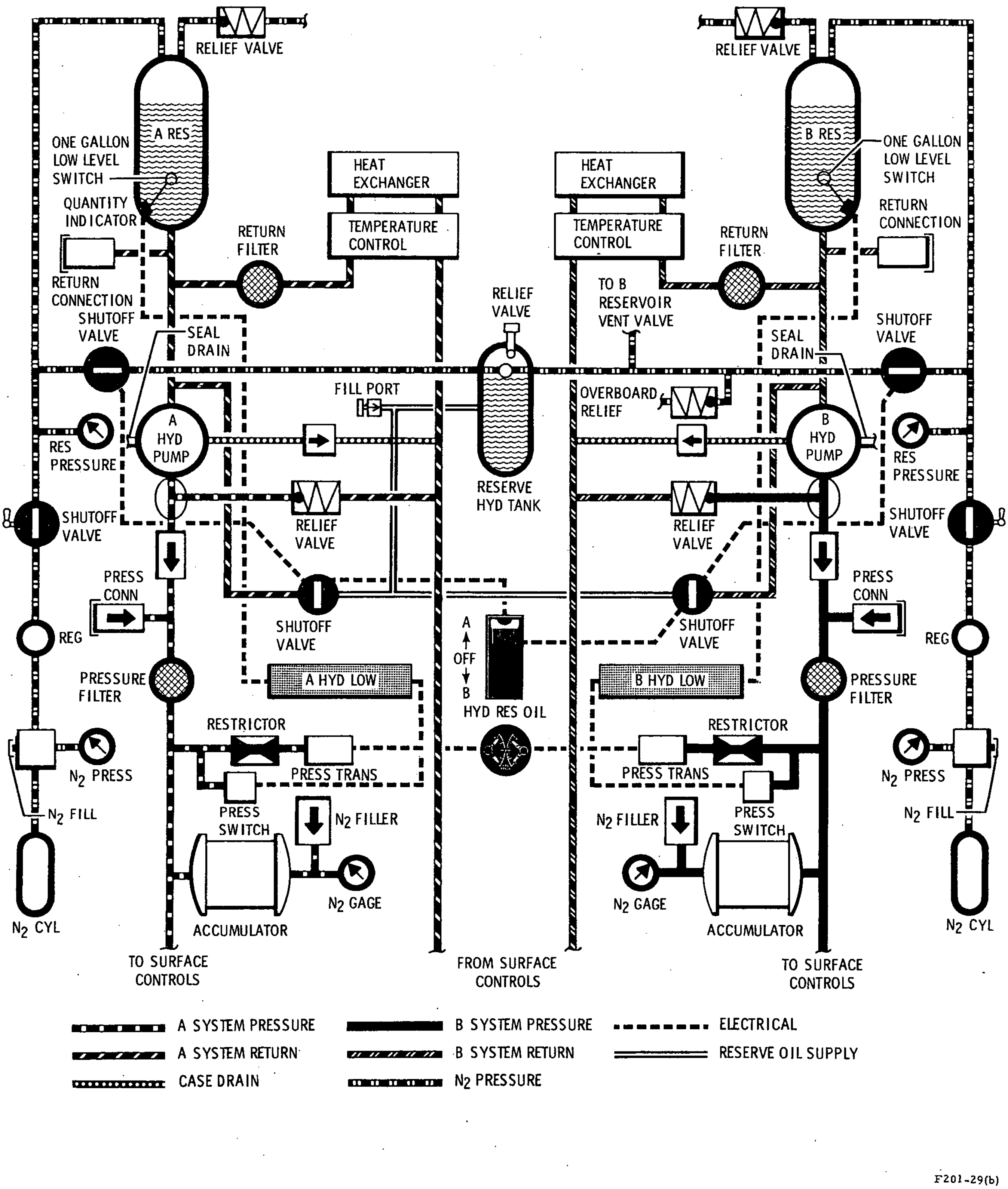


Figure 1-17

L & R HYDRAULIC POWER SUPPLY SYSTEM

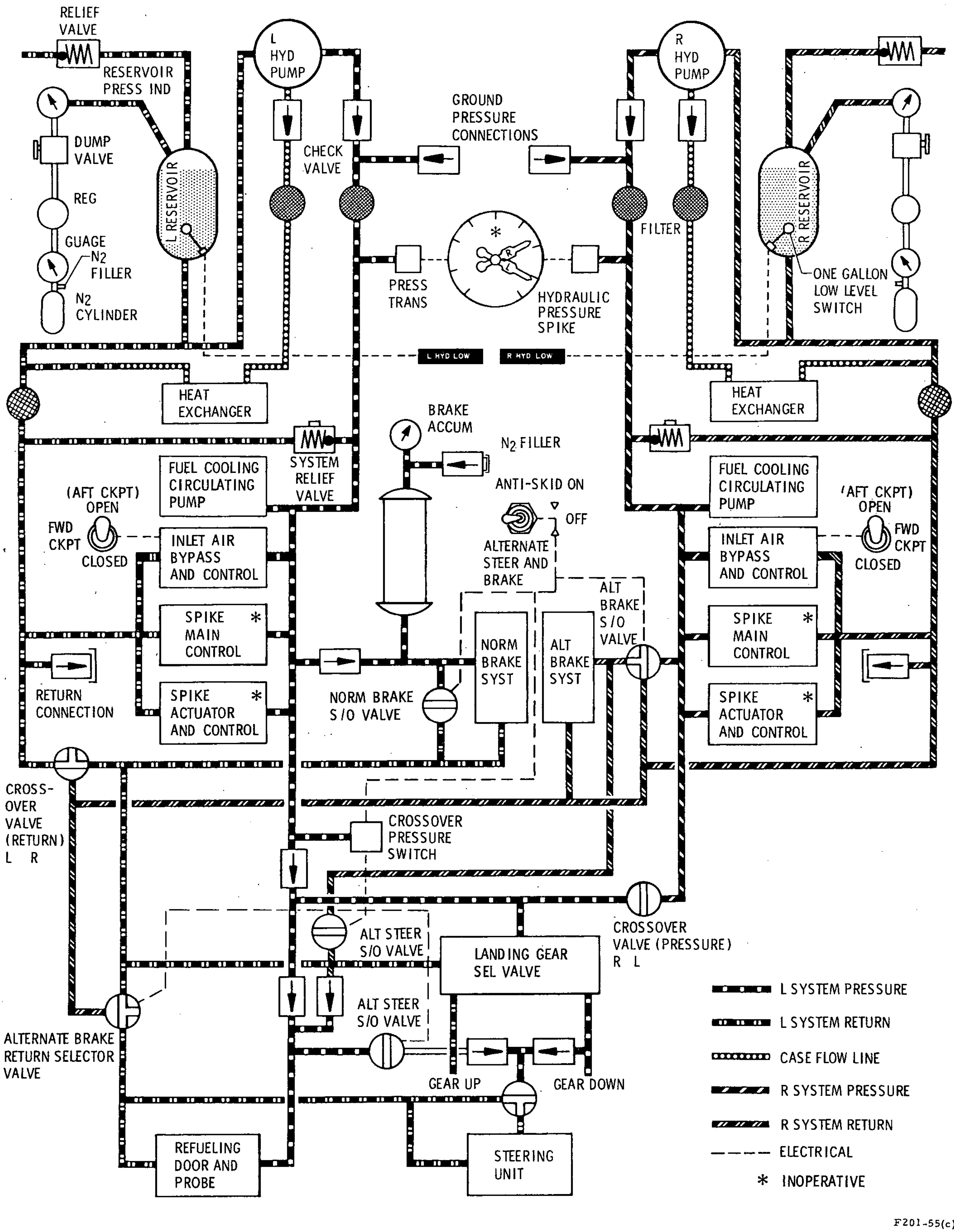


Figure 1-18

systems provide power for all other hydraulic requirements of the aircraft. Under normal operating conditions, the systems are independent of one another. The L hydraulic system provides hydraulic power to the left engine air inlet control, the landing gear (including uplocks and door cylinders), normal brakes, in-flight refueling door, UHF retractable antenna, and normal nosewheel steering. The R hydraulic system provides hydraulic power to the right air inlet control, alternate brakes, nosewheel steering, refueling door and landing gear (emergency retraction only) when the L hydraulic system has failed. If the R hydraulic system is used for emergency operation of the brakes, the anti-skid feature will be inoperative.

A reserve oil supply for the A and B hydraulic systems is contained in an 8.5-gallon (usable) reserve tank mounted in fuel tank No. 4. The reserve hydraulic oil is transferred by gravity flow and nitrogen pressure through solenoid-operated shutoff valves to either the A or B hydrauic system, as selected by a cockpit switch.

Note

> Reserve hydraulic fluid is to be used only to supply the operative A or B system in the event of malfunction of the other system.

Hydraulic Reserve Oil Switch

The hydraulic reserve oil switch, placarded HYD RES, is mounted on the left side of the annunciator panel. It is a three-position switch, guarded in the center OFF position. In the A position, solenoid-operated shutoff valves are opened to the A hydraulic system suction and tank vent lines, allowing the reserve hydraulic fluid to supply the A system, as needed, up to approximately 0.3 gallon per minute. In the B position, the solenoid valves to the B system are opened and the reserve fluid will supply the B system. Power for the valves is furnished from the essential dc bus.

Hydraulic System Pressure Gages

One quad-indicating hydraulic pressure gage is installed on the right side of each instrument panel. The left side of the gage indicates hydraulic pressure of the L and R systems and the right side of the gage indicates hydraulic pressure of the A and B system. The gage is calibrated in 100 psi increments from 0 to 4000 psi. Pressure indication on the gages is accomplished by means of remote transmitters in the individual systems. Power is furnished by the No. 2 instrument transformer.

Hydraulic System Warning Lights

Four hydraulic warning lights are located on the annunciator panel. The A or B HYD LOW lights will illuminate when the pressure in the respective system drops below 2200 ± 150 psi and/or the quantity is less than 1-1/4 ± 1/8 gallons. The L or R HYD LOW light will illuminate when the respective reservoir quantity is less than 1-1/4 ± 1/8 gallons. Power for the lights is furnished by the essential dc bus.

FLIGHT CONTROL SYSTEM

The cockpit flight controls consist of conventional control sticks and rudder pedals. The delta wing configuration utilizes elevons instead of separate aileron and elevator control surfaces. The elevons, moving together in the same direction function as elevators and when moving in opposite directions function as ailerons. Each elevon consists of an inboard and outboard panel with the inboard panel located between the fuselage and the nacelle and the outboard panel outboard of the nacelle. Both panels on one side function as a single unit, with

FLIGHT CONTROL SYSTEM (Rudders)

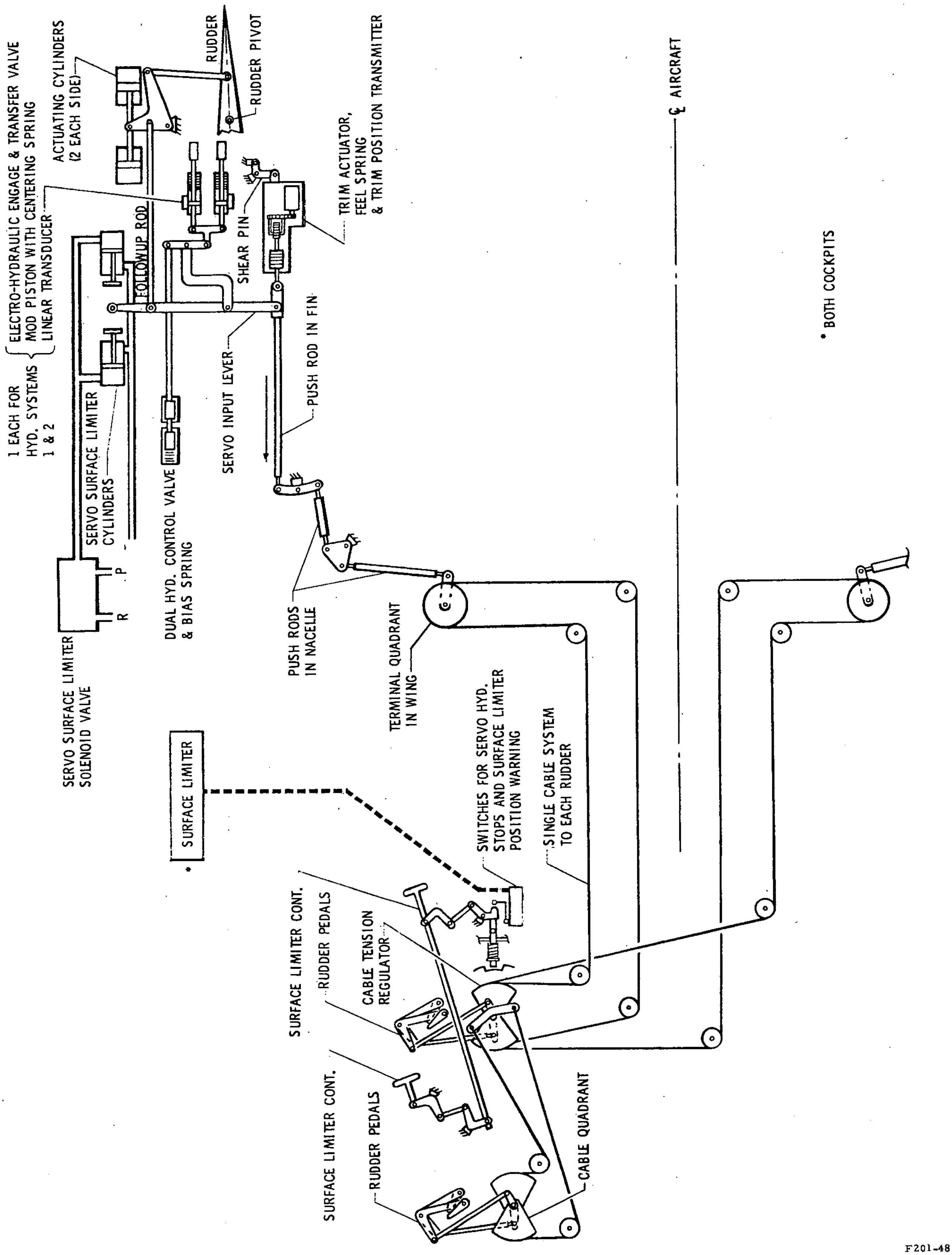


Figure 1-19 (Sheet 1 of 3)

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FLIGHT CONTROL SYSTEM (Inboard Elevons)

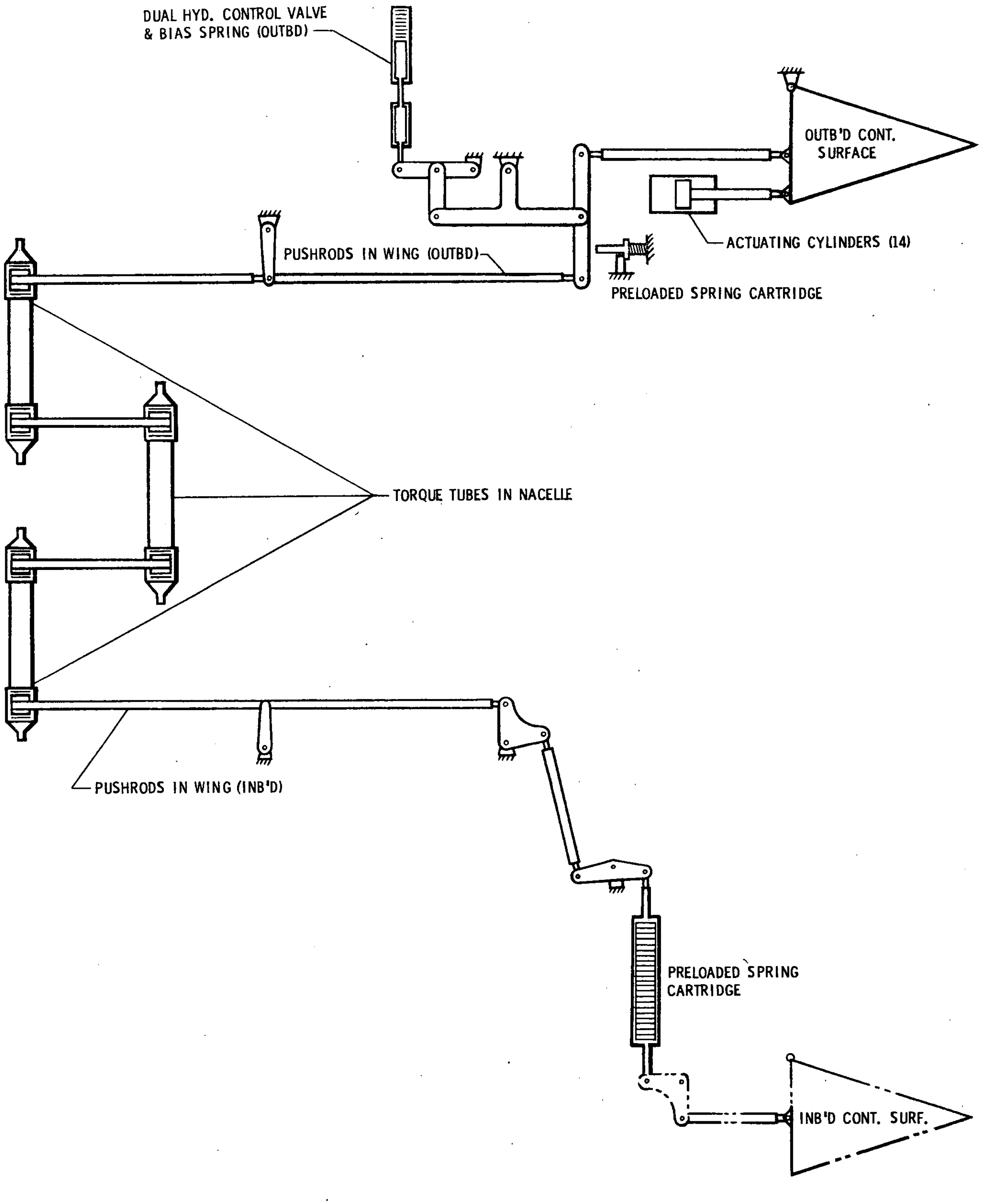


Figure 1-19 (Sheet 2 of 3)

FLIGHT CONTROL SYSTEM (Outboard Elevons)

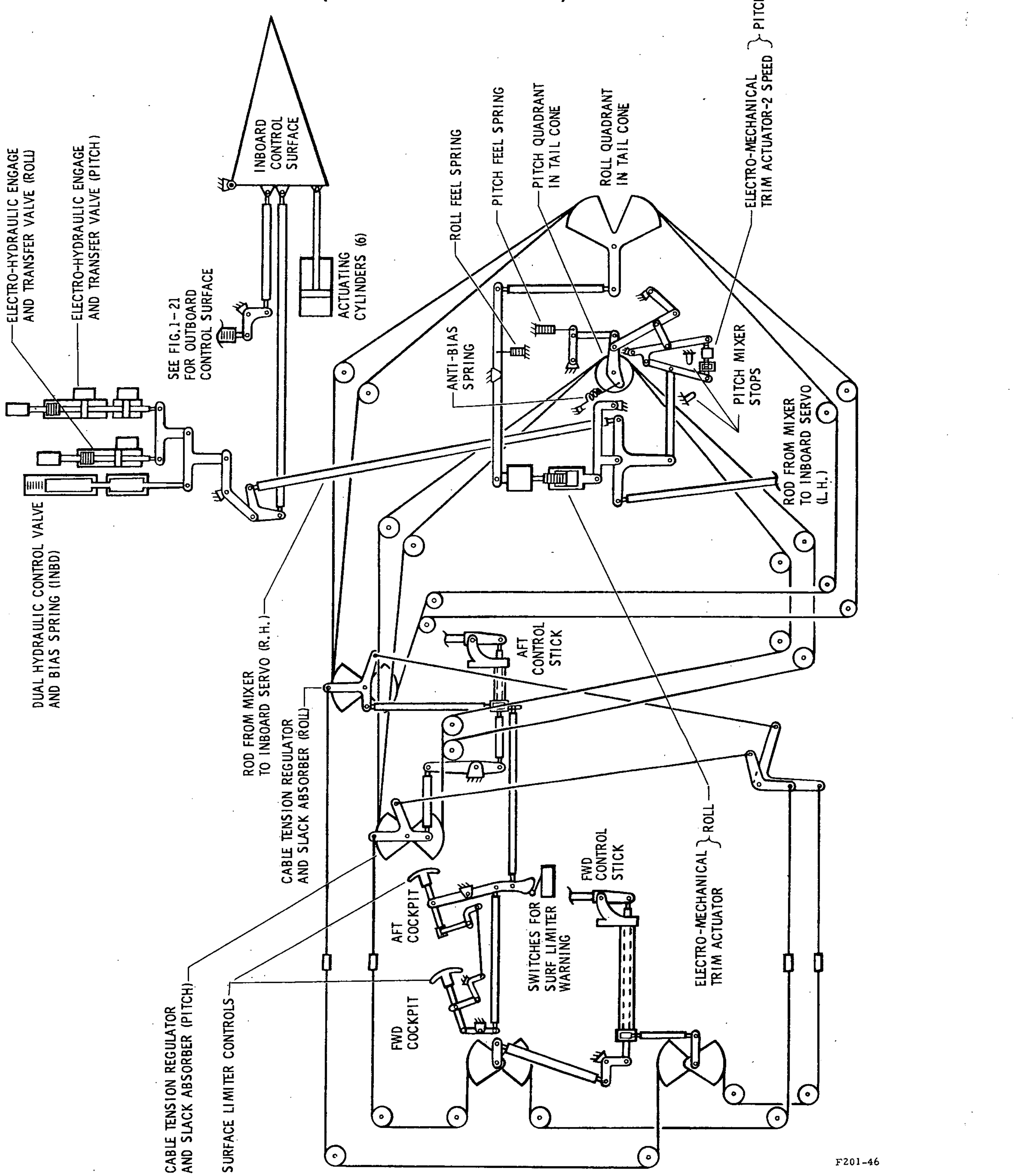


Figure 1-19 (Sheet 3 of 3)

the servo input to the outboard elevon connected directly to the inboard elevon surface. The dual canted rudders are full-moving, one-piece, pivoting surfaces with a small fixed stub at the junction of the vertical surface and the nacelle. Deflection and control of the elevons and rudders is by means of dual, full hydraulic, irreversible actuating systems. Control surface travel limits are as follows:

	Elevons	Rudders
Pitch	11 deg down 24 deg up	
Roll	12 deg down 12 deg up	
Pitch plus Roll	20 deg down 35 deg up	
Yaw		20 deg left 20 deg right

Manually operated mechanical stops are incorporated in the cockpit mechanism to limit the surface movement at high speed. Elevon travel in roll is limited to 7 degrees up, 7 degrees down, and rudder travel is limited to 10 degrees right, 10 degrees left.

An additional stop is installed in each rudder servo package to limit rudder travel. These stops are electrically controlled and hydraulically operated by separate electrical and hydraulic systems. If no electrical power is available, the rudders will be limited to approximately 10 degrees L and R travel. If electrical power is available to one stop, that rudder only will have the full 20 degrees L and R travel available. The rudder cable must be stretched to obtain this travel, causing a noticeable increase in rudder pedal force.

CABLE SYSTEM

Cable systems are utilized to transfer control movements from the control sticks and rudder pedals to the flight control mechanisms. The pitch and roll axis cable systems are duplicated from the aft cockpit only to the mixing mechanism in the aft fuselage. The rudder system has two separate closed loop single cable systems, one to each rudder. Cable tension regulators and slack absorbers are incorporated in the cable systems.

ARTIFICIAL FEEL SYSTEM

The use of a fully powered, irreversible control system for actuation of the surfaces prevents air loads and resulting "feel" from reaching the cockpit controls. Therefore, feel springs are installed in each of the pitch, roll, and yaw axis mechanical control mechanisms to provide an artificial sense of control feel. The springs apply loads to the pilot controls in proportion to the degree of control deflection.

TRIM CONTROL SYSTEM

Flight control trim is accomplished by deflecting the control surfaces through the use of electrical trim actuators. The roll and pitch trim actuators are located downstream of the feel springs so stick position remains neutral, irrespective of the amount of trim. The trim actuator and feel spring location is combined in the rudder mechanism and yaw trim is reflected by rudder pedal position.

Travel limits of the trim system are 3-1/2 degrees down to 6-1/2 degrees up in pitch; 4.5 degrees up and down (each side) in roll; and 10 degrees left to 10 degrees right in yaw. Trim position indicators are provided for each axis. Trim rates are as follows:

Pitch	Roll	Yaw
1.12^{o}/sec.	$.4^{o}$/sec.	1.1^{o}/sec.

Automatic pitch trim uses a separate, slow speed motor for auto trim when the autopilot is engaged and mach trim when the autopilot is not engaged. This trim motor operates at one-tenth the rate of the manual trim motor, or $.112^{o}$/sec.

CONTROL STICKS

The control sticks are mechanically connected by torque tubes, pushrods, bellcranks, and cables to the dual cable system which operates the roll and pitch quadrants in the aft fuselage tailcone. Mechanical pushrod linkages mix the control movements and position dual hydraulic control valves. These valves direct both A and B system hydraulic pressures to the inboard elevon actuating cylinders.

Pushrods, bellcranks, and torque tubes transfer inboard elevon deflection to position the outboard dual hydraulic control valves. These valves direct both A and B system hydraulic pressure to the outboard elevon actuating cylinders. A pushrod followup system closes off the flow of hydraulic fluid to the actuators when the desired elevon deflection is obtained. Located on each control stick grip are pitch and yaw trim switches, a combination nosewheel steering and autopilot control stick command button, a microphone switch for both interphone and radio transmission, an autopilot disconnect switch, and an in-flight refueling disconnect switch.

RUDDER PEDALS

Primary control for the rudders consists of conventional rudder pedals mechanically connected by cables, bellcranks, and pushrods to hydraulic control valves at the rudder hydraulic actuators. The rudder pedals are released for adjustment by pulling the T-handle, labeled PEDAL ADJ, located at the bottom of the respective cockpit lower instrument panel. Wheel brakes are controlled conventionally by toe action on the rudder pedals; refer to Wheel Brake System, this section. Rudder pedal movement also controls nosewheel steering; refer to Nosewheel Steering System, this section.

The pedals in the forward cockpit are hinged to fold inboard and upward, to provide additional foot space on the cockpit floor.

Pitch and Yaw Trim Switches

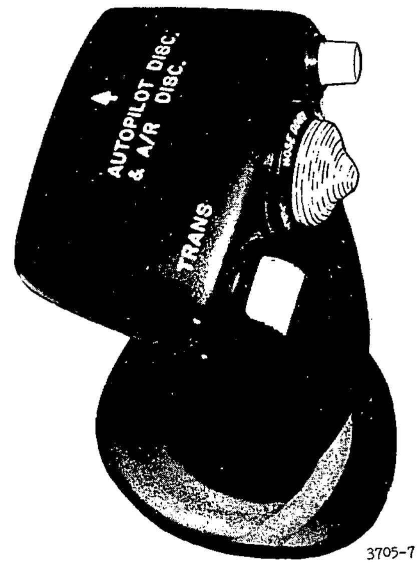
Pitch and yaw trim control is provided by a spring-loaded, four-position, thumb-actuated switch installed on each control stick grip. The switch positions are center OFF, LEFT, RIGHT, NOSE UP, and NOSE DOWN. The switches control trim motors powered by the right generator bus through the 28 volt trim actuator transformer and trim power bus.

Note

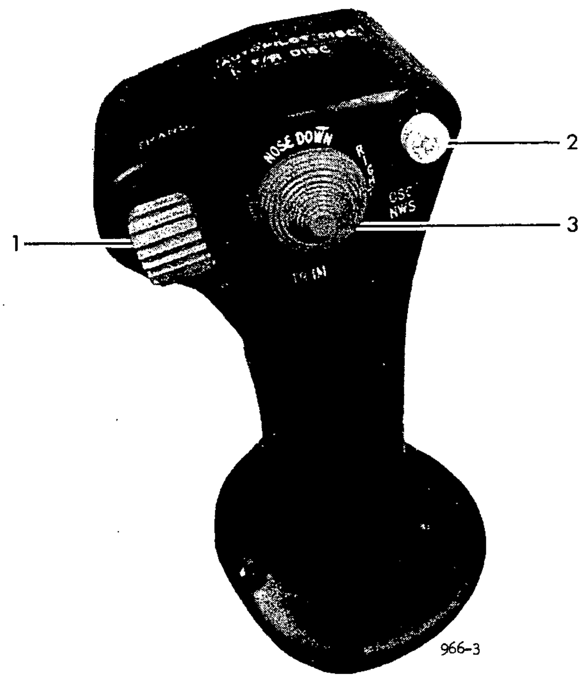
> The trim power switches must be in the ON position before the pitch, roll, and yaw trim switches will operate.

The aft cockpit trim switch is capable of overriding the forward cockpit switch. Lateral movement of either switch to the left corrects for right yaw and lateral movement to the right corrects for left yaw. Forward movement of either switch produces down elevon operation of the trim motors and actuators (aircraft nose down). Aft movement moves the elevons up (aircraft nose up).

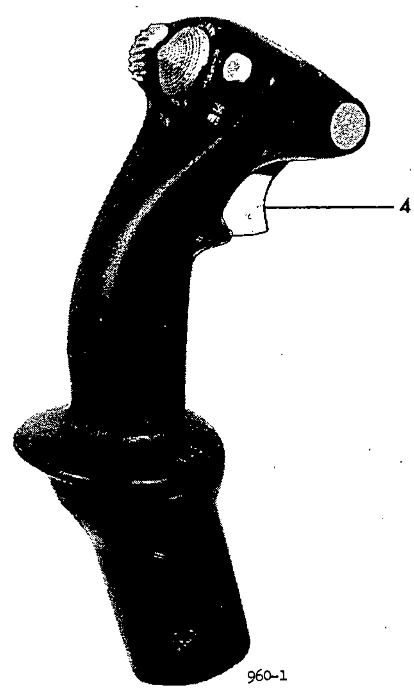
CONTROL STICK GRIP (Both Cockpits)



TOP VIEW



FRONT VIEW



SIDE VIEW

1 TRANSMITTER - INTERPHONE CONTROL SWITCH
2 CONTROL STICK COMMAND - NOSEWHEEL STEERING BUTTON
3 PITCH AND YAW TRIM SWITCH
4 EMERGENCY AUTOPILOT DISENGAGE SWITCH AND AIR REFUEL DISCONNECT

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Figure 1-20

Trim Power Switches

The trim power switch, installed on the annunciator panel in each cockpit, has two positions, ON and OFF. Both the forward and aft cockpit switches must be in the ON position for the system to be operative. To prevent inadvertent movement, the switches must first be pulled out before they can be moved from ON to OFF. When in the ON position, the right generator bus power is provided to the roll, pitch, and yaw trim actuators. The trim power circuit breaker is located in the electrical load center and is not available to the pilots.

Roll Trim Switches

A three-position roll trim switch is installed just forward of each throttle quadrant. The switch positions left and right are indicated by arrows. The switch is spring-loaded to center. When either switch is held in the right position, the roll trim motor actuates to move the right elevons up and the left elevons down. Actuation of the switch to the left position moves the right elevons down and left elevons up. The aft cockpit switch is capable of overriding the forward cockpit switch. 28-volt ac power is furnished by the trim power bus.

Rudder-Synchronization Switches

A three-position rudder synchronization switch is installed just forward of each throttle quadrant. The switch positions (left and right) are indicated by arrows. The switches are spring-loaded to center. When in the left and right positions the switches provide electrical power to the right rudder trim motor which moves the right rudder to agree with the position of the left. Rudder synchronization is obtained by superimposing the L and R pointer on the yaw trim gage. The aft cockpit switch is capable of overriding the forward cockpit switch. 28-volt ac power is furnished by the trim power bus.

Roll, Pitch, and Yaw Trim Indicators

Separate roll, pitch and yaw indicators are installed on the left side of each instrument panel. The ROLL trim indicators use a double-ended pointer to display the amount of differential roll trim from 0 to 9 degrees. The PITCH trim indicators display the amount of pitch trim from 5 degrees nose-down to 10 degrees nose-up, although only 8-1/2 degrees nose-up trim is available. The YAW trim indicators use two separate pointers, one for each rudder and marked R and L, to display the amount of yaw trim from 10 degrees left to 10 degrees right. Rudder synchronization is obtained by superimposing the L and R pointers on the indicators. 26-volt ac power for the indicators is normally furnished by the No. 2 instrument transformer and the No. 3 inverter.

Surface Limiting Control Handles

Interconnected T-handles are located on the annunciator panel. When either handle is turned 90 degrees counterclockwise and released, the mechanical stops in the roll and yaw axis of the cockpit control system are activated. This action also opens an electrical switch which de-energizes a solenoid-operated valve in each rudder servo package and activates the servo package rudder stops. When either handle is pulled out and rotated 90 degrees clockwise, the mechanical stops in the cockpit are released and the solenoid is energized, releasing the servo package stops.

Surface Limiter Indicator Lights

When speed exceeds Mach 0.5, the SURFACE LIMITER indicator lights illuminate on the annunciator panels until either surface limiter handle is released. If the speed is less than Mach 0.5 and the surface limiters are on, the SURFACE LIMITER indicator lights illuminate until either surface limiter handle is pulled out. Power for the lights is furnished by the essential dc bus.

AUTOMATIC FLIGHT CONTROL SYSTEM

The automatic flight control system includes stability augmentation, autopilot, Mach trim, and air data systems, plus additional subsystems furnishing attitude and navigational course inputs for the autopilot. The air data system furnishes signals to the autopilot, Mach trim, and inertial navigational systems. The stability augmentation system supplies signals to the hydraulic servos that operate the control surfaces. The Mach trim system furnishes signals to the slow-speed motor on the pitch trim actuator. The inertial navigation system supplies attitude and navigational course inputs for the autopilot. Heading and attitude reference signals for the autopilot are also supplied by the FRS. The autopilot moves the aircraft hydraulic servos through the stability augmentation system. For further information on the autopilot and inertial navigation systems, refer to Section IV.

STABILITY AUGMENTATION SYSTEM

The three-axes stability augmentation system (SAS) is a combination of electronic and hydraulic equipment which augments the inherent stability of the aircraft. It is designed for optimum performance at the basic mission cruise speed and altitude, but it also provides improved stability for inflight refueling, landing, and takeoff. The SAS is part of the aircraft basic control system and is normally used for all flight conditions.

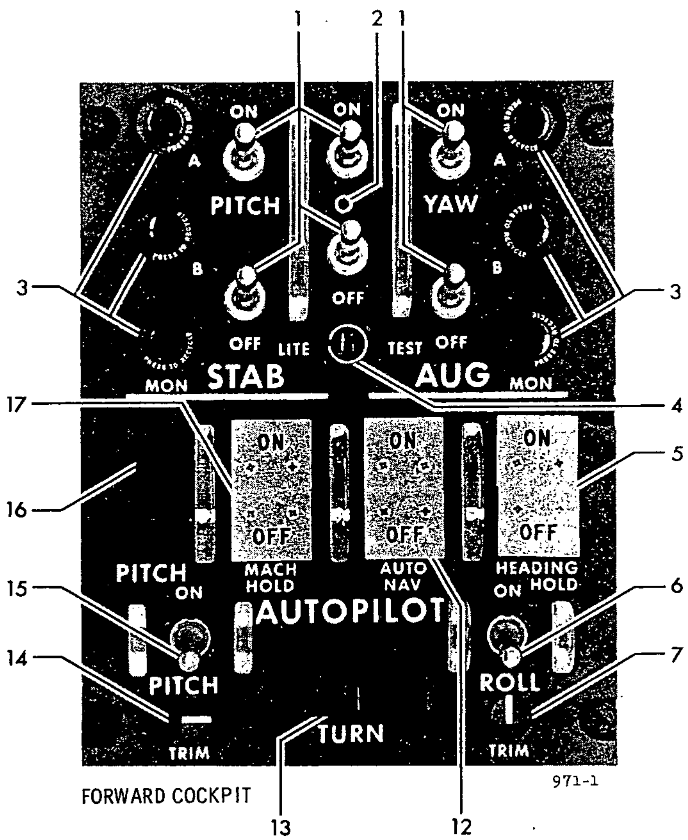
Dual electronic channels are provided for all axes, and a monitor channel is provided for both the pitch and yaw axes. Logic circuits compare the functioning of each pitch and yaw channel and automatically eliminate a failed channel. The pilots are provided with a visual warning on the annunciator panel of a failed channel. The monitor channels for the pitch and yaw axes are powered by inverter 3.

In the roll axis, each channel controls the elevons on only one side of the aircraft. The pilot may select a single channel if desired. Reliability is provided through dual hydraulic and inverter supplies. Each active channel in each axis is powered by separate supplies so that the two halves of each system are operated independently. A simulated logic circuit is provided for the roll channel to warn of a malfunction and to disconnect the two channels. A separate gyro system is provided for each channel in each axis. The design is such that no single failure except overheating of a complete gyro package can cause loss of all channels in one axis. Even if this occurred, it is unlikely that all of the gyros in the package would fail simultaneously.

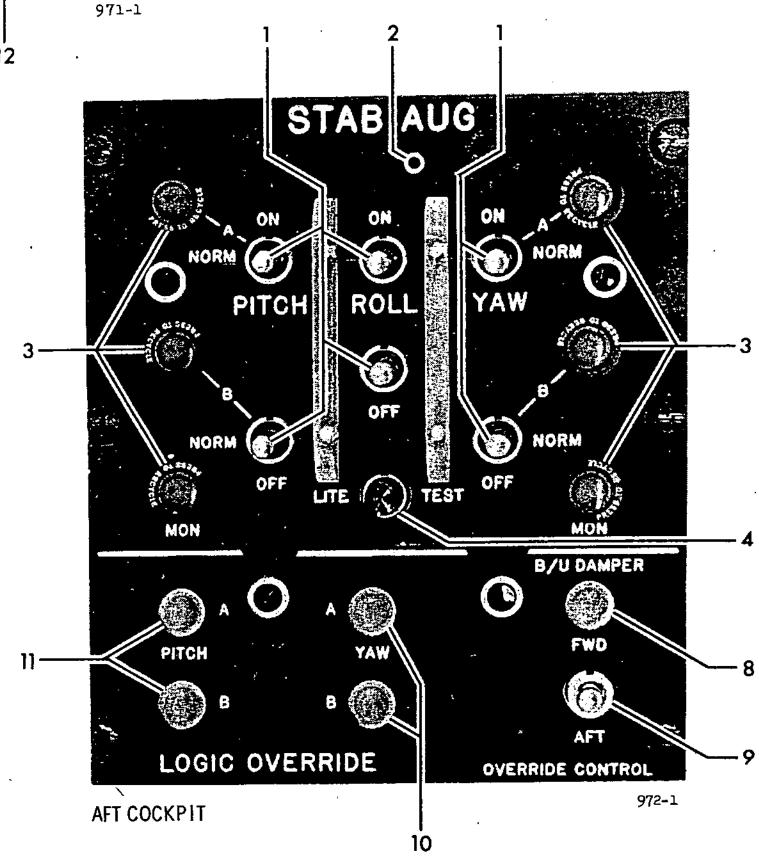
STABILITY AUGMENTATION PITCH AXIS

Two independent active channels termed A and B provide the desired control through two pairs of tandem servos. There is one pair of servos on each side of the aircraft. The servos are in series with the autopilot and the pilot's control movements. Damping signals to the elevons do not move the control stick. Each A and B channel drives one servo on the left side of the aircraft and one on the right side. The A channel uses the A hydraulic system and the B channel uses the B hydraulic system. This avoids loss of both channels in case of failure of either the A or B hydraulic systems. The sensors for the pitch axis are rate gyros located in tank No. 3. The gyros provide signals in proportion to the rate of pitch attitude change of the aircraft. Phasing of the gyro signals is such that an angular pitch motion produces elevon movement to oppose and restrict attitude change. The system will take corrective action rapidly in the event of a gust disturbance. Pilot inputs are also opposed; however, the elevon motion produced by the SAS is designed to aid the pilot in avoiding overcontrol and improve the handling qualities of

SAS AND AUTOPILOT CONTROL PANEL



1 SAS CHANNEL ENGAGE SWITCHES
2 ROLL CHANNEL DISENGAGE LIGHT
3 SAS RECYCLE INDICATOR LIGHTS
4 SAS LIGHT TEST SWITCH
5 A/P HEADING HOLD SWITCH
6 A/P ROLL ENGAGE SWITCH
7 A/P ROLL TRIM SYNCHRONIZATION INDICATOR
8 BACKUP PITCH DAMPER CONTROL INDICATOR LIGHT
9 OVERRIDE POWER TRANSFER SWITCH
10 YAW LOGIC OVERRIDE CONTROL INDICATOR LIGHTS
11 PITCH LOGIC OVERRIDE CONTROL INDICATOR LIGHTS
12 A/P AUTO NAV SWITCH
13 A/P TURN CONTROL SWITCH
14 A/P PITCH TRIM SYNCHRONIZATION INDICATOR
15 A/P PITCH ENGAGE SWITCH
16 A/P PITCH CONTROL WHEEL
17 A/P MACH HOLD SWITCH



F201-18(b)

Figure 1-21

the aircraft. The logic circuit is able to isolate a SAS failure in either the electronics or the servos. When a malfunction is isolated, the failed channel will disengage and the system continues in operation on a single channel. Malfunctioning and disengaging of channels is indicated to the pilots by indicator lights. The pitch axis can command a maximum elevon surface travel of 2.5 degrees up to 6.5 degrees down. Dual or single channel operation produces the same corrective action of the elevon surface. Power for A channel is from the A phase of No. 1 inverter bus. Power for B channel is from the A phase of No. 2 inverter and MON channel power is from the B phase of the No. 3 inverter. Each power source is protected by individual circuit breakers in the forward cockpit.

STABILITY AUGMENTATION YAW AXIS

The yaw axis of the SAS is very similar to the pitch axis, using two independent A and B channels and a monitor channel. There is one pair of hydraulic servos for each rudder, each pair mounted in a whiffletree arrangement. Damping signals to the rudder do not move the rudder pedals. Each A and B channel drives one servo on each side of the aircraft. The A hydraulic system is connected to A channel and the B hydraulic system to B channel. The rate gyro sensors for the three channels are identical to the pitch rate gyros, except for the physical orientation to sense yawing motions. A "Hi Pass" filter circuit is installed to allow passage of normal short term damping signals, but will stop the signals when a deliberate turn is made. A lateral accelerometer sensor is also used in each channel of the yaw axis to minimize steady-state sideslip caused by an engine failure until the pilot can retrim the rudders. The logic circuit is identical to the pitch axis and functions in the same manner. The yaw axis can produce a maximum rudder travel of 8 degrees left to 8 degrees right (each surface). Corrective surface motion is the same regardless of one or two-channel operation. Power for the A channel is from the B phase of inverter 1, for the B channel from the B phase of inverter 2, and for the monitor channel from the B phase of inverter 3. The circuitry from each power source is protected by individual circuit breakers.

STABILITY AUGMENTATION ROLL AXIS

The reliability requirements for the roll axis are not as severe as for pitch and yaw; therefore, less-complicated circuitry and components are used. The roll axis has two independent channels, each operating the elevons on one side of the aircraft. The A channel positions the left elevon surfaces and operates from the A hydraulic system; the B channel positions the right elevon surfaces and operates from the B hydraulic system. Each channel can be operated individually. There is no monitor channel as such; there is, however, a simulated logic circuit to disengage both channels and illuminate a light on the SAS panel if a roll channel malfunctions. Although the system gain is the same as for two-channel operation, roll control is not symmetrical. Coupling into the yaw and pitch axes is possible, but the systems operating in those axes minimize undesirable aircraft motion. Maximum elevon travel in the roll axis is 2 degrees up to 2 degrees down (each side), for a total of 4 degrees differential with both systems operating. Power for A channel is from the C phase of inverter 1, and power for the B channel from the C phase of inverter 2.

STABILITY AUGMENTATION SYSTEM (SAS) CONTROL PANELS

The SAS control panel on each right console contains six channel engage switches, A and B channels for the pitch, roll and yaw axes. The panels also contain a press-to-test switch and six indicator lights for the A, B, and MON channels in the pitch and yaw axes. Three guarded switches for the backup pitch damper, pitch logic override, and yaw logic override are located on the lower instrument panel and right side of the center console. Individual circuit breakers are located on both right and left consoles.

Aft Cockpit Stability Augmentation System Override Panel

The aft cockpit SAS panel also contains an additional panel with five lights and a toggle switch. The switch is labeled OVERRIDE CONTROL and has two positions, FWD (up) and AFT (down). The five lights are identified as follows: one each for A and B channels of the pitch logic override circuit, one each for the yaw logic override circuit, and one for the backup pitch damper. When the switch is in the FWD position, it allows the aft cockpit pilot to determine the position of the pitch logic override, yaw logic override, and backup pitch damper switches in the forward cockpit by observing which of the lights are illuminated. When the aft cockpit pilot moves the switch to the AFT position, control of the BUPD and logic override circuits is transferred to the aft cockpit and the five lights indicate aft cockpit switch positions.

Channel Engage Switches

There are six channel engage toggle switches on each SAS control panel. One pair is provided for each axis, pitch, roll, and yaw. The forward switch of each pair controls the A channel and the rear switch controls the B channel. The forward cockpit switches have two positions, ON (forward) and OFF (aft). The aft cockpit switches have three positions, ON (forward), NORM (center), and OFF (aft). The NORM position on the aft cockpit switches allows the forward cockpit pilot to assume control of the channel engage switches. When the aft cockpit switches are in the ON or OFF position they override the forward cockpit switches. When electrical power is on the aircraft and the channel engage switches are OFF, the SAS electronics are powered but the channel servos are not engaged with the control system. Moving the switches to the ON position engages the SAS servos, provided that the recycle light is extinguished. If the light is on, the light must be depressed before engagement is possible.

Recycle Indicator Lights

Six recycle indicator lights are located on the SAS control panel on each right console adjacent to the pitch and yaw channel engage switches. One light is provided for each A, B, and MON channel in the pitch and yaw axes. When the channel switch is on and the light is not illuminated the channel is functioning properly. If the light is illuminated, it indicates that the channel has disengaged and the light may be depressed to recycle the channel. If the failure is momentary, the channel will reengage; if the light reilluminates, it indicates that the channel is malfunctioning. (It is not necessary to turn the channel engage switch off in a malfunctioning channel because the light indicates automatic disengagement.)

Note

> The recycle indicator light should be pressed down firmly and released. If the recycle light is held down, a control surface transient will occur if a hardover servo condition exists in that channel. Refer to Section III for additional information.

The six recycle lights will illuminate when electrical power is first applied to the aircraft. The channel switches must be on and the recycle lights must be pressed to engage the channel electronics with the servos. When engaged and operating, the channel lights will be out.

Roll Channel Disengage Light

A single roll channel disengage light is located between the two roll channel switches on the forward cockpit SAS panel, and the forward of the two switches on the SAS panel in the aft cockpit. When illuminated, the light indicates that both roll channels have disengaged. This disengagement results when the roll servo channel outputs differ by more than an amount equivalent to 0.6 degree surface deflection. When operating on a single roll channel the light will not be illuminated and disengagement in the event of a failure is not provided. The switch must be ON for the active channel and OFF for the malfunctioning channel.

Light Test Switch

A pushbutton light test switch is located in the center of each SAS control panel. Depressing the pushbutton illuminates the six recycle lights and one roll disengage light for test.

SAS Pitch Logic Override Switch

The SAS pitch logic override switch is a guarded, three-position switch, located on each annunciator panel. Placing the switch in the A (up) position eliminates the logic circuit and selects A-channel operation. In the B (down) position, the logic circuit is eliminated, and B-channel operation is selected. When the switch is in the center, guarded OFF position, the logic circuit functions normally. The override switch is only used as an emergency control. The switch must be placed in either the A or B position when the BUPD is used.

SAS Yaw Logic Override Switch

The three-position SAS yaw logic override switch is located on each annunciator panel. The switch is guarded in the OFF position. The A (up) position eliminates the logic circuit and selects A-channel operation. The B (down) position eliminates the logic circuit and selects B-channel operation. The override switch is only used as an emergency procedure.

BACKUP PITCH DAMPER

The primary purpose of the backup pitch damper (BUPD) is to provide an emergency system for pitch stability augmentation during refueling and landing approach. It is used in case the SAS pitch channels are unusable due to electronics malfunction or overheating of the pitch gyro package. The system is optimized for use at light weight, aft center of gravity, and subsonic speeds from 0.3 to 0.8 Mach number; it is not intended as an emergency backup system during cruise.

Backup Pitch Damper Switch

A guarded BUPD switch is located on each annunciator panel. It is guarded in the OFF position. When in the ON position, the backup gyro located in the electronics compartment supplies pitch rate signals through an independent electronic channel to either the A or B servo, depending on which is selected by the pitch logic override switch.

MACH TRIM SYSTEM

In the transonic region in this aircraft, the variation of elevon angle with Mach number is such that it would normally require the pilot to use nose-up trim with increasing Mach number. This characteristic is referred to as "speed instability". To compensate for this, the Mach trim system is incorporated in the aircraft control system to slowly drive the trailing edge of the elevons upward as Mach number increases, thus providing artificial stability by requiring the pilot to apply nose-down trim as Mach number increases. The system operates between Mach 0.2 and 1.5 on a schedule which varies with Mach number in the 8-1/2 degrees nose-up and 5 degrees nose-down trim limits range of the elevons. The trim change rate is 15 degrees per Mach between 0.95 and 1.30 Mach, and 5 degrees per Mach between 0.2 and 0.95 Mach and between 1.3 and 1.5 Mach. Signal input to the Mach trim system is obtained from the air data computer and the electronic components associated with the system are located in the autopilot electronic component assembly. The system is operative whether or not any SAS channel is engaged; however, the Mach trim system does not function when the pitch autopilot is engaged. The only controls over the system are the circuit breakers in the forward cockpit which should be pulled in the event of an air data computer malfunction to prevent undesirable Mach trim effects. Power for Mach trim is furnished by the No. 1 or No. 3 inverters, and the essential dc bus.

PITOT-STATIC SYSTEM

Three-pitot-static systems supply the total and static pressures necessary to operate the basic flight instruments and air data system components. Normally, the pressures are sensed by an electrically heated probe mounted on the nose of the aircraft. The pitot orifice of the probe is divided inside the head to provide two separate pressure sources. It also has two circumferential sets of four static pressure ports each. One pitot and the aft set of static ports supply pressure signals to the air data computer system; the other set of pickups supply the normal ship system pitot and static pressure directly to the speed sensors on the ejection seats, the altimeters, the rate of climb, and airspeed indicators. An offset head on the left side of the probe provides yaw and pitch pressure signals to the stall warning light sensor. An alternate pitot-static source is available from the flight recorder system for flight instruments in the forward cockpit.

Pitot Heat Switches

The heating elements of the nose and flight recorder probes are controlled by two OFF-ON pitot heat switches, located on the annunciator panel in each cockpit. Power is furnished by the left ac generator bus.

Pitot Pressure Selector Lever

The pitot pressure selector lever is located on the forward cockpit right trim panel. It is normally safety wired in the NORMAL position. In the event of a malfunction of the normal pitot-static position system, the lever may be moved to ALT position. This furnishes pitot-static pressure from the flight recorder system to the altimeter, the rate of climb and the airspeed indicator in the front cockpit only.

Pitot Heat Indicator Lights

A pitot heat indicator light labeled PITOT HEAT, is located on each annunciator panel. When illuminated, the light indicates that the pitot heat switch is not in the correct position for the aircraft altitude. Power for the lights is furnished by the essential dc bus.

AIR DATA COMPUTER

The air data computer performs two functions, computation and display. The total and static pressures from the pitot-static probe are converted into the electrical signals required for the pilot triple display indicators and for the automatic flight control and inertial navigation systems. The ports which supply pressure to the air data computer are separate from those that furnish pressure to the basic flight instruments; therefore, failure of the air data computer pressure source will not leave the pilot without the necessary altitude, vertical velocity,

PITOT STATIC

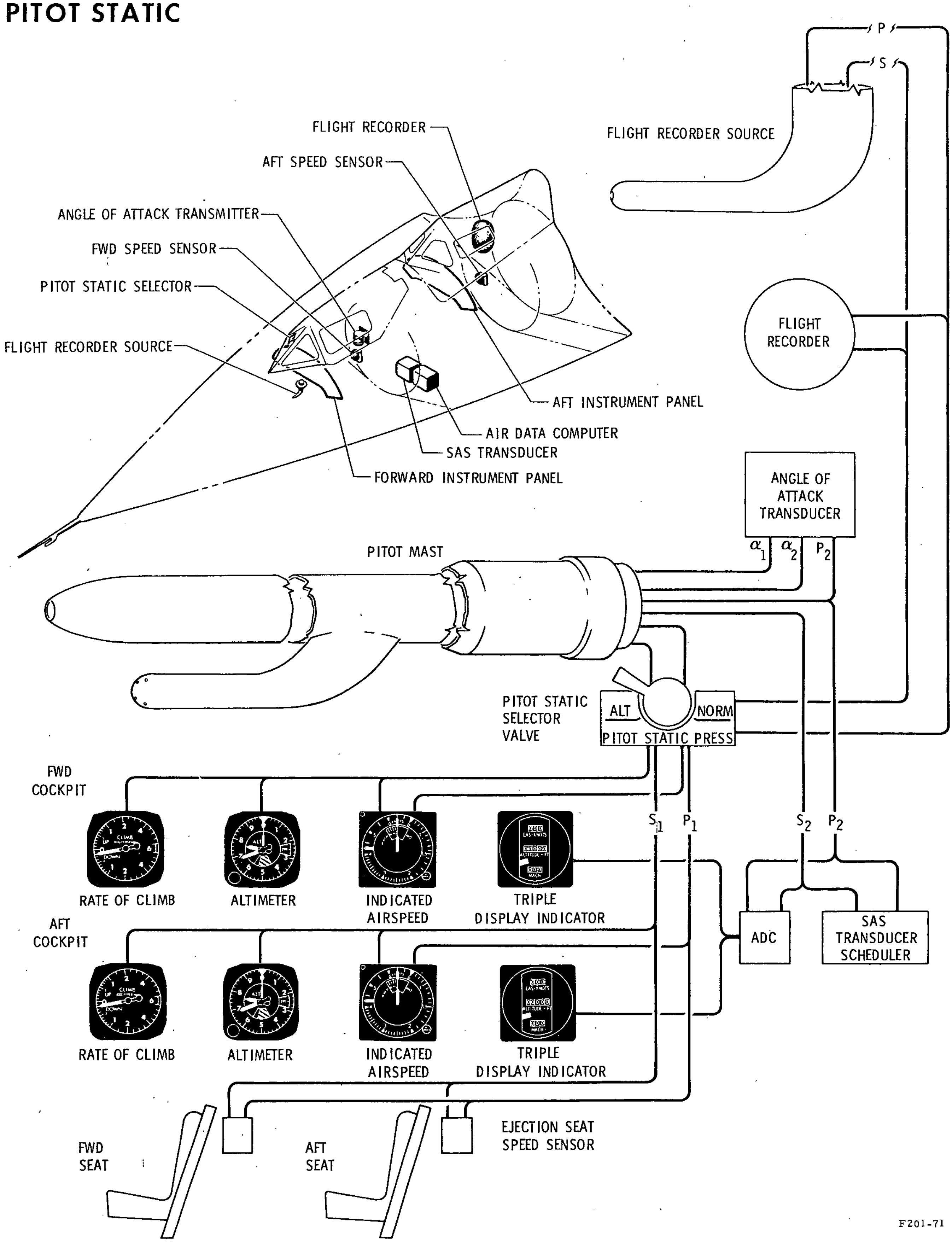


Figure 1-22

or airspeed information to fly the aircraft. The air data computer converts pitot-static pressures into proportional rotary shaft positions which are equivalent to pressure altitude and dynamic pressure. These shaft positions are combined in a mechanical analog computer made up of cams, gears, and differentials to drive the output functions. Outputs of the air data computer and the using equipment are as listed below:

OUTPUTS	USING EQUIPMENT
Pressure Altitude Equivalent Airspeed Mach	Triple-Display Indicator
Mach Mach Rate Altitude Dynamic Pressure	Autopilot
Mach	Mach Trim System
Pressure Altitude	Inertial Navigator Computer

Power for the air data computer is furnished either by inverter 1 or 3, as selected by the autopilot selector switch.

Triple-Display-Indicators

Triple-display indicators (TDI) are installed on each instrument panel. The indicators present digital indications of altitude in 50-foot increments, Mach number in 0.01-Mach increments, and equivalent airspeed in 1-knot increments. Altitude readout range is -1000 to 110,000 feet; Mach range is 0.2 to 3.5; and speed range is 100 to 560 KEAS at sea level (decreasing to 466 KEAS at Mach 2.5 and 460 KEAS at Mach 3.2.) If the ADC loses power, an OFF flag appears on the face of each indicator.

Note

If KEAS indications oscillate between two values on the high end of the range, it is an indication that the indicator limit is being approached.

WARNING

The digital speed and altitude indications are primarily used for aircraft control above FL 180 and to maintain proper airspeed control during climbs to FL 180. Pitot-static instruments shall be used in the landing pattern, during takeoff until proper climb schedule is established on the TDI, and during all simulated or actual instrument flight below FL 180. During subsonic flight pitot-static instruments should be consulted frequently to confirm correct air data system operation.

INSTRUMENTS

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

Airspeed-Mach Meter

A combination airspeed and Mach meter operating directly from pitot-static pressure is installed in the basic six flight instrument group on each instrument panel. This is a special instrument with airspeed and Mach number ranges compatible with aircraft performance. Mach number and airspeed are simultaneously read on the window and outer index, respectively. A limit airspeed needle (white-barred) shows the airspeed limit of the aircraft. The actual airspeed limit is an equivalent airspeed; however, the limit is shown as indicated airspeed, the needle varying with altitude to read the indicated airspeed that converts to limit equivalent airspeed.

Altimeter

A sensitive pressure altimeter is installed on each instrument panel. In addition to the 1000-foot and 100-foot pointers, it also has a 10,000-foot indicator. This pointer extends to the edge of the dial with a triangular marker at its extremity. The center disc has a cutout through which black and yellow warning stripes appear at altitudes below 16,000 feet. The barometric pressure scale is in a cutout at the right side and is set by a knob located at the lower left side of the instrument.

Attitude Indicator

An attitude indicator, located on the instrument panel in each cockpit, combines the functions of an attitude indicator and a turn and slip indicator. Pitch and roll signals from the INS or FRS are connected to each indicator through an ATT/AP select switch that is located on each instrument panel. Control is transferred from one cockpit to the other by moving the TACAN/INSTR transfer switch on the left console in either cockpit. The incoming signals are used to position an attitude sphere that has unrestricted motion, allowing pitch and roll presentation through 360 degrees. The sphere moves behind a miniature aircraft silhouette fixed at the center of the instrument. A pitch trim knob allows manual positioning of the sphere in pitch with relation to the miniature aircraft. Pitch angle is displayed by the relationship of the miniature aircraft to markings located on the sphere. The sphere is marked with a horizon line, small dots for 5 degree increments, short lines for 10 degree increments, numeral markers for each 30 degree increments, and large dots to indicate the poles. Bank angle is shown at the bottom circumference of the instrument. Ten degree graduations are provided for angles to 30 degrees, and 30 degree graduations for angles up to 90 degrees of bank. The turn and slip indicator is mounted at the bottom of the attitude indicator, and is centered with the vertical axis. A deflection of one needle width indicates a four minute 360 degree standard turn. The rate of turn transmitter receives power from the essential dc bus. Bank and pitch steering bars and a glideslope needle which are visible when the instrument is deenergized, are not used and are out of view when the instrument is energized.

Standby Attitude Indicators

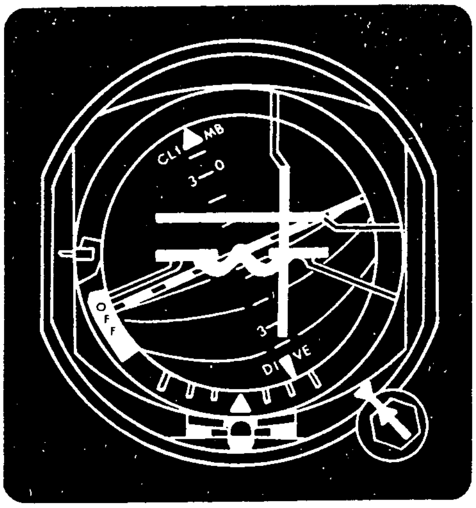
A standby attitude indicator located on each instrument panel provides the pilot with an independent attitude reference. It contains a sphere inscribed with an artificial horizon and calibrated in degrees of aircraft angle of pitch. The globe is detailed to represent the sky and earth areas, and is capable of rotating to indicate pitch angles of ± 82 degrees and roll angles of 360 degrees. The bank angle scale is marked on the outer periphery. A pitch reference adjustment knob is provided on the lower right corner of the instrument for positioning the reference bar as desired. A fast erect pushbutton is located adjacent to the throttles in each cockpit.

CAUTION

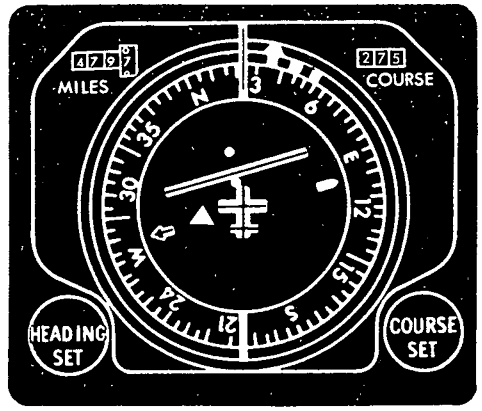
> Do not hold fast erect button for more than 45 seconds to prevent overheating of fast erect motor.

The OFF flag will be visible whenever power to the indicator is interrupted. This instrument has its own self-contained gyro and is not dependent on another reference source.

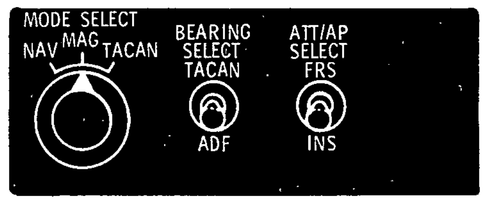
NAVIGATION INSTRUMENTS



ATTITUDE INDICATOR



HORIZONTAL SITUATION INDICATOR



FLIGHT INSTRUMENT CONTROL PANEL

NOTE

THE ATT/AP SELECT SWITCH DETERMINES WHICH SYSTEM, NAV OR FRS SUPPLIES PITCH AND ROLL TO THE ATTITUDE INDICATOR AND PITCH, ROLL AND HEADING TO THE AUTOPILOT. (AUTO-NAV STEERING SIGNALS ARE ONLY AVAILABLE IN THE INS POSITION)

		DISPLAY MODE SELECTOR SWITCH					
		NAV.		MAG		TACAN	
		BEARING SELECT SWITCH		BEARING SELECT SWITCH		BEARING SELECT SWITCH	
INDICATOR	INDICATOR FUNCTION	TACAN	ADF	TACAN	ADF	TACAN	ADF
HORIZONTAL SITUATION INDICATOR	HEADING MARKER	NAV STEERING		NAV STEERING		MANUALLY SET	
	BEARING POINTER	TACAN	ADF	TACAN	ADF	TACAN	ADF
	COURSE ARROW	SERVOED TO LUBBER LINE		SERVOED TO LUBBER LINE		MANUALLY SET TO SELECT. TACAN COURSE	
	COURSE DEVIATION	CENTERED		CENTERED		LEFT - RIGHT TACAN COURSE	
	COMPASS CARD	TRUE		MAGNETIC		MAGNETIC	
	TO-FROM	OUT OF VIEW		OUT OF VIEW		TACAN	
	RANGE INDICATOR	DISTANCE TO SELECTED TACAN STATION					
	K SHUTTER	NOT USED →		→		→	
	DIST. SHUTTER	OUT OF VIEW IF TACAN DISTANCE VALID					
	DIGITAL COURSE DISPLAY	SERVOED TO LUBBER LINE		SERVOED TO LUBBER LINE		MANUALLY SET TO SELECT. TACAN COURSE	
ATTITUDE INDICATOR	BANK DIRECTOR NEEDLE	OUT OF VIEW - NOT USED		→		→	
	PITCH DIRECTOR NEEDLE	OUT OF VIEW - NOT USED		→		→	
	GLIDE SLOPE INDICATOR	OUT OF VIEW - NOT USED		→		→	
	LOCALIZER FLAG	OUT OF VIEW - NOT USED		→		→	
	GLIDE SLOPE FLAG	OUT OF VIEW - NOT USED		→		→	
	POWER FLAG	OUT OF VIEW IF ATTITUDE REFERENCE VALID					

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Figure 1-23

HORIZONTAL SITUATION INDICATOR (HSI)

There is a horizontal situation indicator located on the instrument panel in each cockpit. Each HSI visually presents information from Tacan, ADF, INS and FRS. Display functions for both indicators are selected by the use of the display MODE SELECT switch and BEARING SELECT switch in either cockpit. Control with these switches is transferred from one cockpit to the other by using the TACAN/INSTR transfer switch on either control transfer panel. Power for the HSI is supplied by the No. 1 inverter. The various components of the indicators are described below.

Rotary Compass Card

The compass card is a rotating azimuth ring read at a stationary lubber line at the 12-o'clock position. The card displays true heading from the INS source when the display MODE SELECT switch having control is in the NAV position. When the display MODE SELECT switch having control is in the MAG or TACAN position the card displays magnetic heading from the FRS source.

Bearing Pointer

The bearing pointer is a small arrow on the outer periphery of the rotary compass card, and indicates the bearing to either the TACAN or ADF station as selected with the BEARING SELECT switch on the instrument panel which has control.

Heading Marker

The heading marker is a rectangular marker located just outside of the rotating compass card. When the display MODE SELECT switch having control is in NAV or MAG position the heading marker displays navigational steering. When the display MODE SELECT switch having control is in the TACAN position the heading marker can be set manually with the HEADING SET knob on the lower left corner of the HSI instrument.

Course Arrow and Course Deviation Bar

The course arrow and course deviation bar are located inside the rotating compass card. The course arrow points to the lubber line and the course deviation bar is centered when the display MODE SELECT switch having control is in the NAV or MAG position. When the display MODE SELECT switch having control is in the TACAN position, the course arrow may be manually set to the desired tacan course with the course set knob on the lower right corner of the HSI instrument, and the course deviation bar will indicate deviation left and right of the selected course.

Digital Course Display

A digital course display located in the upper right corner of the HSI displays at all times, the same course indicated by the course arrow on the compass card.

To-From Arrows

The to-from arrows are located on a radial near the center of the HSI instrument, in line with the course arrow. One or the other arrow will be exposed to indicate the direction to the station when TACAN mode is selected and reliable tacan signals are being received. At any other time, both arrows will be masked from view.

Range Readout Window

The range readout window located in the upper left corner of the HSI instrument is labeled MILES and displays the slant range in nautical miles to a selected tacan station regardless of the position of the display MODE SELECT switch.

Vertical-Velocity Indicators

A vertical-velocity indicator is installed on each instrument panel and shows the rate of change of altitude in feet per minute. Changes in pressure due to changes in altitude are sensed by the static system and transmitted to the indicator. The instrument is capable of indicating vertical speeds from 0 to $\pm$ 12,000 feet per minute. An over-pressure diaphragm and valve prevent excessive rates of climb or descent from damaging the instrument.

Clocks

Two elapsed time clocks are installed on each instrument panel. The elapsed time mechanism is started by pushing in on the winding knob.

EMERGENCY EQUIPMENT

MASTER WARNING SYSTEM

An annunciator panel is located on the center pedestal in each cockpit. Each panel contains individual warning lights which indicate malfunction or failures of equipment and systems. Illumination of any individual light also illuminates a red CAUTION light on the upper portion of each instrument panel. Once illuminated, the CAUTION light can be extinguished (reset) by depressing the light. The individual annunciator panel light will remain illuminated. Another malfunction will illuminate the CAUTION light again. Warning lights are automatically dimmed when the instrument panel lights are on. The master warning system does not include the fire warning and landing gear unsafe lights. Power is furnished by the essential dc bus.

NACELLE FIRE WARNING SYSTEM

A fire warning system is provided to detect the presence of a fire in the engine nacelles. A hot spot anywhere along the length of the detection circuit will illuminate the light of that particular nacelle. The lights are located on the upper right side of each instrument panel.

Nacelle FIRE Warning Lights

Left and right nacelle fire warning lights are located on the upper right side of each instrument panel. These lights illuminate when nacelle temperature at the turbine or afterburner exceeds $1050^{\circ}F \pm 50^{\circ}F$. They are also illuminated for test by depressing the IND & LT TEST pushbutton switch. Individual metal shields are provided which can be pulled down over the lights to shade them if necessary during illumination. Power for the lights is furnished by the No. 1 inverter.

STALL WARNING LIGHT

A STALL WARNING light is located on the annunciator panel in each cockpit and illuminates when the aircraft angle of attack reaches +14 degrees and the nose landing gear scissor switch is open. A steady tone warning signal is also produced in the pilot's earphone. Power for the stall warning light is furnished by the essential dc bus.

LANDING GEAR SYSTEM

The tricycle-type landing gear and the main wheelwell inboard doors are electrically controlled and hydraulically actuated. The main gear outboard doors and the nose gear doors are linked directly to the respective gear struts. Each three-wheeled main gear retracts inboard into the fuselage and the dual-wheeled main gear retracts inboard into the fuselage and the dual-wheel nose gear retracts forward into the fuselage. The main gear is locked UP by the inboard doors, and the nose gear by an uplock which engages the strut. There is no hydraulic pressure on the gear when it is up and locked. Downlocks inside the actuating cylinders hold the gear in place in the extended position. L hydraulic pressure is on the gear in the extended position as long as system pressure is available. The landing gear cylinders and doors are actuated in the correct order by two sequencing valves. Normal gear operation is by pressure from the L hydraulic pump on the left engine. Should pressure drop to 2200 psi during retraction, the power source automatically changes to the R hydraulic pump. R hydraulic pressure will not, however, extend the gear in the event of an L system failure; the manual landing gear release must be used in that case.

LANDING GEAR LEVER

A wheel-shaped landing gear lever is installed in the forward cockpit on the lower left side of the instrument panel, just forward of the throttle quadrant. The lever has two labeled positions, UP and DOWN. A locking mechanism is provided to prevent the gear lever from being inadvertently placed in the DOWN position. A pushbutton, which extends upward from the top of the lever, must be pressed forward in order to release the lock mechanism. An override button is installed just above the gear lever to override the ground safety switch should it become necessary to raise the gear when the weight of the aircraft is on the landing gear. Once energized, the gear lever must be recycled to the DOWN position in order to bring the ground safety switch back into the circuit. A red light installed in the transparent wheel (forward cockpit) and the GEAR NOT LOCKED light (aft cockpit) illuminate during cycling or when the gear is in an unsafe condition. The aft cockpit has a three-position guarded toggle switch located on the lower left side of the instrument panel. The switch is labeled UP and DOWN. It is lock-wired in the off position since it is to be used only for emergency operation of the landing gear. The switch will actuate the gear regardless of the position of the landing gear lever in the forward cockpit. Power for the circuit is furnished by the essential dc bus.

Manual Landing Gear Release Handles

Handles, labeled GEAR RELEASE, for lowering the gear when no L system hydraulic pressure is available are located on the annunciator panels. When the gear release handle is pulled, gear uplocks are released in sequence and the gear falls and locks down by force of gravity. The total effective pull of the release cable attached to the gear release handle is 9 inches, with allowance for cable stretch and loosening in the system the cable may be withdrawn as much as 12 inches. Pulling the handle out approximately 3 inches releases the nose gear uplocks; continuing the pull for the remaining 6 inches normal travel releases the four main gear uplocks in the sequence of right door first, aft locks before forward locks. If R hydraulic pressure is available, the landing gear lever must be put in the DOWN position before pulling the gear release handle, or the landing gear CONT circuit breaker must be pulled; otherwise, R system pressure will retract the gear. After manual gear extension, the gear may be retracted normally if L or R pressure becomes available.

LANDING GEAR SYSTEM

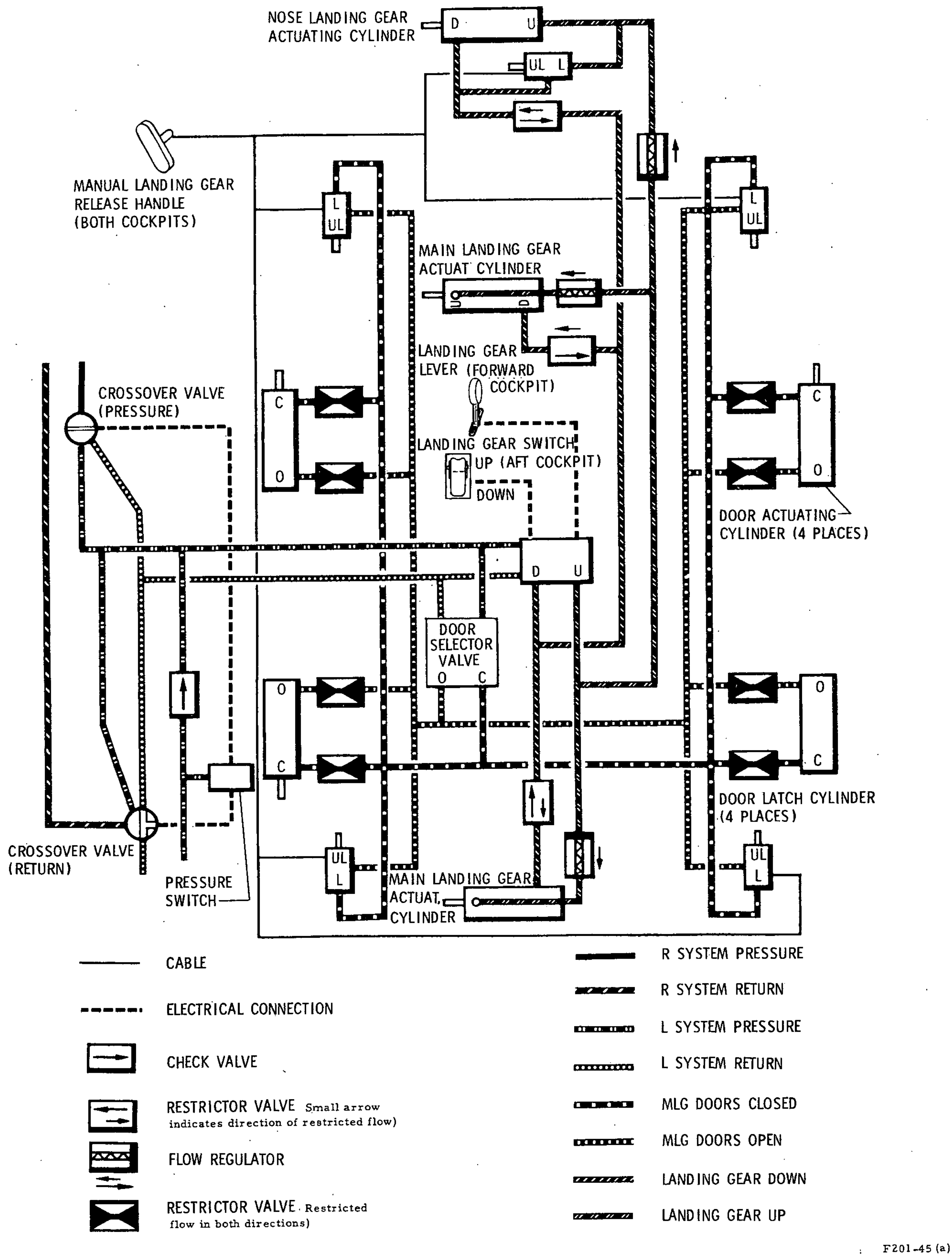


Figure 1-24

Landing Gear Position Lights

Three green lights, located in the left side of each instrument panel, indicate the down-and-locked condition of the landing gear. The location of each light corresponds to the respective wheel it monitors. Power is from the essential dc bus.

Landing Gear Warning Light and Audible Warning

The warning light in the forward cockpit gear handle illuminates red. When illuminated, it indicates at least one of the following conditions:

1. Gear is cycling.

2. Gear system is unsafe, though programmed UP or DOWN.

3. Gear is UP and power settings are below minimum cruise.

An audible warning signal is produced in the pilots headsets when the throttles are retarded to less than minimum cruise setting, the landing gear is not in the down-and-locked position, and aircraft altitude is below 10,000 ($\pm$500) feet. Power for the light and audible warning circuit is furnished by the essential dc bus.

Landing Gear Warning Cutout Button

The aural gear warning circuit may be disarmed by pressing the GR SIG REL push-button switch which is located on the left side of each instrument panel. The circuit is rearmed when the throttles are advanced to more than the minimum cruise setting. Power is supplied from the essential dc bus.

Landing Gear Ground Safety Pins

Removable ground safety pins are installed in the landing gear assemblies to prevent inadvertent retraction of the gear while the aircraft is on the ground. Warning streamers direct attention to their removal before flight. Spare safety pins are provided in a box in the aft cockpit.

NOSEWHEEL STEERING SYSTEM

The nosewheel steering system provides power steering for directional control when aircraft weight is on any one gear. The nosewheel is steerable 30 degrees either side of center. Steering is accomplished by a hydraulic steer-damper unit controlled through a cable system by the rudder pedals. L hydraulic system pressure from the nose landing gear down line is routed to the steering system through a shutoff valve, controlled by a nosewheel steering button on each control-stick grip. Depressing the nosewheel steering (NWS) button engages nosewheel steering whenever the nosewheel and rudder pedals are aligned. A holding relay circuit maintains nosewheel steering until the NWS button is depressed a second time, when nose steering will be disengaged. Steering is engaged at any time the NWS button is held in and the nosewheel angle and pedal position are matched. Nosewheel steering radius is approximately 75 feet. A mechanically operated centering cam automatically centers the nosewheel when it retracts. Power for the system is furnished by the essential dc bus.

Note

> Nosewheel steering is operable only if essential dc bus power is available and weight of the aircraft is on any one gear. If the L system pressure should drop below 1250 psi alternate nosewheel steering may be obtained by placing the brake switch to ALT STEER & BRAKE position.

WARNING

The landing gear side load strength is critical. Side loads during takeoff, landing and ground operation must be kept to a minimum.

WHEEL BRAKE SYSTEM

The aircraft is equipped with artificial-feel hydraulically operated power brakes. Depressing the rudder pedals actuates the 4 rotor brakes on each of the six main wheels. The L hydraulic system furnishes brake pressure with optional anti-skid operation. The hydraulic pressure to the brakes is approximately 1200 psi. Should the L hydraulic system fail, alternate brakes are available. The alternate brakes operate from an independent system using R hydraulic pressure with no anti-skid provision.

A small accumulator is incorporated in the normal brake system which should provide up to five brake applications provided accumulator pressure has not been dumped by selecting alternate brakes or the left hydraulic system has not been depleted by actuation of anti-skid, leakage, or other hydraulic malfunctions. Normal or anti-skid brakes are usable if left hydraulic pressure is steady and above 2200 psi. Alternate brakes are used if left hydraulic system pressure is below this pressure.

Brake Switches

A three-position brake switch is located on the left side of each instrument panel. When in the NORM (center) position, brake pressure from the L hydraulic system is available, but the anti-skid system is not operative. When in the ANTI-SKID (up) position, the anti-skid system is operative whenever the weight of the aircraft is on any one gear. When in the ALT STEER & BRAKE (down) position, the brakes, nosewheel steering and air refueling system are powered by the R hydraulic system if left system pressure is below 1250 psi. When the aft cockpit switch is placed in the ANTI-SKID or ALT STEER & BRAKE position, it is capable of overriding the forward cockpit switch. Power for the circuit is furnished by the essential dc bus.

WARNING

Do not switch to alternate brakes unless normal left hydraulic pressure is unavailable or normal brakes are inoperative. Pressure may be trapped in the brakes after the pedals are released, causing grabbing or locking.

Anti-Skid Out Indicator Lights

Illumination of the ANTI-SKID OUT indicator light on each annunciator panel indicates that the anti-skid system is inoperative. When the aircraft is on the ground, the lights will be illuminated when either cockpit switch is in the NORM or ALT STEER & BRAKE position. The lights will be off when either switch is in the ANTI-SKID position, and the anti-skid control box and wheel generators are operative. If the fail-safe circuit within the anti-skid control box is tripped the lights will illuminate and only power brakes will be available. The lights are off at all times when the weight of the aircraft is off the gear.

DRAG CHUTE SYSTEM

The drag chute system is provided to reduce landing roll and aborted takeoff rollout distance. A ribbon-type parachute is packed in a deployment bag and stowed in a compartment in the upper aft end of the fuselage. The chute rides free in the compartment and is snapped onto the airplane in the initial stage of deployment. The

BRAKE SYSTEM

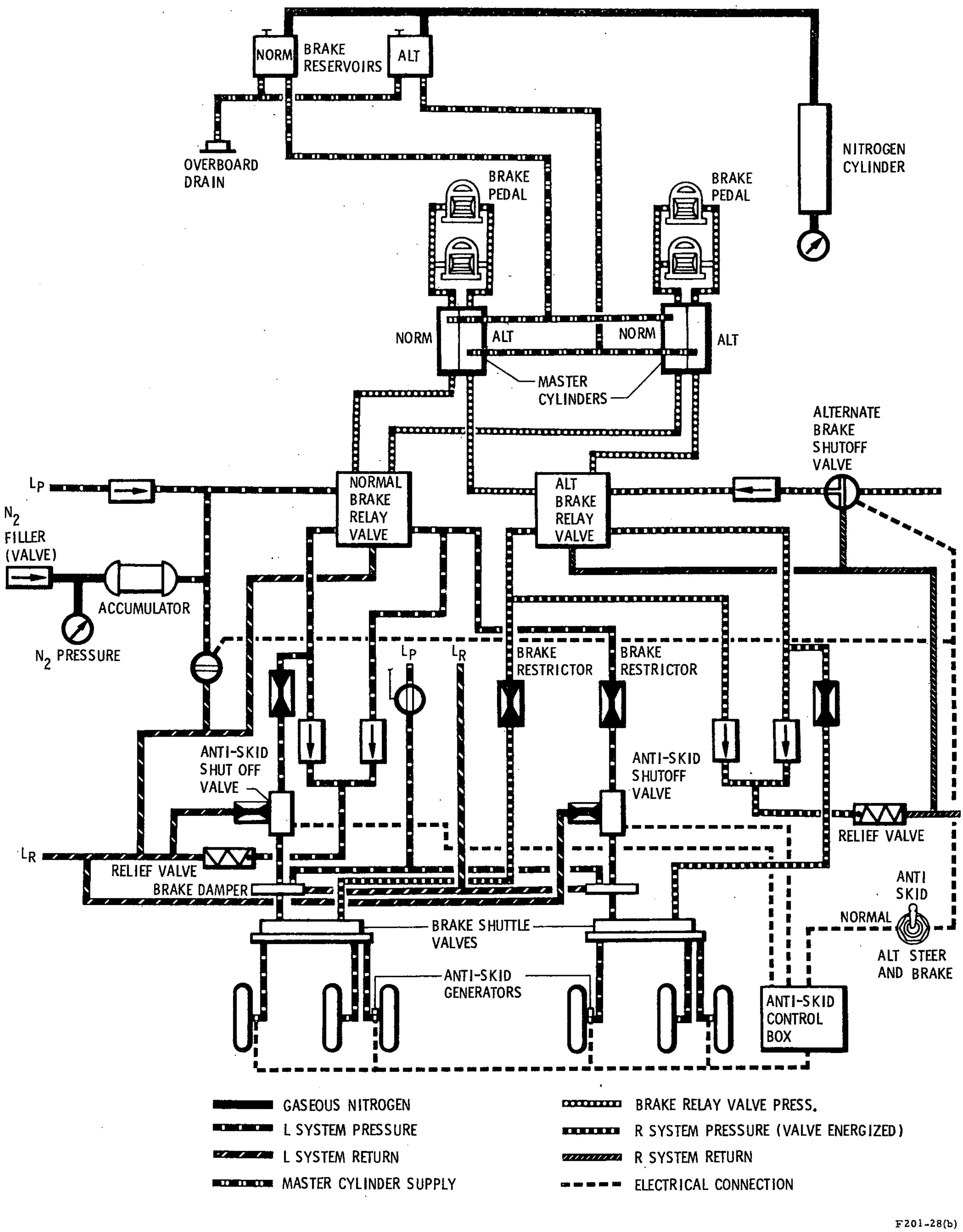


Figure 1-25

chute mechanism incorporates a shear section in the attachment yoke which ruptures if the chute is deployed above the limit airspeed. Chute deployment is actuated electrically from the forward cockpit by pulling out and pushing in a drag chute handle, and from the aft cockpit by operating a toggle switch. The aft cockpit drag chute switch has the capability of overriding the forward cockpit drag chute handle. System power is furnished by the essential dc bus.

Drag Chute Handle

A drag chute handle, labeled DRAG CHUTE, is located on the upper left glare shield of the forward cockpit. The handle is normally in the stowed (off) position, with the handle horizontal. Pulling the handle out to the limit of its travel activates a microswitch to deploy the drag chute. Rotating the handle 90 degrees counterclockwise and pushing in to the stop activates other microswitches to jettison the chute. Ground crew personnel reset the handle to the neutral position after flight.

Drag Chute Switch

A three-position drag chute toggle switch is located on the upper left side of the aft cockpit instrument panel. The labeled switch positions are CHUTE DEPLOY (up), off (center), and JETT (down). The switch functions are identical to those of the drag chute handle.

AIR-CONDITIONING AND PRESSURIZATION SYSTEM

Similar left and right air-conditioning and pressurization systems utilize high pressure ninth-stage compressor air from each engine to pressurize and cool the cockpits and equipment compartments. System shutoff valves allow compressor air to flow when the engines are running and the system switches are ON. Cooling is accomplished by ducting the bleed air through a ram-air heat exchanger, primary and secondary fuel-air heat exchangers, and an air-cycle refrigerator. Temperature of the air supplied by each system is modulated by the positions of temperature control bypass valves located upstream from the air-cycle refrigerators. The bypass valves are positioned by control switches located in the cockpits.

The left engine normally furnishes air for the forward cockpit, ventilated flying suits, inverters, and INS platform. The right engine normally furnishes air for the aft cockpit. A crossover system is provided for emergency operation to supply right engine system air to the forward cockpit and equipment normally supplied by the left engine system. High pressure canopy seal and windshield defog air is furnished from both right and left engine systems by ducts connected downstream from the primary fuel-air heat exchanger.

COCKPIT COOLING AND PRESSURIZATION

When the aircraft is at high altitude, the pressurization systems maintain a constant altitude of approximately 26,000 feet in the forward cockpit and 28,000 feet in the aft cockpit.

TYPICAL COCKPIT PRESSURIZATION SCHEDULE

Aircraft Alt	Cockpit Alt
10,000 ft	8,000 ft
20,000 ft	16,000 ft
30,000 ft	24,000 ft
35,000 ft & Up	26,000 ft

A crossover duct allows the pilot who has control of the air-conditioning system to divert aft cockpit air to the forward cockpit

AIR CONDITIONING

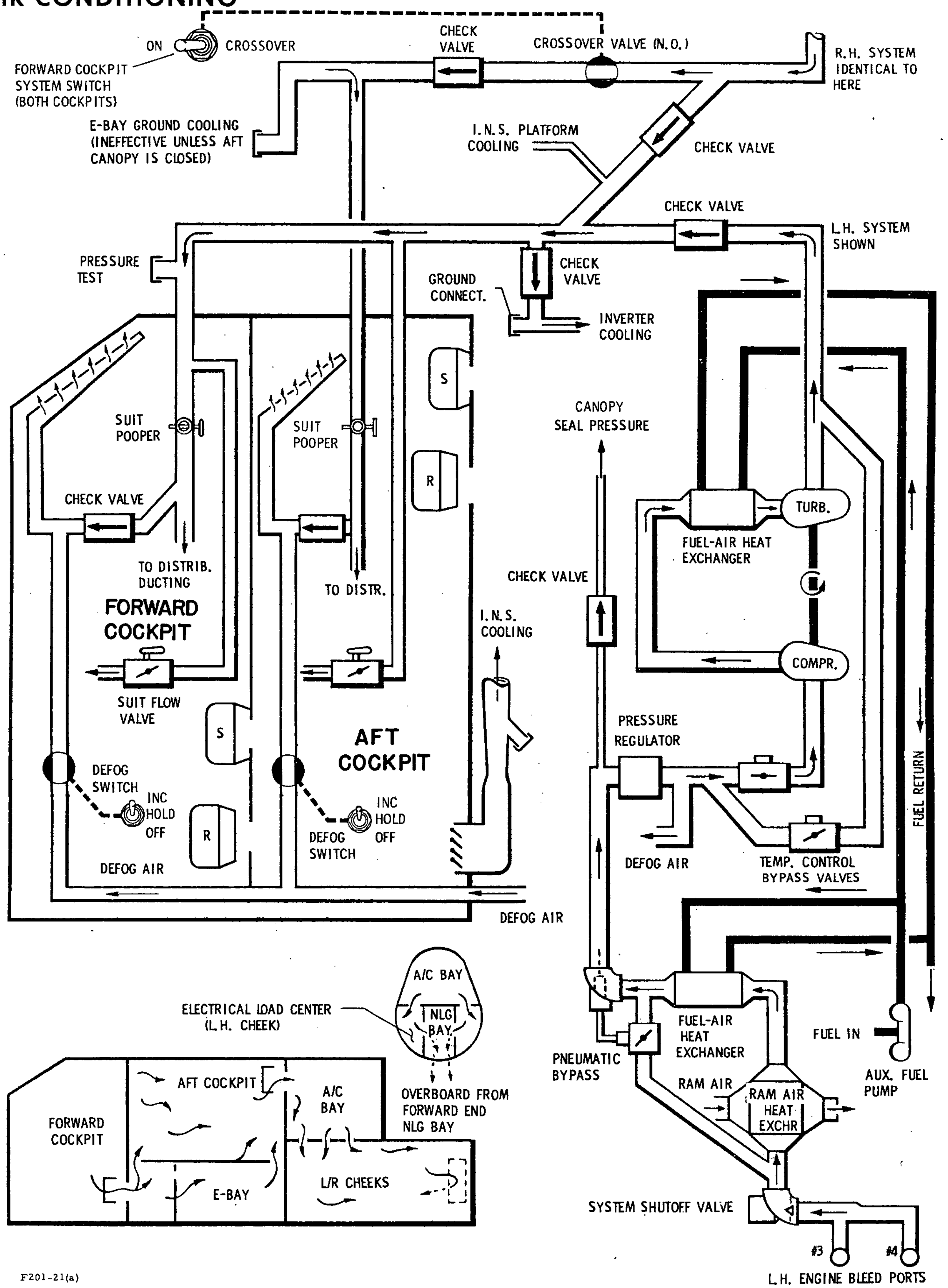


Figure 1-26

in case of malfunction of the forward cockpit system. The actuation of the crossover system will not depressurize the aft cockpit since the forward cockpit air exhausts into the aft cockpit; however, a rise in temperature will occur in the aft cockpit.

Forward Cockpit System Switches

The forward cockpit system three position switches are installed on the upper left side of each instrument panel. In the ON (left) position the normally open system shutoff valve is de-energized and the left system is operative when the left engine is running. In the OFF (center) position the shutoff valve is energized closed, shutting off the air. In the CROSSOVER (right) position, left system air is shutoff and the normally open crossover valve closes, forcing right engine air to the forward cockpit when the right engine system is operating. The circuit is powered from the dc essential bus.

Aft Cockpit System Switches

The aft cockpit system two position switches are located on the upper left side of each instrument panel. In the SYS ON (up) position the right engine system's normally open shutoff valve is de-energized so that right engine air can flow to the aft cockpit. If the forward cockpit system switch is in CROSSOVER, this air will all be ducted to the forward cockpit and will enter the aft cockpit through the forward cockpit pressure regulator valve. In the OFF position the shutoff valve is energized and aft cockpit system air is shut off. The circuit is powered from the essential dc bus.

Temperature Control Selector Switches

Two selector switches, one for each cockpit air installed on the upper left instrument panels. Each switch has four positions; AUTO (up), COLD (down left), WARM (down right) and HOLD (center). The switches are spring loaded to HOLD from the COLD and WARM manual control positions. The switches will normally be in the AUTO position; however, in case of a malfunction in the automatic operation of the system, the pilot can manually override the automatic feature by moving the switch to either the momentary COLD or WARM position. The No. 1 inverter powers the cockpit temperature control system.

Temperature Indicators and Monitor Switches

A temperature indicator and monitor switch located on each upper left instrument panel allows the pilots to monitor individual cockpit temperature conditions. The switches are labeled FWD CKPT (left) and AFT CKPT (right). Each pilot can monitor either forward or aft cockpit air discharge temperature by placing his switch in the desired position. Power for the indicator is furnished by the essential dc bus.

Note

Up to a point, the insulation and ventilation of the pressure suit will keep the pilot comfortable in a cockpit environment that is too warm. The gage is provided to allow anticipation of a temperature condition that might eventually become too hot for comfort. If the cockpit temperature approaches 140°F, the suit will not keep the pilot comfortable.

Temperature Control Knobs

Two temperature control rheostats, one for each cockpit, are installed on the upper left instrument panels. Arrows on the panel adjacent to the knobs show the direction of rotation necessary to increase temperature. Generally, it is necessary to periodically rotate the respective temperature control rheostat toward the COLD (counterclockwise) position to maintain a comfortable temperature in the ventilated flying suits and keep the temperature of the cockpits within tolerance. Electrical power for the cockpit temperature control circuits is from the No. 1 inverter.

Cabin Altimeters

A forward and aft cockpit pressure altitude gage is installed on each left forward panel and indicates either forward or aft cockpit altitude as selected by the cabin altimeter selector lever.

Cabin Altitude Selector Switches

A switch, labeled FWD CKPT in the up position and AFT CKPT in the down position, is installed on each left forward panel. Operating the switch selects the respective cockpit pressure altitude on the cabin altitude gage.

Cockpit Depressurization (Dump) Switches

A guarded, two-position cockpit depressurization switch, labeled PRESS DUMP, is installed on the left side of each instrument panel. Either pilot may depressurize (dump) or repressurize both cockpits, but must first obtain control of both cockpit air-conditioning systems by use of the control transfer panel (refer to Control Transfer Panels, Air-Conditioning Switches and Transfer Lights, this section). When control of the air-conditioning is obtained, actuation of the PRESS DUMP switch to the up position (guard up) will depressurize both cockpits. When the PRESS DUMP switch is moved to the down position (guard down), the cockpits will repressurize.

OXYGEN SYSTEM AND PERSONAL EQUIPMENT

AIRCRAFT OXYGEN SYSTEM

The aircraft is equipped with two independent, high-pressure, gaseous oxygen systems. Both systems supply each pilot, and oxygen is consumed from the two systems simultaneously. If one system fails, the other system will continue to supply both pilots, but with reduced duration. Each system is supplied by one 875-cubic-inch, 1800-psi oxygen bottle. Both bottles are located in the nosewheel well and are serviced at the bottom of the right-hand chine. As oxygen leaves the bottles the pressure is reduced to 75 psi. ON-OFF levers for the two systems are located on the oxygen control panels installed on the left consoles. A dual system low pressure gage installed between the levers will read approximately 75 psi during normal operation. The needles on the gage will fluctuate, indicating oxygen flow when the pilot inhales. Oxygen quantity is displayed on the dual indicating high pressure gages located on the left side of the instrument panels just forward of the throttle quadrants. The NO. 1 OXY LOW or the NO. 2 OXY LOW lights on the annunciator panels will illuminate when the respective oxygen supply pressure decreases below 400 psi, or when the regulated pressure drops to 58 $\pm$ 3 psi.

OXYGEN SYSTEM

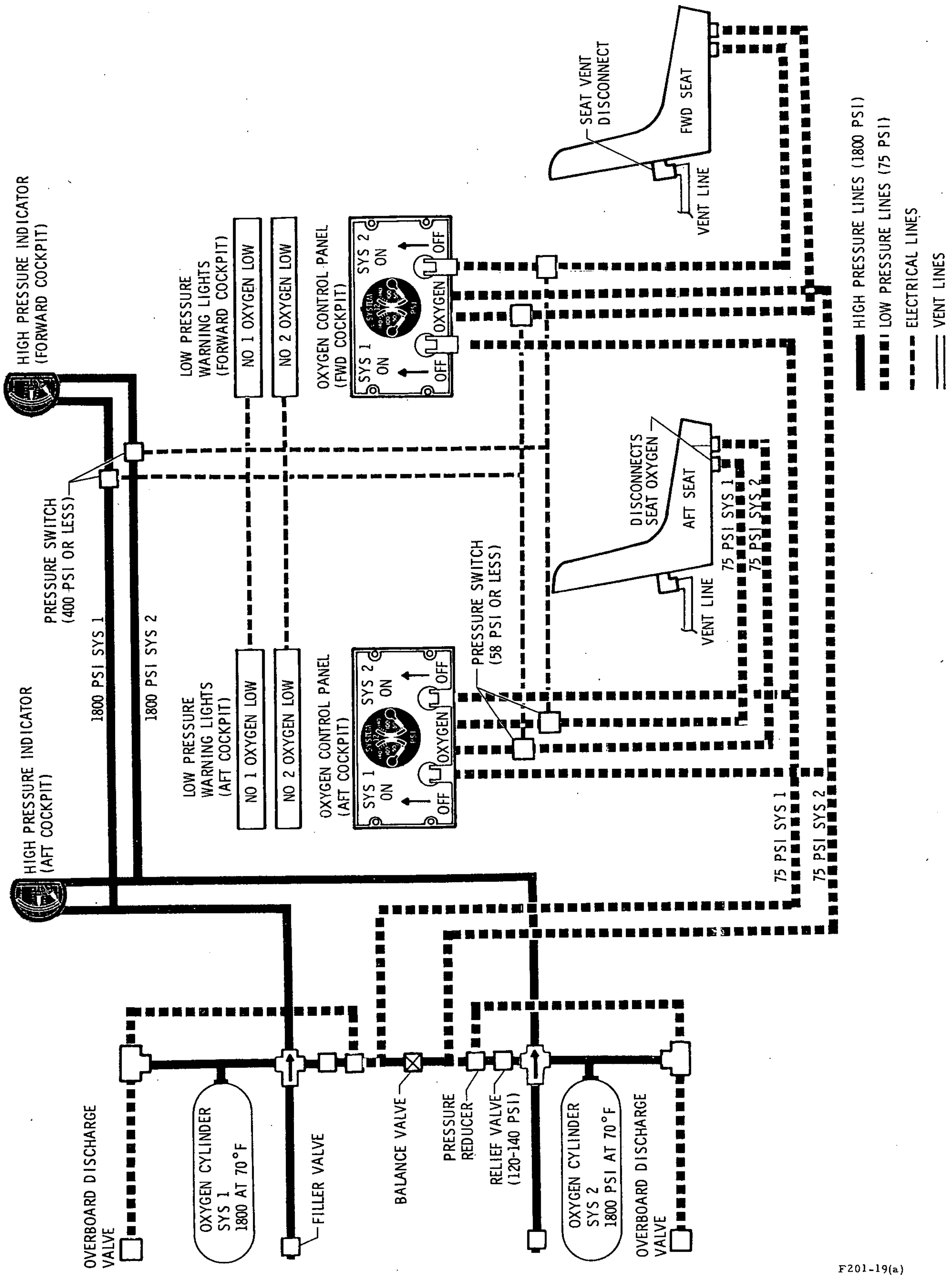


Figure 1-27

EMERGENCY OXYGEN SYSTEM

Two independent emergency oxygen systems are installed in the pilot's parachute pack. Each system consists of three 20 cubic inch, 2100 psi cylinders attached to a common manifold. These systems will supply oxygen simultaneously during bailout or if the aircraft oxygen system fails. An oxygen line from each system is routed around both sides of the pilot's waist and connects to the suit controller valve. Check valves prevent emergency flow when the aircraft systems are supplying oxygen. When the emergency system is actuated, check valves prevent oxygen flow into the aircraft system. Emergency oxygen flow pressure is slightly lower than aircraft system pressure. Oxygen duration of each emergency system is approximately 15 minutes.

Emergency Oxygen System Actuation

The emergency oxygen system may be actuated either manually by pulling the convential green apple, or automatically by the upward motion of the seat during ejection. The emergency oxygen system should be actuated if the aircraft is not delivering the desired amount of oxygen or hypoxia or noxious fumes are suspected.

FULL-PRESSURE SUIT

A full-pressure suit is provided which is capable of furnishing the pilot with a safe environment regardless of pressure conditions in the cockpit. The suit consists of four layers, ventilation garment, bladder, link net, and heat-reflective outer garment. The ventilation garment layer allows ventilation air to circulate between pilot's underwear and the bladder layer. The bladder provides an air-tight seal to hold pressurized air in the suit. The link net is a mesh which holds suit configuration in conformance with the pilot's body. The outer layer of heat-reflecting aluminized cloth provides some protection from a hot environment. Air pressure to the suit is regulated by a suit controller valve, located on the front of the suit just above the waist.

Pressure Suit Ventilation Air

Air for suit ventilation is provided by the cockpit air-conditioning system. Temperature of the ventilation air cannot be varied except by changing cockpit air temperatures. Ventilation airflow rate may be regulated by a suit flow control valve installed at the hose connection point on the suit. Ventilation air and exhaled breathing air are exhausted from the suit, controlled by the pilot operating the suit ventilation boost valve lever which changes the air pressure of the incoming suit air. The aft cockpit has no control, depending only on the valve setting in the forward cockpit.

Suit Ventilation Boost Valve Lever

The suit ventilation boost valve lever, labeled SUIT VENTIL BOOST, is located in the forward cockpit only, on the left console. The lever positions are marked NORMAL (aft) and EMERG (forward). Operating the lever positions a butterfly valve in the cockpit air-conditioning air supply line in such a way as to vary the pressure of the air available to the suit system. Increased pressure results in more air to the suit. Moving the lever toward EMERG position progressively results in more pressure to the suit system by constricting the air-conditioning airflow to the cockpit; in the NORMAL position (used when engine rpm is high) the cockpit air-conditioning line requires no constriction to provide sufficient airflow to the suit. At IDLE engine rpm the ventilation boost valve lever must be kept at 2/3 of the way from NORMAL to EMERG in order to provide sufficient air for cooling the INS platform, inverters and conditioning the suit when it is used. (When the pressure suit is not worn the suit air hose should be capped.) During takeoff and normal flight the valve lever is kept in the NORMAL position. If the pilot suffers discomfort, such as might happen with a gradual climb to an extreme altitude or during low-rpm descents, the valve lever is gradually moved toward the EMERG position until a comfortable pressure and ventilation condition is attained. The valve lever should not be moved toward EMERG more than necessary to provide pilot comfort; excessive suit system pressure will unduly reduce the available refrigeration.

Suit Controller Valve

All four aircraft and emergency oxygen system lines enter the controller valve at the front waist of the pressure suit. The controller valve contains a sensor that programs airflow to keep internal suit pressure at 3.5 psia (equivalent to pressure at 35,000 ft) in the event of cockpit depressurization. A press-to-test button for each oxygen system is installed on the controller valve, which allows the pilot to check suit inflation.

Faceplate Heat Switches

Faceplate heat switches are installed on the right console in each cockpit. Each switch has four positions; OFF, LOW, MED, and HIGH. Heat may be regulated to defog the faceplate as required. Defogging is accomplished by the combination of faceplate heat and oxygen flow.

HELMET

The helmet head area is divided into two separate sections by a rubberized cloth face seal. The front area between the faceplate and the face seal receives oxygen from either the aircraft or emergency oxygen system through regulators built into the helmet. Oxygen flows across the faceplate from the inhalation valves inside the helmet and accomplishes some faceplate defogging before it is inhaled. The rear area receives ventilation air for helmet interior temperature regulation. The face seal is not positive; however, the pressure of the oxygen in the front area is slightly higher to prevent ventilation air from leaking forward. An external crank on the helmet is provided for adjusting the head band. Buttons on each side of the helmet, when actuated, will lower the faceplate and visor. The faceplate is opened by moving the buttons and dumping the pressure, allowing the faceplate to be rotated upward. If the aircraft or emergency oxygen supply to the helmet is interrupted or exhausted, the regulators in the helmet sense the drop in pressure and the faceplate seal deflates, allowing ambient air to enter the helmet so the pilot will not suffocate.

GLOVES

Leather gloves attach to the suit at the wrist rings. The inner liner of the glove is similar to the suit inner liner and will retain pressure. There is little or no ventilation for the hands.

BOOTS

The sock or boot liner attaches to the suit at the ankle by means of a zipper. The boots are made of white leather to take advantage of heat reflection, and fit snugly over the socks. A spur is attached to each boot.

OXYGEN MASK AND REGULATOR

When permitted by appropriate regulations, a substitute oxygen mask assembly may be used in place of the pressure suit. The assembly consists of a specially designed A-13 oxygen mask, oxygen regulator, anti-suffocation valve, and two oxygen personal leads with connectors for both aircraft and emergency oxygen systems. In the event the regulator should malfunction or the oxygen supply be exhausted, the anti-suffocation valve, installed between the regulator and the mask, will sense the drop in oxygen pressure and allow ambient air to enter the mask.

SURVIVAL KIT

A reinforced fiberglas survival kit container fits into the seat bucket and attaches to the parachute by snap attachments on each side. A door on the top-rear provides access to the survival items stored inside. The kit contains a two-way radio, smoke generator, mirror, whistle, knife, matches, water, food, first-aid kit, moccasins, and a compass, all packed in a waterproof bag attached to a 20-foot retention lanyard. If an overwater flight is anticipated, a liferaft may be stowed on top of the plastic bag and attched to the lanyard. During ejection the liferaft inflating device is armed. Following ejection, the survival kit release handle should be pulled before reaching the ground. This action separates the survival gear from the pilot and inflates the liferaft. The survival gear and liferaft remain attached to the parachute harness by the retention lanyard. During rapid abandonment of the aircraft on the ground, the survival kit release handle may be used to free the pilot from the survival kit (including the lanyard) without inflating the liferaft.

PARACHUTE

A special parachute with a 35 foot canopy is used. The large canopy provides a normal descent rate with the bulky personal equipment required for high altitude flight. A small diameter, ribbon type stabilizing drogue chute is also provided. Above 16,000 (± 400) feet altitude, the drogue chute is deployed first in order to stabilize free fall of the pilot. The drogue is automatically jettisoned at 15,000 (± 400) feet after an aneroid controlled opener deploys the main chute. Below 15,000 feet the main chute only deploys immediately. A manual "D" ring is also available for opening the main chute. The chute pack is equipped with conventional quick release buckles. The emergency oxygen bottles are located between the chute canopy and the pilot's back. A combination hand squeezed bulb and manually operated pressure relief valve located adjacent to the suit controller is used to adjust cushion pressure as desired. A red knob located on the left harness strap is connected to the parachute timer arming cable and is used to manually actuate the timer when bailout is made without using the ejection seat.

WINDSHIELD

The windshield is composed of two glass assemblies secured and sealed in a V-shaped titanium frame. The glass surfaces are coated with low reflective magnesium fluoride. A collapsible vision splitter is also installed on the windshield center line to minimize reflections.

DEFOG SYSTEM

The defog system delivers hot air from both right and left air systems through check valves to defog the windshields and canopies. A plastic V-shaped air duct runs along the lower edge of each windshield through which hot defog air is supplied when selected by a defog switch that is located in both cockpits. The air is directed to the windshield through a series of holes on the upper surface of the duct. Holes are also provided at the aft ends of the duct to direct air toward the canopy glass.

Defog Switch

A 3-position defog switch is located on the right console in each cockpit. When held in the momentary DEFOG INCREASE (forward) position the motor driven defog valve will open. Time of travel to full open is approximately 7-13 seconds. In the HOLD (center) position the valve will stop at any partial open position; in the OFF position the valve will completely close. The circuit is powered by the essential dc bus.

WINDSHIELD RAIN REMOVAL SYSTEM

A rain removal system is provided for clearing the forward windshield when operating the aircraft in rain. It has a tank that is pressurized by air and the tank is connected to spray tubes located on each side of the windshield center divider. A pushbutton switch, located on the glareshield panel, is used to spray the rain removal fluid onto the windshield. Power is furnished from the essential dc bus.

CANOPIES

Each canopy consists of two high-temperature-resistant glass windows secured in a reinforced titanium frame and hinged at the aft end by two hinge pins. Operation of the canopy is completely manual. Small holes in each side of the canopy are provided as lifting points from the outisde. No handles are provided on the inside of the canopy for moving it up or down. A prop assembly locks the canopy in the full-open position. The canopy is secured in the closed-and-locked position by a four-hook interconnected latching mechanism. An air boost counterbalancing system is provided to aid in the manual opening and closing of the canopy. Individual internal latching handles are installed below each right canopy sill, allowing each canopy to be latched separately from the inside. External fittings located on the left side of the aircraft can be used to operate the latches from the outside.

CAUTION

> The canopy should be opened or closed only when the aircraft is stationary. Maximum taxi speed with canopy open is 40 knots. Gust or severe wind conditions should be considered as a portion of the 40-knot-limit taxi speed.

CANOPY SEAL

An inflatable rubber seal is installed in the edge of each canopy frame. The seal seats against the mating surfaces of the canopy sill and windshield and provides sealing for retaining cockpit pressurization.

Canopy Seal Pressurization Lever

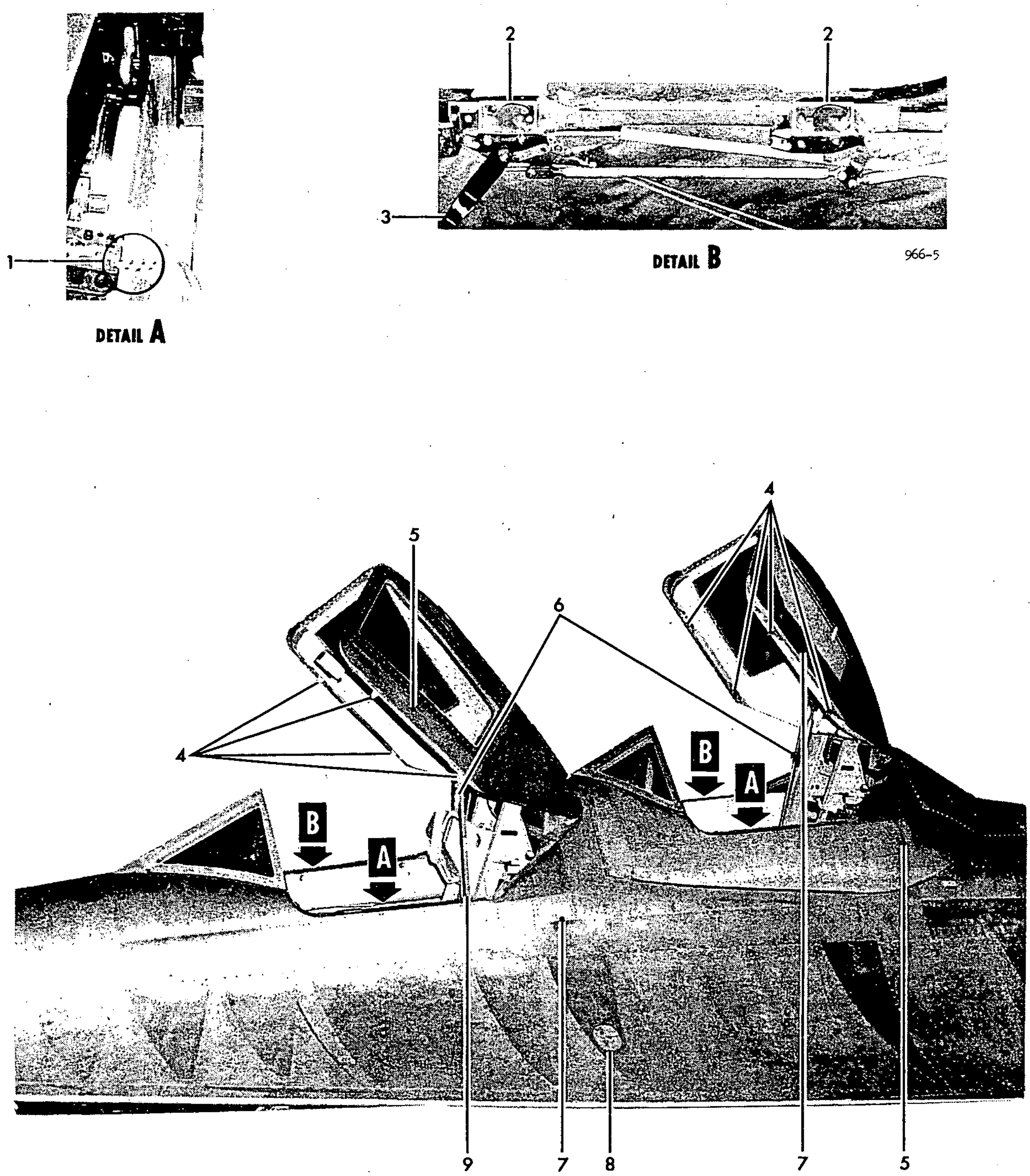
A canopy seal pressurization lever, labeled CANOPY SEAL PRESSURE, is located in each cockpit above the forward right console. The lever positions are ON (forward) and OFF (aft). Moving the lever to the ON position controls a valve to supply pressure to the canopy seal.

CANOPY CONTROLS AND INDICATORS

Canopy Latch Handles

Canopy latch handles are located under the right sill in each cockpit and rotate forward to lock. Each sill trim is cut out to expose the action of the locking lugs and pins as the handle is rotated forward. A cam over-center

CANOPIES AND CONTROLS



1 CANOPY INTERNAL JETTISON HANDLES
2 CANOPY LATCH HOOKS
3 CANOPY LATCH HANDLES
4 CANOPY LATCH ROLLER BRACKETS
5 CANOPY LIFTING HOLES
6 CANOPY PROP ASSEMBLY AND UPLOCKS
7 CANOPY EXTERNAL LATCH CONTROLS
8 CANOPY EXTERNAL JETTISON HANDLE HIDDEN
9 CANOPY PROP (GROUND HANDLING)

F201-20

Figure 1-28

action ensures that the handle will remain only in the latched or unlatched position. There are no canopy unsafe warning lights installed in the aircraft.

Canopy External Latch Controls

Flush-mounted external latch fittings are located on the left side of the aircraft, permitting the canopies to be opened from the outside. These controls accept a 1/2-inch square bar extension. Once a canopy is unlocked, it may be raised manually until the prop locks it in the open position.

Canopy Internal Jettison Handles

A canopy jettison T-handle is located on the left console wall adjacent to the left leg of each pilot. The handle can be used to individually jettison the canopies without initiating the seat ejection system. Each handle is held in the stowed position by a safetywire and a ground safety pin. Cable travel is approximately 6 inches.

Canopy External Jettison Handle

The canopy external jettison handle, located beneath an access panel on top of the left chine, permits ground rescue personnel to jettison both canopies simultaneously for emergency entrance. Actuation of the jettison handle jettisons the forward canopy immediately and the aft canopy after a 1-second delay. Sufficient cable length is provided to allow the operator to stand clear of the fuselage during the jettison procedure.

Canopy Jettison Sequence

The canopy jettison system is designed to unlatch and jettison each canopy individually from the aircraft. Each system consists of two initiators, which are independently actuated by either the ejection seat D-ring or the canopy jettison handle; a canopy unlatch thruster; a canopy removal thruster; a canopy seal hose cutter; cable linkage; and gas pressure lines. Either the D-ring initiator or the canopy initiator will fire the unlatch thruster which unlocks the canopy. This thruster then activates the canopy removal thruster which jettisons the canopy. During canopy jettisoning by use of the canopy jettison handle, the canopy jettison initiator gas pressure positions a seat jettison safety valve to prevent initiating the seat ejection sequence. Pulling the D-ring jettisons the canopy as the initial step in the ejection sequence.

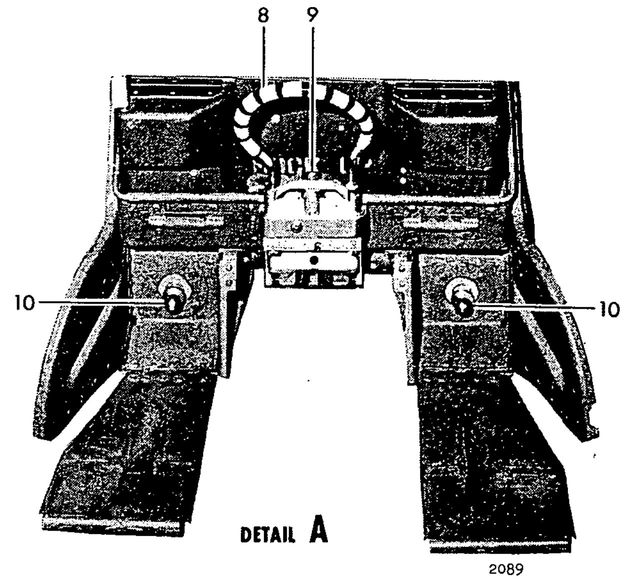
EJECTION SEATS

Individual ejection seat systems utilize a rocket-catapult, upward-ejection seat capable of safely ejecting the crewmember at ground elevation provided that a level flight path speed of 65 KIAS or greater is achieved before ejecting. Each seat incorporates an ejection ring, headrest, knee guards, automatic foot retractors, automatic foot retention separation devices, a pilot-seat separation device, a shoulder harness, an inertia reel lock assembly, and an automatic-opening seat belt. A speed sensor mounted on the fuselage behind each seat automatically selects one of two seat separation delays, depending upon airspeed at ejection. (See Seat Ejection System, this section). Quick-disconnect fittings installed on the seat rails and the floor of the aircraft permit disconnecting the oxygen, ventilated suit, and electrical lines.

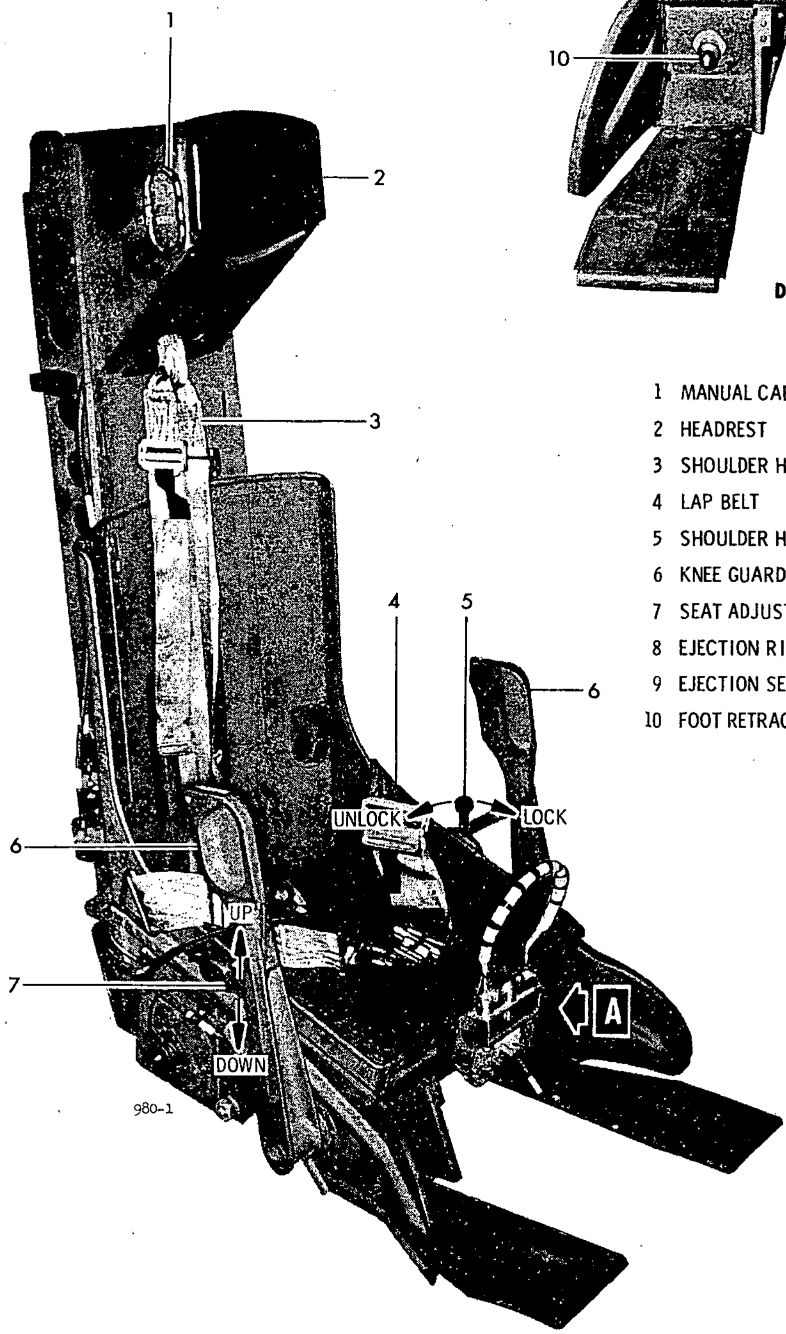
Seat Vertical Adjustment Switches

The seats may be adjusted vertically by means of an electric actuator mounted on the lower end of the catapult. The switch is located on the right side of the seat bucket. Power for seat adjustment is furnished by the essential dc bus.

EJECTION SEATS (Both Cockpits)



1 MANUAL CABLE CUTTER RING
2 HEADREST
3 SHOULDER HARNESS
4 LAP BELT
5 SHOULDER HARNESS INERTIA REEL LOCK LEVER
6 KNEE GUARDS
7 SEAT ADJUSTMENT SWITCH
8 EJECTION RING
9 EJECTION SEAT T HANDLE
10 FOOT RETRACTOR FITTINGS



F201-22(b)

Figure 1-29

Shoulder Harness Inertia Reel Lock Levers

A shoulder harness inertia reel lock lever installed on the left side of each seat bucket is provided for locking and unlocking the shoulder harness. The lever has two positions, LOCK and UNLOCK. Each position is spring-loaded to hold the lever in the selected position. An inertia reel located on the back of the seat will maintain a constant tension on the shoulder straps to keep them from becoming slack during backward movement. The reel also incorporates a locking mechanism which will lock the shoulder harness when a 2G to 3G force has been exerted in a forward direction. When the reel is locked in this manner, it will remain locked until the lock lever is moved to the LOCK position and then returned to the UNLOCK position.

Ejection (D) Rings

An ejection (D) ring, located on the front of each seat bucket, is the primary control for ejection. An ejection safety pin is installed in the ejection ring housing bracket.

Ejection Seat T-Handle

A secondary seat-ejection system is incorporated in each cockpit. The operating T-handle for this ejection system is unlocked and made accessible when the ejection D-ring is pulled. If the seat fails to eject, pulling the T-handle causes a separate initiator to fire the seat catapult and a 2-second delay seat-separation and belt-opening initiator.

WARNING

> There is no safety interlock to prevent actuating the secondary seat ejection system with the canopy in place.

Foot Spurs

Foot spurs (attached to the pilot's shoes) are attached to each ejection seat by cables. Normal foot movement is in no way restricted since the cables, under a slight spring tension, reel in and out freely. When the ejection ring is pulled, the knee guards rotate from the stowed position, the cables to the foot spurs are reeled in, and the pilot's feet are retracted into the foot rests as part of the ejection sequence. The foot cables are subsequently automatically severed by a set of cutters during the ejection sequence.

Manual Cable Cutter Rings

Each ejection seat incorporates an emergency means for cutting the foot retractor cables. A D-ring, located to the right of the seat headrest will actuate the cable cutters initiator if the automatic cable cutter systems fail or rapid abandonment of the aircraft is required on the ground.

PILOT-SEAT SEPARATION SYSTEM

Each ejection seat is provided with a pilot-seat separation which operates in conjunction with the automatic seat belt release system. A windup reel is mounted behind the headrest, and a single nylon web is routed from the reel halfway down the forward face of the seat back. From this point two separate nylon straps continue down, pass under the survival kit, and are secured to the forward seat bucket lip. After ejection, as the seat belt is released an initiator actuates the windup reel which winds the webbing onto a cross-shaft, pulls the webbing taut, causes the pilot to be separated from the seat with a slingshot action.

AUTOMATIC SEAT BELTS

Each ejection seat is equipped with an automatic-opening seat belt which facilitates pilot separation from the seat following ejection. Belt opening is accomplished automatically as part of the normal ejection sequence and requires no additional effort on the part of the pilot.

SEAT BELT-PARACHUTE ATTACHMENTS

If the pilot is wearing an automatic-opening aneroid type parachute, the parachute lanyard anchor from the parachute aneroid must be attached to the swivel link. As the pilot separates from the seat, the lanyard, which is anchored to the belt, serves as a static line to arm the parachute aneroid. The parachute aneroid preset altitude is approximately 15,000 feet.

EJECTION SEQUENCE

Pulling the D-ring is the only action required to initiate pilot ejection and results in firing both the canopy jettison and ejection seat systems.

Note

> The ejection seat cannot fire until the canopy jettison system has fired. This design safety feature is necessary to prevent pilot ejection through the metal canopy.

All ejection actions occur automatically and in a specific sequence. The D-ring cable fires the ejection sequence initiator, actuating the canopy jettison system and the leg-guard thruster. The leg-guard thruster rotates the leg guards, retracts the pilot's feet, activates the 2-seond delay cable cutter backup initiator, and locks the shoulder harness. Movement of the canopy jettison thruster (final step in canopy jettison sequence) actuates an initiator which fires a 0.3-second delay seat catapult initiator and arms the speed sensor. (The 0.3-second delay ensures that the canopy has separated completely prior to seat ejection.) Gas pressure from the catapult initiator fires the seat rocket-catapult, the 4-second seat separation delay initiator, and enters the speed sensor.

Note

> If airspeed is less than 265 KIAS, the gas pressure passes through the speed sensor and fires the 0.6-second delay seat separation initiator. If airspeed is more than 300 KIAS, the pressure is blocked by the speed sensor. Between 265 to 300 KIAS, seat separation time will be 0.6 or 4 seconds, depending on the tolerance of the speed sensing unit.

Initial seat movement upward on the rails disconnects normal oxygen, ventilated suit, and electrical lines, and activates the emergency oxygen supply. Either the 0.6-second delay initiator or the 4-second delay initiator actuates the cable cutters, opens the seat belt, and fires the seat separation system.

Note

> The 2-second delay cable cutter backup initiator will actuate the foot cable cutters and cut the cables if they were not cut as a result of the 0.6-second delay initiator firing. The firing of the 4-second delay initiator will again actuate the foot cable cutters, cutting the cables if they were not cut as a result of the 0.6-second initiator or 2-second backup initiator firing.

A static line, attached to the seat belt, is pulled as the pilot separates from the seat and activates the automatic parachute sequence.

EGRESS COORDINATION SYSTEM

An egress coordination system is installed in the aircraft to supplement normal interphone communication. With this system the aircraft commander always has the capability to issue and check compliance with a bailout signal, regardless of which cockpit he may be occupying. Power for the system is furnished by the essential dc bus. See Emergency Escape, Section III for additional information.

Egress Lights and Switches

The forward cockpit lower right instrument panel contains a guarded toggle switch, labeled BAILOUT (up), and two lights which read BAILOUT (red) and AFT SEAT EJECTED (amber) when illuminated. The aft cockpit lower instrument panel contains a guarded switch, labeled BAILOUT (up) and a light which reads BAILOUT (red) when illuminated. Actuation of a BAILOUT switch illuminates the BAILOUT light in the opposite cockpit. The AFT SEAT EJECTED light is wired directly to a switch on the aft cockpit ejection seat tracks and will illuminate whenever the aft seat is ejected.

SECTION II

NORMAL PROCEDURES

TABLE OF CONTENTS

PREPARATION FOR FLIGHT

FLIGHT RESTRICTIONS

Refer to Section V for Operating Restrictions and Limitations.

FLIGHT PLANNING

Refer to the Appendix.

TAKEOFF AND LANDING DATA CARDS

Refer to Appendix for information necessary to fill out Takeoff and Landing Data Cards before each flight.

WEIGHT AND BALANCE

Refer to Section V for Weight and Balance limitations. For detailed loading information, refer to Handbook of Weight and Balance Data. Before each flight, check takeoff and anticipated landing gross weights, and Weight and Balance Clearance, Form 365F.

AIRCRAFT STATUS

Refer to Form 781 for engineering, servicing, and equipment status.

EXTERIOR INSPECTION

It is not practical for the pilot to perform an exterior inspection while wearing a pressure suit; therefore, the exterior inspection should be accomplished by other qualified personnel.

PREFLIGHT CHECK

ENTRANCE

Ladder platform stands which overhang the chine are used to gain entrance to the cockpits. The canopies are unlatched externally by rotating each external canopy control clockwise with an L-shaped, 1/2-inch-square bar. The canopies are manually raised to the fully open latched position.

BEFORE ENTERING COCKPIT

The following checks apply to both cockpits:

1. Manual cable cutter ring - Secured.
2. Ejection seat and canopy safety pins installed - Check.

AFT COCKPIT CHECK (Solo Flights Only)

1. Lap belt shoulder harness and all personal leads - Secured.
2. All circuit breakers - In.

LEFT CONSOLE

1. Emergency fuel control switches - NORM.
2. Control transfer panel - Check.
3. UHF command radio - TR + G.
4. Oxygen supply lever - OFF.

INSTRUMENT AND ANNUNCIATOR PANEL

1. Cockpit temperature rheostats - Mid-range.
2. Cockpit temperature switches - AUTO.
3. Aft cockpit air system switch - ON.
4. Forward cockpit air system switch - ON.
5. Landing and taxi lights switch - OFF.
6. Afterburner switches - OFF.
7. Brake switches - NORM.
8. Landing gear switch - OFF.
9. Pressure dump switch - NORM.
10. Drag chute handle - Neutral.
11. Forward bypass control - FWD CKPT.
12. Pitot heat - OFF.
13. Trim Power - ON.
14. Hydraulic reserve oil - OFF.
15. BUPD switch - OFF (guard down).
16. Pitch logic override switch - OFF (guard down).
17. Yaw logic override switch - OFF (guard down).
18. Gear release handle - Stowed.
19. Air refuel switch - OFF.
20. Fuel dump switch - OFF.
21. Fuel transfer switch - OFF.
22. Emergency fuel shutoff - OFF (guard down).
23. Fuel quantity selector switch - TOTAL.
24. Inverter switches - OFF.
25. Generator switches - Neutral.
26. Battery switch - OFF.

RIGHT CONSOLE

1. Canopy seal pressure - ON.
2. SAS switches - All NORM.
3. SAS override control transfer switch - FWD.
4. TACAN - ON and tuned.
5. ADF - As desired.
6. Faceplate heat switch - OFF.
7. Floodlight rheostat - OFF.
8. Instrument and Panel lights - OFF.
9. Defog switch - OFF.
10. Beacon lights switch - OFF.
11. Flight recorder - OFF.

INTERIOR CHECK (Dual Flights)

For dual flights all items marked with an asterisk must also be checked in the aft cockpit.

*1. Throttles - OFF.

*2. Landing gear lever - DOWN.

*3. All circuit breakers - In.

*4. Foot retractors - Attach.

CAUTION

Foot spurs must be attached or removed while the cables are fully retracted to prevent damage to the cables.

*5. Accomplish personal equipment hook-up. See Figure 2-1.

*6. Battery switch - Check.

a. Forward cockpit - EXT PWR.

b. Aft cockpit - OFF.

LEFT CONSOLE

*1. Emergency fuel control switches - NORM.

2. IFF/SIF switches - STDBY (Proper Mode and Code).

*3. Control transfer panel - As desired.

4. Suit ventilation boost valve lever - Set at 2/3 of lever travel from NORM to EMER.

*5. UHF command radio - T/R + G.

6. Radar beacon switch - ON.

*7. No. 1 and No. 2 oxygen systems - ON (when using pressure suit). Check system pressures.

8. Throttle friction lever - As desired.

*9. Aft bypass switch - CLOSED (Inop).

INSTRUMENT AND ANNUNCIATOR PANEL

*1. Cockpit temperature rheostat - As desired.

*2. Cockpit temperature indicator switch - Check

a. Forward cockpit - FWD CKPT.

b. Aft cockpit - AFT CKPT.

*3. Cockpit temperature switch - AUTO.

*4. Aft cockpit air system switch - ON.

*5. Forward cockpit air system switch - ON.

6. Periscope MIRROR SELECT handle - Fully forward (projector).

*7. Landing and taxi lights switch - OFF.

*8. Afterburner switches - OFF.

*9. Landing gear lights - Check green.

*10. Brake switch - Set.

a. Forward cockpit - ANTI SKID

b. Aft cockpit - NORM.

*11. Oxygen quantity indicator - Check.

*12. Cabin altimeter switch - Set.

a. Forward cockpit - FWD.

b. Aft cockpit - AFT.

*13. Pressure dump switch - NORM.

*14. Drag chute handle - Stowed.

*15. CIT gage - Pointers together and indicating ambient temperature.

*16. TDI - Check for proper indication.

*17. Altimeter - Set.

*18. Clocks - Check.

*19. Forward bypass door indicator - Check.

PERSONAL EQUIPMENT HOOKUP (Shirt sleeve flight)

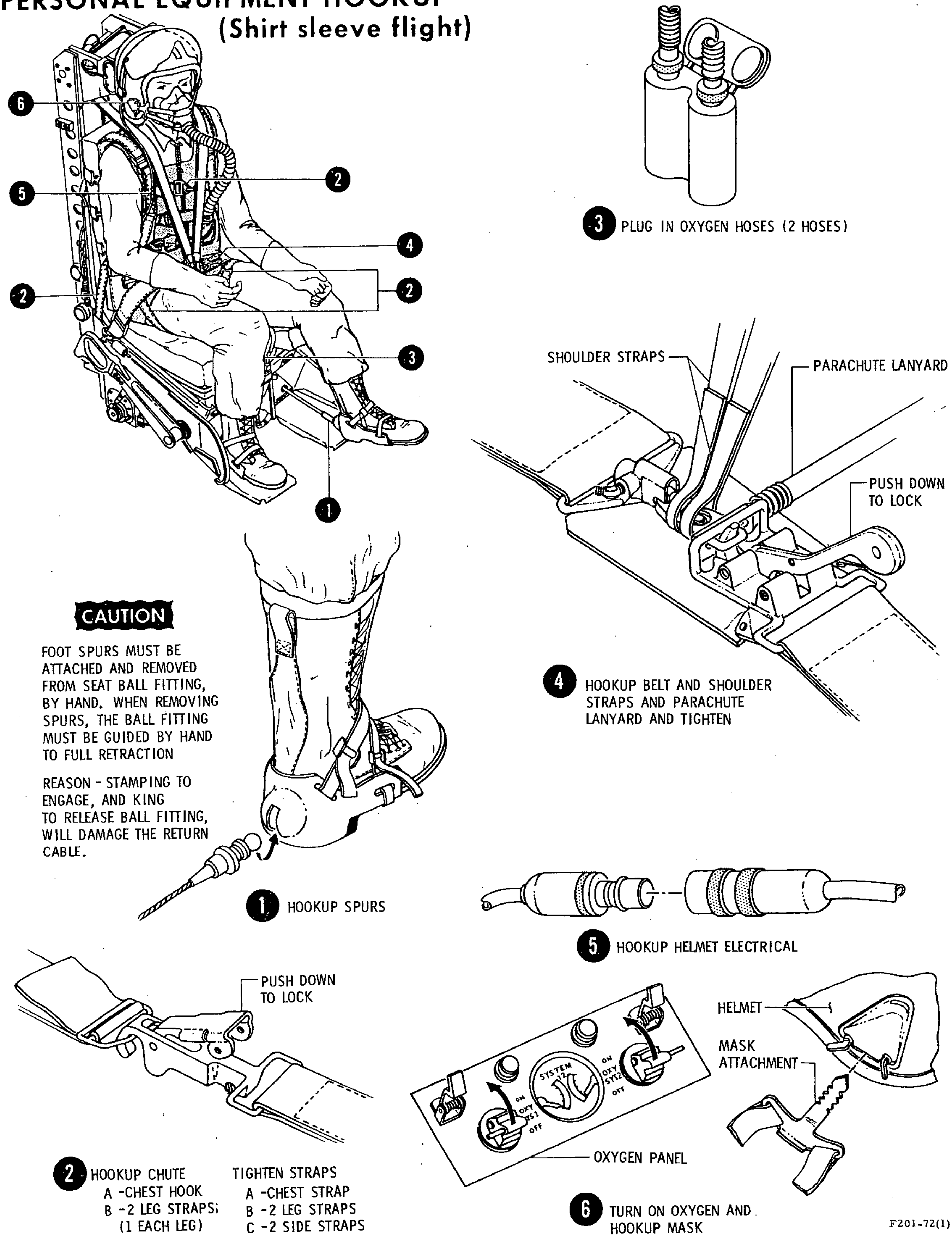
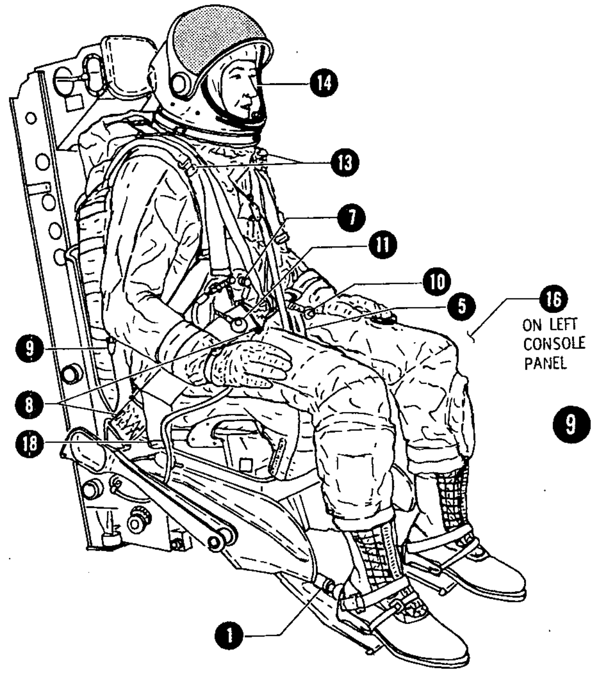
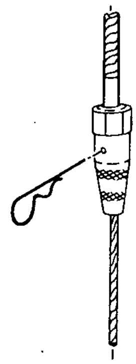


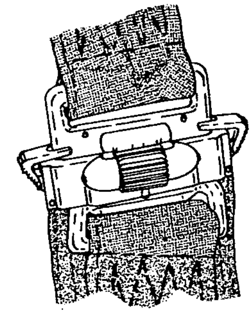
Figure 2-1 (Sheet 1 of 3)

PERSONAL EQUIPMENT HOOKUP





9 CHECK EMERGENCY OXYGEN CABLE AND REMOVE SAFETY PIN

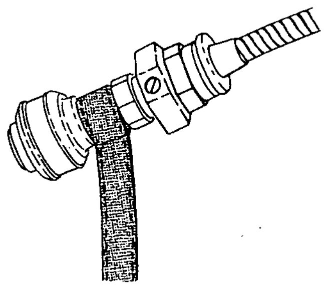


13 CHECK (TWO) PARACHUTE CANOPY ROCKET JET RELEASES. INSURE ROLL BAR PIN IS IN DOWN (LOCKED) POSITION. PULL ON EACH RELEASE TO INSURE LOCK POSITION

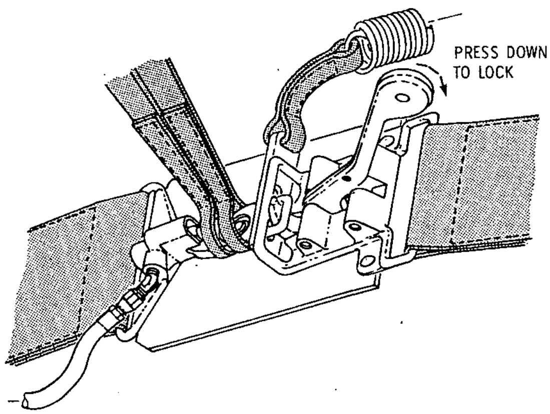
14 CHECK FACE HEAT, PLACE BACK OF HAND ON VISOR

15 CONNECT HEAT PROBE (IF APPLICABLE)

16 PRESS TO TEST BOTH SUIT EMERGENCY PRESSURIZATION SYSTEMS, (SEE ILLUSTRATION NO. 7) ONE AT A TIME. CHECK PRESSURE, APPROXIMATELY 75 PSI AND FLUCTUATING



10 CHECK PARACHUTE ARMING (RED KNOB) KNOB IS SECURED INTO DETENT

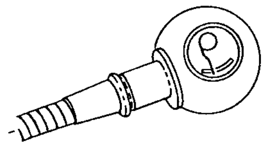


17 CHECK ACCESSIBILITY OF SUIT FLOATATION KNOB PULL TAB

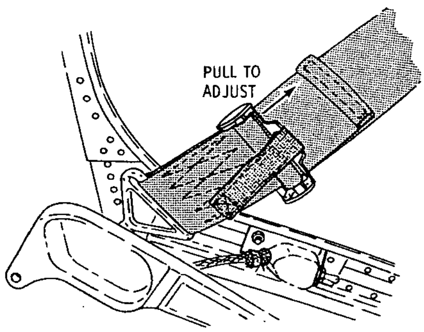
18 READJUST LAP BELT

19 CHECK OXYGEN QUANTITY, BOTH SYSTEMS

20 CHECK FOOT REST GUARDS

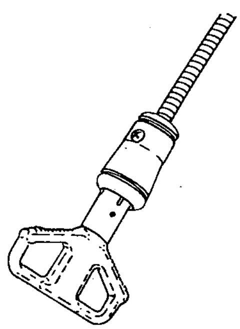


11 CHECK ACCESSIBILITY OF EMERGENCY OXYGEN ACTUATOR (GREEN APPLE) 1800 PSI MINIMUM BOTH SYSTEMS. INSURE GREEN APPLE IS SNAPPED SECURE INTO DETENT

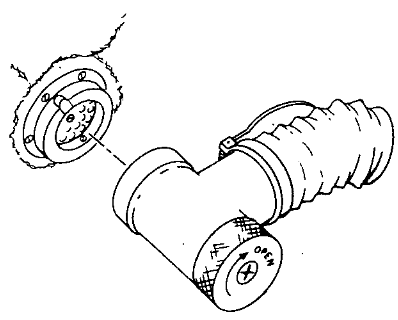


8 LAP BELT

SECURE SHOULDER HARNESS STRAPS AND PARACHUTE TIMER ARMING KEY. LOCK BELT AND ADJUST



12 CHECK PARACHUTE MANUAL "T" HANDLE. INSURE HANDLE IS SNAPPED SECURE INTO HOUSING



21 CONNECT VENT HOSE

NOTE

THIS WILL BE ACCOMPLISHED AFTER ENGINES ARE RUNNING UNLESS EXTERNAL AIR CONDITION VENTILATION UNIT IS HOOKED TO AIRCRAFT VENT SYSTEM. PULL DOWN ON VENT HOSE CONNECTION TO INSURE LOCK POSITION

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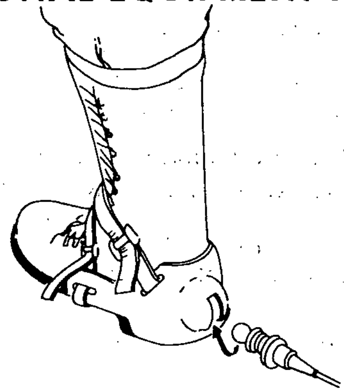
Figure 2-1 (Sheet 2 of 3)

PERSONAL EQUIPMENT HOOKUP

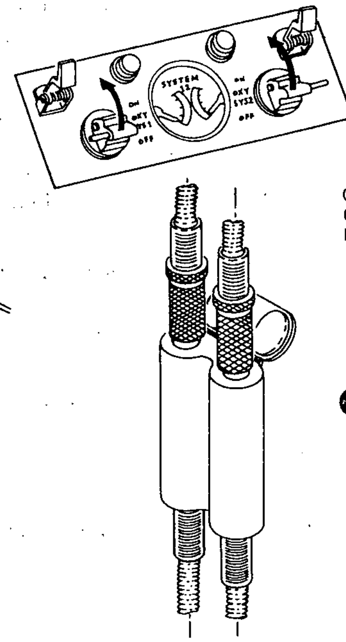


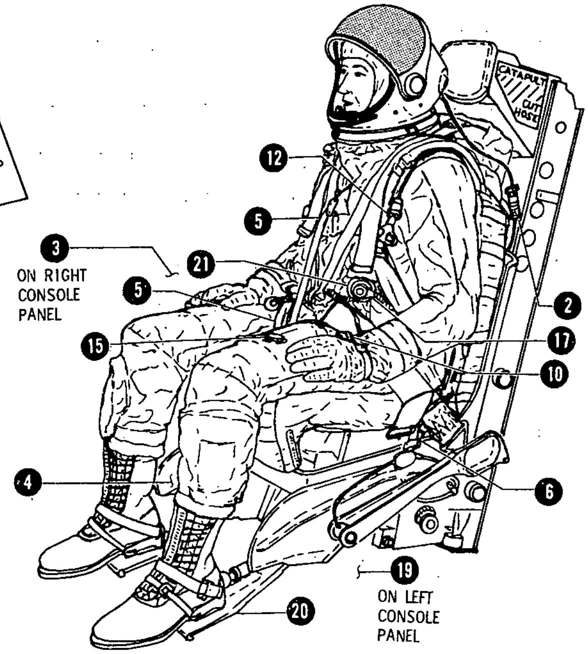
1 HOOK UP SPURS

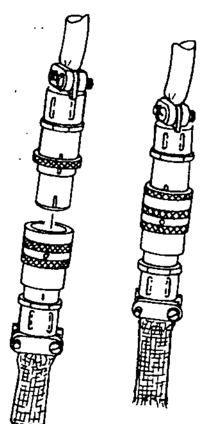
FOOT SPURS WILL BE ATTACHED AND REMOVED BY PILOT FROM A STANDING POSITION UPON ENTERING AND LEAVING COCKPIT

CAUTION

PERSONAL EQUIPMENT TECHNICIAN WILL ASSIST IN ATTACHING SPURS AND BALL FITTING BY HAND IF REQUESTED



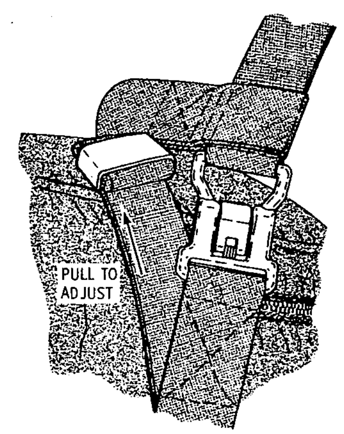




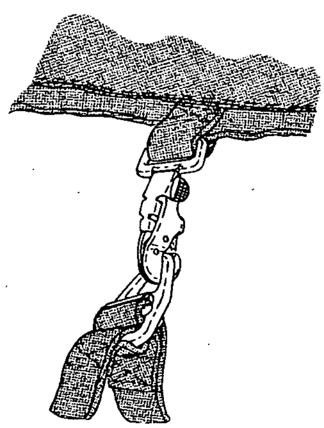
2 COMMUNICATIONS (FACE HEAT AND RADIO) CONNECT HELMET CHORD TO PARACHUTE EXTENSION CHORD

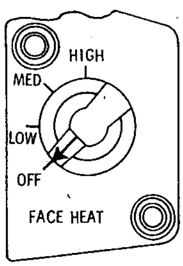
4 SECURE OXYGEN PERSONAL LEAD HOSES IN QUICK DISCONNECT (INSIDE FRONT OF SEAT BUCKET)

- a INSTALL NO. 2 HOSE CONNECTION AND TURN PRESSURE ON
- b INSTALL NO. 1 HOSE CONNECTION AND TURN PRESSURE ON
- c CHECK PRESSURE 75 PSI



6 ADJUST KIT SEAT STRAPS; RIGHT AND LEFT SIDE

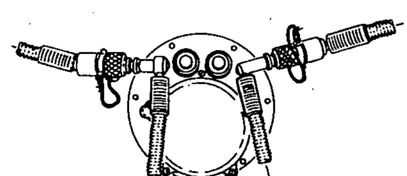




3 TURN FACE HEAT ON LOW (CONTROL ON RIGHT HAND CONSOLE)

5 CONNECT PARACHUTE HARNESS, THREE PLACES

- a CHEST STRAP (UNDER HELMET HOLD DOWN LANYARD)
- b RIGHT LEG STRAP (OVER PERSONAL OXYGEN LEAD HOSES)
- c LEFT LEG STRAP



7 CONNECT EMERGENCY OXYGEN HOSES, SLIDE KNURLED FITTING INTO PLACE, INSERT SAFETY CLIP, PULL ON HOSE SLIGHTY TO ASSURE OF LOCKED POSITION

NOTE

LEFT HOSE OVER HELMET HOLD DOWN STRAP

F201-72(3)

Figure 2-1 (Sheet 3 of 3)

*20. Spike Controls - AUTO (Inopv.)

*21. Forward bypass controls - Check.

a. Forward cockpit - CLOSED.

b. Aft cockpit - FWD CKPT.

*22. Display MODE SELECT switch - As desired.

*23. BEARING SELECT switch - TACAN.

*24. ATT/AP Select switch - As desired.

*25. Surface limiter handle - Pull out.

*26. Pitot heat switch - OFF.

*27. Trim power switch - ON.

*28. Hydraulic reserve oil switch - OFF.

*29. BUPD switch - OFF (guard down).

*30. Pitch logic override switch - OFF (guard down).

*31. Yaw logic override switch - OFF (guard down).

*32. Gear release handle - Stowed.

*33. Air refuel switch - OFF.

*34. Fuel dump switch - OFF (guard down).

*35. Fuel transfer switch - OFF (guard down).

*36. Emergency fuel shutoff switches - Fuel On (guard down).

37. Nitrogen indicator - Check.

RIGHT CONSOLE

1. Pitot-static source lever - NORMAL.

*2. Canopy seal pressure lever - OFF.

*3. SAS switches - Check

a. Forward cockpit channel engage switches - ALL OFF.

b. Aft cockpit channel engage switches - ALL NORM.

c. Aft cockpit SAS override panel transfer switch - FWD.

4. Autopilot switches - OFF.

5. INS panel - As required.

*6. Defog switch - OFF.

*7. Faceplate heat - As desired.

*8. TACAN - ON and tuned.

*9. FRS TAKE CMD button - As required.

*10. FRS function selector switch - MAG.

*11. Floodlight switch - As desired.

*12. Instrument and panel lights - As desired.

*13. Beacon lights switch - OFF.

*14. Flight recorder switch - OFF.

ELECTRICAL FUNCTION CHECK

1. Inverter switches - Check.

a. No. 1 and No. 3 switches - NORM.

b. No. 2 switch - ON.

*2. IND & LT TEST switch - Press.

a. N_2 quantity indicators should decrease to zero. Nitrogen quantity warning lights on annuciator panel should come on at 1-liter point.

b. Fuel tank boost pump lights should illuminate.

c. All warning and FIRE lights should illuminate.

d. Landing gear unsafe warning should be heard.

3. Crossfeed and manual boost pump switches - Press (check lights ON).

4. Pump release switch - PUMP REL, then release.

5. Tank boost pumps - Check 1, 2, and 6 tank lights ON (automatic sequencing).

6. Crossfeed switch - Press (check light OFF).

7. Fuel quantity indicating system - Check.

   a. Individual (1, 2, 3, 4, 5 and 6) tank quantities - Check.

   b. Total fuel quantity - Check.

8. UHF and IFF/SIF - Check.

9. IFF/SIF - As required.

STARTING ENGINES

Either engine may be started first. Normally, the left engine is the first to be started.

CAUTION

. Before starting an engine, verify that wheels are firmly chocked. There is no parking brake and brakes are inoperable until hydraulic pressure is available.

. Determine that intake and exhaust areas are clear of personnel and ground equipment. Ground personnel using interphone equipment will be in position to observe exhaust nozzle and nacelle inspection panels during start.

Do not move either control stick until at least 1500 psi hydraulic pressure can be maintained on the A or B system gages; otherwise, a control system inspection will be necessary.

[1.] Check with INS crew prior to starting engines.

2. Fuel low pressure lights - OFF.

3. Ground air supply - Request ON.

4. Engine start switch - GND at 15 percent rpm.

5. Throttle - IDLE above 16 percent rpm.

6. Fuel flow - Check.

7. Engine start switch - Release when EGT rises.

8. EGT - Check (400°C maximum).

9. Ground air - Request OFF at 40 percent rpm.

10. Idle rpm - Adjust to 60-64 percent rpm.

11. Engine and hydraulic pressure instruments - Check normal.

   a. Fuel flow - Check.

   b. EGT - Check.

   c. Oil pressure indicator - Check.

CAUTION

Discontinue start if oil pressure rise is not observed within 60 seconds from start of rotation.

   d. Hydraulic system pressures - Check.

12. Other engine - START, using same procedure.

[ ] INS mission only.

CAUTION

- If throttle is inadvertently retarded to OFF during the start do not advance in an attempt to restart engine. In case of false start use Clearing Engine procedure, this section. Afterburner duct must be visually checked and unburned fuel removed prior to attempting another start.
- Never apply ground air supply to engine starter when engine rpm exceeds 40 percent rpm.

CLEARING ENGINE

When a false start occurs, trapped fuel and fuel vapor may be removed from engine by using following procedure:

1. Throttle - OFF.
2. Start switch - OFF (release).
3. Continue cranking engine or request ground crew to apply starter air supply at 40 percent rpm or below.
4. Ground air - Signal OFF after 15 seconds.

CAUTION

Never reapply air to starter when engine rpm exceeds 40 percent rpm.

BEFORE TAXIING

1. Emergency fuel system - Check.
   a. Throttle - IDLE.
   b. Emergency fuel control switch - EMER.
   c. Tachometer - Check for stable engine operation. RPM may increase, decrease, or show no change.
   d. Emergency fuel control switch - NORMAL.
2. Generator switches - RESET above 60 percent rpm after check with INS crew.
3. Battery switch - BAT (within 3 seconds).
4. Generator-out lights - Check out.

Note

If the generator-out warning lights fail to extinguish, return the battery switch to the EXT PWR position and repeat steps 2 and 3.

[5.] INS DEST/FIX switch - VARIABLE DEST.

[6.] INS MODE switch - NAV. (Check with INS crew prior to actuating switch.) Depress STORE pushbutton and check HSI heading marker for 10-deg right and DTG for 122 nmi.

[7.] INS indications - Report destination coordinates, distance-to-go, and ground speed when slewing is completed.

[8.] INS DEST/FIX switch - VARIABLE FIX and STORE. Check INS FIX REJECT light on.

[9.] INS DEST/FIX switch - VARIABLE DEST and STORE. Check INS FIX REJECT light off.

[10.] INS umbilical cord - Disconnected (confirmed by INS crew).

11. External power - Signal for disconnect.

12. Inlet air forward bypass - Ground crew confirm open.

13. SAS engage switches - ALL ON.

14. SAS recycle lights - Press (lights should go out).

15. SAS light test switch - Press. (All lights should illuminate.)

16. Autopilot pitch and roll engage switches - ON.

17. Autopilot disengage switch (control stick) - Press. Check that autopilot disengages.

18. SAS engage switches - OFF. Pitch and yaw A and B lights illuminate, both MON lights must stay out.

19. Surface trim - Check operation and set to zero. Confirm that direction of movement corresponds with indication.

20. Control system - Check for correct direction of movement. Individually check each axis in both directions and request ground personnel to verify proper deflection of control surfaces.

21. Seat and canopy safety pins - Removed and stowed.

*22. Canopy - Close and lock.

*23. Canopy seal pressure lever - ON.

CAUTION

The canopy should be opened or closed only when the aircraft is completely stopped. Maximum taxi speed with canopy open is approximately 40 knots. Gusts or severe wind conditions should be considered as a portion of the 40-knot limit taxi speed.

24. Rear view periscope - Check.

25. Taxi clearance - Obtain from control tower.

26. Chocks and downlock pins - Signal for removal. Observe crewchief for clearance to taxi.

27. Nosewheel steering - Engage. Check operation of nosewheel steering.

TAXIING

1. Brakes - Check.

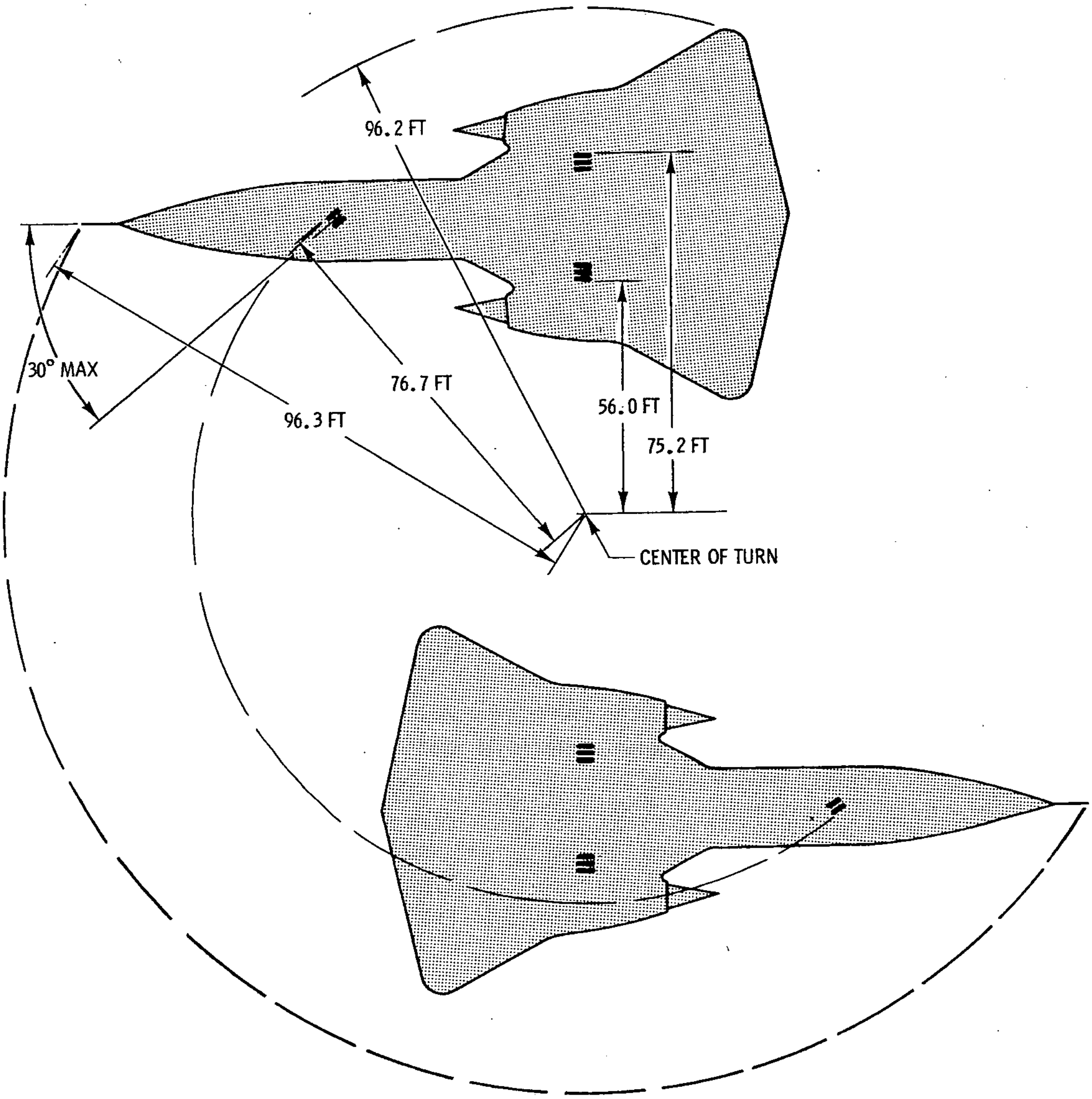
WARNING

Do not select alternate brakes with both L and R hydraulic systems operative.

*2. Flight instruments - Check. (Check turn-and-slip indicator for turn needle deflection in the direction of turn while taxiing and ball free in race).

*3. Navigation equipment - Check operation. Check ADF, TACAN and INS.

TURNING DIAGRAM



NOTE: 151.9 FT MINIMUM RUNWAY WIDTH REQUIRED FOR 180-DEGREE TURN (MAIN GEAR WHEELS ON EDGE OF RUNWAY AT START OF TURN).

F201-61(a)

Figure 2-2

CAUTION

All taxiing and turns should be accomplished at slow speeds to limit side loads on the landing gear. Fast taxiing should also be avoided to prevent excessive brake and tire heating and wear.

BEFORE TAKEOFF

1. Engine instruments - Check at Military thrust (run up one engine at a time).
2. SAS channel engage switches - All ON.
3. SAS recycle lights - Press, if necessary (lights should go out).
4. Surface trim indicators - Check for zero setting.
5. Tanks 1, 2, and 6 - Check ON.
6. INS - Check and fix as required. At designated runway position, select correct STORED FIX position and fix. Check INS FIX REJECT light off. Reset DEST/FIX briefed initial destination position, and store. Check distance to go after slewing completed, then reset DEST/FIX to STORED AUTO if desired.

*7. Compasses - Check and synchronize FRS and check INS if applicable and return display mode select switch to desired position. Check standby compass against runway heading.

8. Pitot heat - ON.

*9. All warning lights - OUT.

*10. Shoulder harness - LOCK.

11. Beacon light switch - ON (if required).
12. Flight controls - Cycle and check hydraulic pressure.
13. Suit ventilation boost valve lever - NORMAL just before taking runway and applying power.

TAKEOFF

1. Brakes - HOLD.
2. Elapsed time clock - Start.
3. Nosewheel steering - Engaged.
4. Throttles - Advance.
5. Brakes - Release at 80 percent rpm.

CAUTION

The tires may skid if the brakes are held at high thrust.

6. Engine instruments - Check at Military thrust.
7. Afterburner switches - ON (simultaneously). Afterburners should light within 5 seconds, indicated by a noticeable increase in thrust. Faulty afterburner operation can be detected by EGT and fuel-flow indications.

WARNING

Monitor nosewheel steering because the afterburners may not light simultaneously.

TAKEOFF

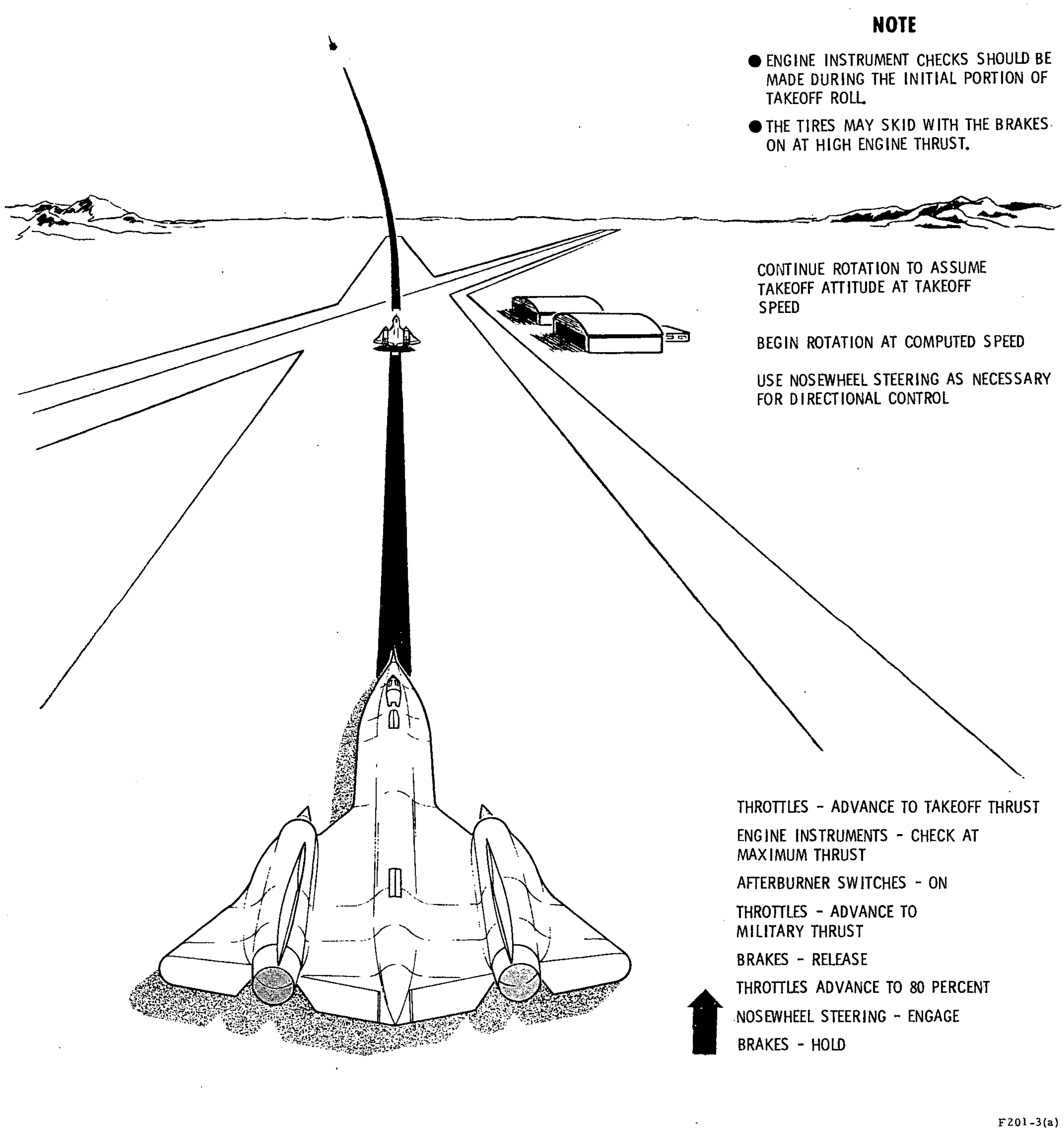


Figure 2-3

8. Engine instruments - Recheck at Maximum thrust.

Note

Exact readouts on these instruments is time consuming. The readout should be anticipated and needle position checked against a clock position. If there is any indication of improper engine performance during power advancement, the takeoff should be aborted. Monitor ground run distance and airspeed during the takeoff roll. If possible, any abort decision should be made before the aircraft has reached high groundspeed. Refer to performance data, Appendix I, for takeoff information. Directional control can be maintained with nosewheel steering up to nosewheel liftoff speed.

9. Acceleration - Check. Check indicated airspeed against computed acceleration check speed at selected acceleration check distance. Refer to performance data, Appendix I, for takeoff information.

10. Rotation - Begin at computed airspeed approximately three seconds before reaching takeoff speed. Apply smooth, constant back pressure so that required control deflection and rotation to takeoff attitude occurs at takeoff speed. Refer to Appendix I for rotation and takeoff speeds.

Note

Use indicated airspeed during takeoff and climb until proper climb schedule speed is indicated on the triple display indicator.

CROSSWIND TAKEOFF

During crosswind takeoffs the aircraft tends to weather vane into the wind. This will be noted when the nosewheel lifts off and nosewheel steering is no longer available. Rudder pressure must be held to counteract the cross wind effect. A definite correction must be made as the aircraft breaks ground. Apply lateral control as necessary for wings-level flight. Both the directional and lateral control applications are normal and no problems should be encountered when taking off during reasonable crosswind conditions.

ROTATION TECHNIQUE

During takeoff, the maximum load on the main wheel tires occurs during rotation to takeoff attitude.

CAUTION

Avoid abrupt rotation since this can impose an excessive load on the tires and cause blowouts.

In general, the tires are more critical during takeoff than landing because of the higher groundspeeds and gross weights involved. Wing lift quickly relieves the gear load as the nose is raised. Start rotation at computed rotation speed, approximately 3 seconds before reaching the scheduled takeoff airspeed. Premature nosewheel lift-off should be avoided because the unnecessary drag will extend the ground run. Delayed rotation also extends the ground run and can result in excessive tire speeds.

AFTER-TAKEOFF CLIMB

When definitely airborne:

1. Landing gear lever - UP. Accelerate to correct climb speed.

Note

The landing gear will retract in approximately 12 seconds. Observe landing gear limit speed while gear is extended.

WARNING

Single engine operation is critical immediately after takeoff. Increasing airspeed and decreasing angle of attack has greater benefits than gaining altitude at a maximum rate.

2. Engine instruments - Check.
3. Surface limiter handle - Push in at Mach 0.5.

*4. Altimeters - Set to 29.92 in. Hg prior to reaching FL 180.

5. IFF/SIF - As briefed.

CLIMB

The aircraft accelerates rapidly to climb speed. A definite rotation and pitch change is required to establish the climb. With maximum afterburning, the climb angle is about 20 degrees at low altitude. Begin the rotation sufficiently in advance of reaching climb speed to avoid exceeding the recommended airspeed schedule. The recommended climb speed schedule with afterburning is 350 KEAS to approximately 26,000 feet and a constant Mach 0.9 above 26,000 feet. The recommended Military (non-afterburning) climb speed is a constant 300 KEAS. Refer to Appendix I for climb performance.

CRUISE

Observe limitations of Section V.

Center-of-gravity control is important for optimum cruise performance. Fuel load distribution and the automatic tank sequencing provide a forward center-of-gravity for takeoff and climb. During cruise, the automatic sequencing provides an aft center of gravity to minimize elevon deflection and resulting trim drag. Supplemental manual control of fuel usage is also possible, but should only be used if automatic fuel tank sequencing malfunctions.

SUPERSONIC ACCELERATION

Maximum afterburning is required for all supersonic accelerations. Variations in outside air temperature have a pronounced effect on supersonic acceleration capabilities. Advantage of cold temperatures should be taken to obtain the best acceleration. One of three procedures is recommended, depending on temperature.

Climbing Acceleration

A 400-KEAS climbing acceleration is not recommended if the temperature is warmer than 5^{o} above standard at altitudes above 20,000 feet. When this procedure is used, accelerate to 370 KEAS and rotate to climb attitude. Rotation should not be delayed because it is possible to inadvertently accelerate to 425 KEAS or faster. Establish 400 KEAS and climb at this speed. Mach number will increase with altitude. The rate of climb and acceleration will be slow between 25,000 and 30,000 feet; approximately Mach 1.0 to 1.1.

Note

The bypasses should be opened manually at Mach 1.35. If the doors are not opened, duct "buzz" will occur at approximately Mach 1.4.

Diving Acceleration

A diving acceleration from 40,000 feet is recommended when the temperature is warmer than standard at low altitudes and cold above 35,000 to 40,000 feet. Starting from approximately Mach 1.0 and 40,000 feet, make a shallow dive to Mach 1.2 at 35,000 feet. The acceleration will be slow between Mach 1.1 and 1.2. Pull out and start climbing from approximately 35,000 feet at a constant 400 knots EAS.

Note

Do not make an abrupt pull-out because this will increase load factor and bleed off Mach number.

Manually open the bypass doors at Mach 1.35.

Level Acceleration

Level accelerations can be made at 40,000 feet if desired. Accelerate at constant altitude to 400 knots EAS and then climb at this speed. The acceleration will be noticeably slower in the range from Mach 1.1 to 1.2. Manually open the bypass doors at Mach 1.35.

DESCENT

Descent performance charts are shown in Appendix I. The descent fuel consumption should be minimized to obtain maximum flight duration with the J-75 engines.

The inlet air bypass doors can be opened to act as thrust spoilers and increase the rate of descent.

1. Defog switch - As desired.

2. Landing gear - As desired below speed limit.

Note

The landing gear may be lowered to increase the rate of descent.

3. IFF/SIF - As briefed.

4. Altimeter - Set to station pressure when passing through flight level 180.

Note

Use pitot-static instruments for airspeed and altitude data during all operations below flight level 180 except in climbs.

5. Bypass doors - OPEN (if desired).

AIR REFUELING PROCEDURES

Either of two methods of handling power during refueling may be used. Whenever the initial fuel quantity remaining is over approximately 15,000 pounds it is possible to use minimum afterburning on one engine and less than Military thrust on the other. This allows refueling to be accomplished at a constant altitude of approximately 32,000 feet, using the non-afterburning engine for thrust control. Normally or when at light weight, the initial contact should be made using non-afterburning power settings. One afterburner should then be lighted after temporarily disconnecting when the aircraft becomes power limited at Military thrust. The conventional procedure of completing refueling without use of an afterburner can also be used; however, a toboggan to approximately 25,000 feet will be necessary as the tanks are filled.

Prior to air refueling, stabilize and trim at refueling speed for contact. Observe the tanker for director light signals and maneuver as directed by the lights. A successful connection is confirmed by a mild jolt to the aircraft, steady illumination of the director light panel and the extinguishing of the READY light. Slight maneuvering may be necessary at this point to illuminate the azimuth and elevation neutral lights during fuel transfer. Contact can be maintained between the aircraft and tanker during a turn or in a descent. No adverse flight characteristics are present due to tanker downwash. After the disconnect occurs, separation is made down and to the rear of the tanker.

PRIOR TO REFUELING

Accomplish the following prior to refueling:

1. Air refuel switch - READY.

Note

Amplifier requires up to approximately five minutes for warmup.

2. Forward transfer switch - FWD TRANS. (2000 lbs to tank 1).
3. Fuel quantity indicator selector - TOTAL. Monitor total fuel quantity.
4. Seat - Lower.

When in observation position after rendezvous with tanker.

5. READY light - Push on (green) if necessary.
6. Forward transfer switch - OFF.
7. Stabilize in pre-contact position.
8. Beacon light switch - OFF.
9. Observe tanker director lights illuminated and boom in ready for contact position.

NORMAL REFUELING

Normal refueling is accomplished as follows:

1. Establish contact.

After contact is made:

2. READY light - Check out.
3. Total fuel quantity - Monitor.

When refueling is complete:

4. Control stick disconnect - Press.
5. Air refuel switch - OFF. (When probe is clear of receptacle.)
6. Tanks 1, 2, 6 - Check ON.

In case L hydraulic pressure is lost, R pressure may be utilized for refueling by moving the brake switch to ALT STEER & BRAKE position.

CAUTION

Do not leave the brake switch in the ALT STEER & BRAKE position after refueling.

ALTERNATE REFUELING

The boom may be latched in the refueling receptacle manually as an alternate procedure by using the following procedure:

1. Air refuel switch - MANUAL. Check READY light on.
2. Control stick disconnect - Press and hold.

When nozzle has bottomed in the receptacle:

3. Control stick disconnect - Release.

AIR REFUELING BOOM ENVELOPE LIMITS

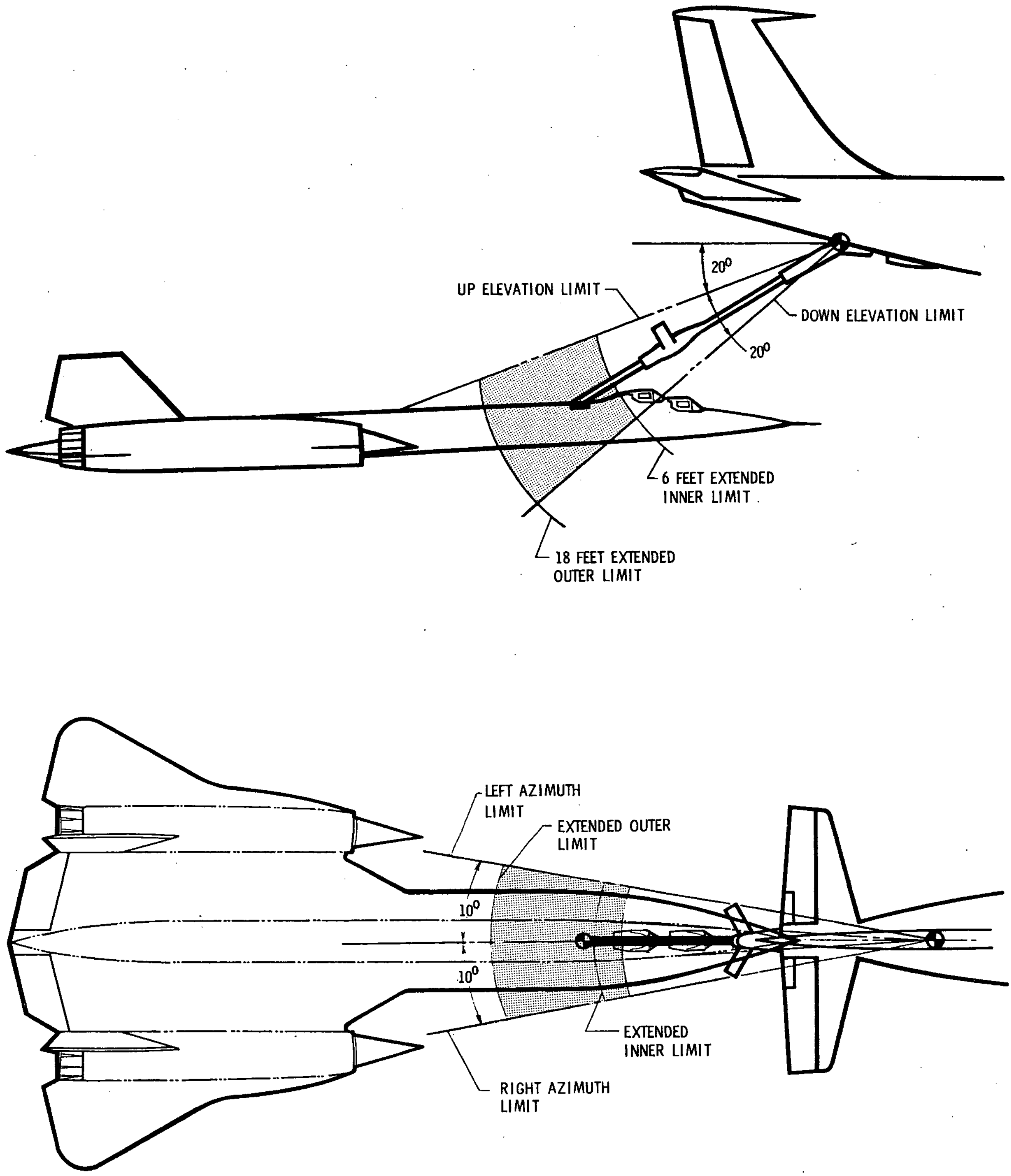


Figure 2-4

AIR REFUELING DIRECTOR LIGHTS

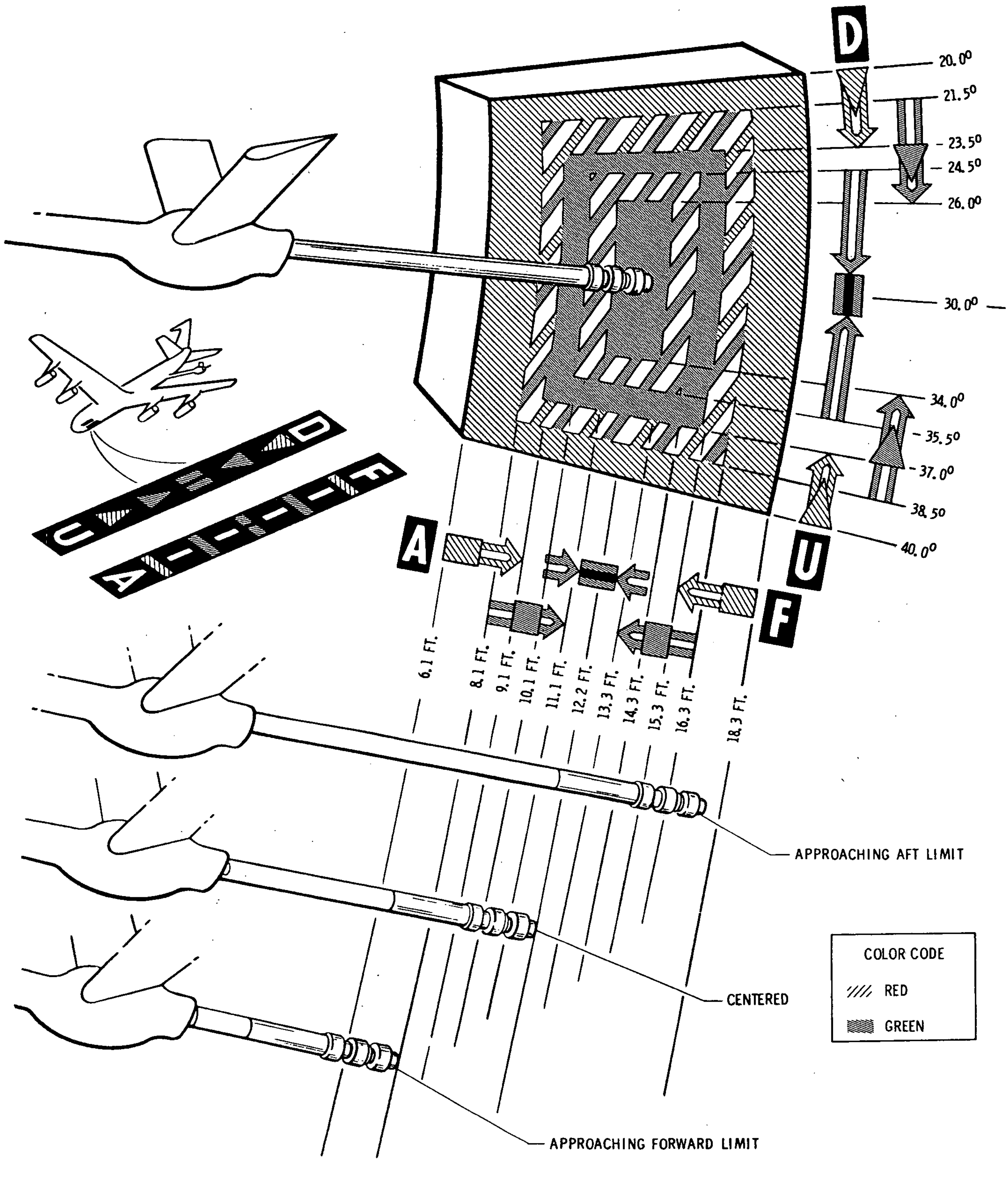


Figure 2-5

CAUTION

If the disconnect trigger is released before the nozzle is in the bottom of the receptacle, it is possible for the nozzle to damage nozzle latches, preventing any further refueling.

4. Fuel quantity - Monitor TOTAL fuel.

When refueling is complete:

5. Control stick disconnect - Press.

CAUTION

The automatic limit disconnect system is inoperative. All disconnects must be initiated by the receiver aircraft, as the tanker operator is unable to release the nozzle latches during manual boom latching.

6. Air refuel switch - OFF. READY light out.

Note

If a malfunction occurs which prevents disconnecting the boom, place the Air Refuel switch in the MANUAL position, depress the IFR DISC trigger. If disconnect is not accomplished, proceed with brute force pullout by retarding throttles.

BEFORE LANDING

1. Fuel transfer switch - FWD TRANS (if required).

Note

When tank 5 or 6 contains fuel, transfer 1000 to 3000 pounds forward to obtain slight nose-up pitch trim.

2. Surface limiter handle - Pull out (released) at Mach 0.5.

3. Periscope MIRROR SELECT handle - Fully forward.

4. Hydraulic pressures - Check.

5. Fuel transfer switch - OFF.

*6. Brake switches - Set.

   a. Forward cockpit - As required.

   b. Aft cockpit - NORM.

*7. Shoulder harness - Manually locked.

*8. Faceplate - Open.

*9. Oxygen - OFF.

10. Traffic pattern entry - 275 to 350 <u>KIAS,</u> 1500 feet above field elevation.

11. Downwind - 250 <u>KIAS,</u> 1500 feet above field elevation.

12. Landing gear lever - DOWN (check gear warning lights).

Note

Normal gear extension time is approximately 16 seconds. Observe gear limit speed with gear extended.

13. Base leg 220 to 230 <u>KIAS,</u> descending.

14. Final approach - Maintain best final approach speed, minimum 165 KIAS.

Note

- 165 KIAS is best final approach speed with 5000 pounds fuel remaining. Increase approach and landing speeds 1 knot for each additional 1000 pounds of fuel above 5000 pounds remaining.
- See Figure 2-3 for a typical landing pattern.

15. Landing and taxi lights switch - As required.

LANDING

NORMAL LANDING

Refer to the Appendix for landing ground roll distances. If airspeed becomes excessively low, a high sink rate will develop, resulting in a hard landing. During the flare, throttles are moved to IDLE and touchdown is made at approximately 10 degree pitch angle (nose approximately on the horizon).

1. Throttles - Retard to IDLE in flare.

CAUTION

Allow throttle to follow quadrant curvature so that the hidden ledge at the IDLE position will prevent inadvertent engine cutoff.

2. Touchdown speed - As required.
3. Hold nosewheel in air.

CAUTION

Fuselage angle must not exceed 14 degrees to avoid scraping the tail.

4. Drag chute handle - Pull out to deploy. Chute deployment requires approximately 3 seconds.
5. Lower nosewheel at 110 KIAS.
6. Engage nosewheel steering for directional control. Steering will not engage until rudder pedals align with nosewheel position (straight ahead) and weight of aircraft is on any one gear.
7. Brakes - Apply after chute deploys. Moderate braking may be used prior to chute deployment.

CAUTION

If the chute does not deploy, observe the brake energy limit speeds in Section V.

8. Drag chute handle - Rotate counterclockwise and push in to jettison chute.

Note

The drag chute should be jettisoned at 55 KIAS unless the crosswind component exceeds 12 knots.

CAUTION

If the chute is not jettisoned, the elevons should not be moved during taxiing as the shroud lines may jam between the inboard elevons and the fuselage and cause structural damage.

AFT COCKPIT LANDING TECHNIQUE

Fly a normal traffic pattern. After rollout onto final approach establish an approach angle sufficiently steep to permit full view of runway threshold.

LANDING PATTERN

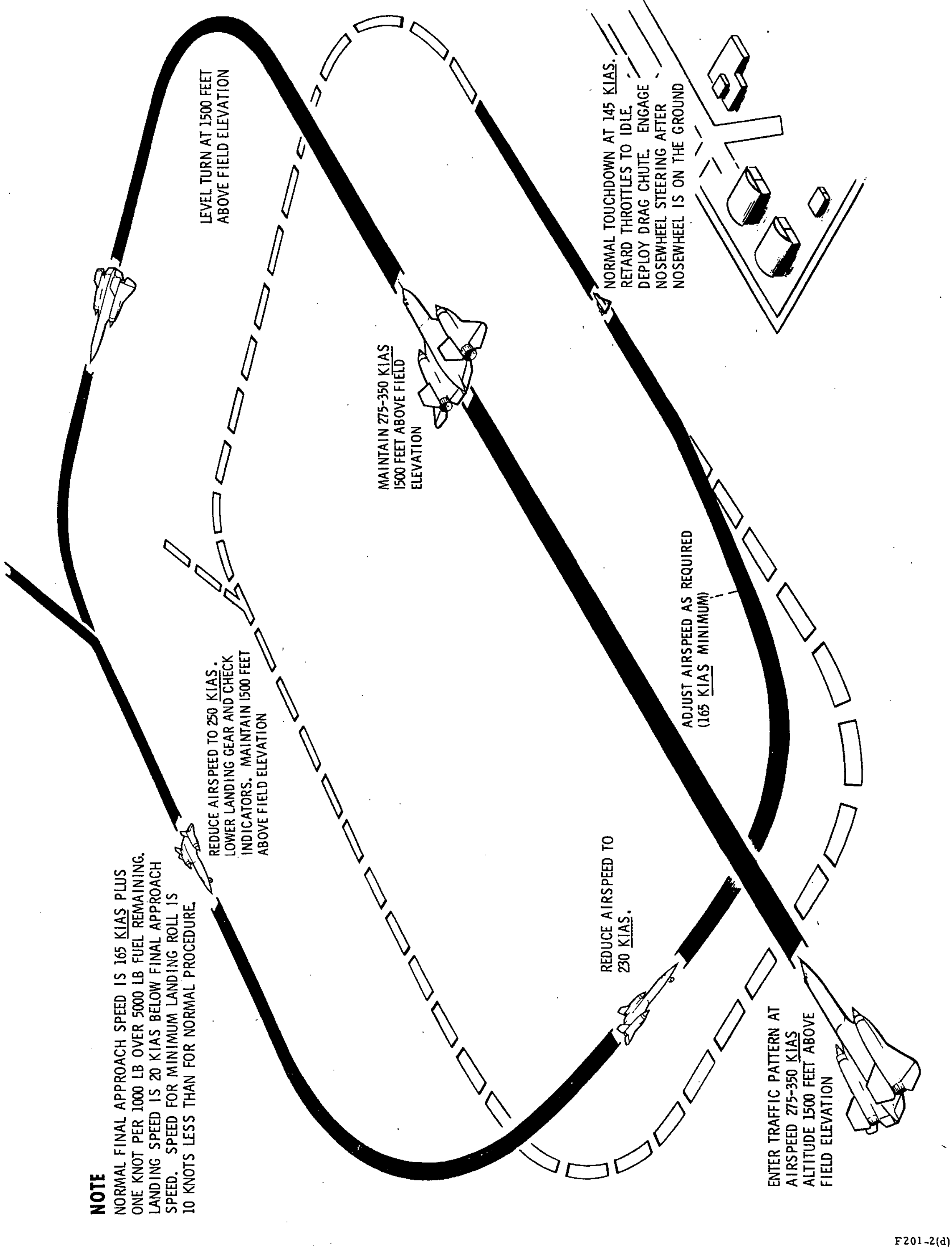


Figure 2-6

CROSSWIND LANDING

The traffic pattern for a crosswind landing should be normal, making proper allowances for velocity and direction of the crosswind. Proper runway alignment on final approach can be maintained by crabbing or dropping one wing; however, a combination of the two is recommended just prior to flare. Remove crab before touchdown, using wing low technique to prevent side drift. Reduce sink rate to a minimum to accomplish smooth touchdown. At increased crosswind components, sink rate must be minimized due to increase of side loads imposed on the landing gear. In severe crosswinds the nose should be lowered and nosewheel steering engaged prior to drag chute deployment.

LANDING ON SLIPPERY RUNWAYS

Wet Runways

Use normal technique. Landing roll will increase due to reduction in available braking force. Braking effectiveness is increased if ANTI-SKID is off.

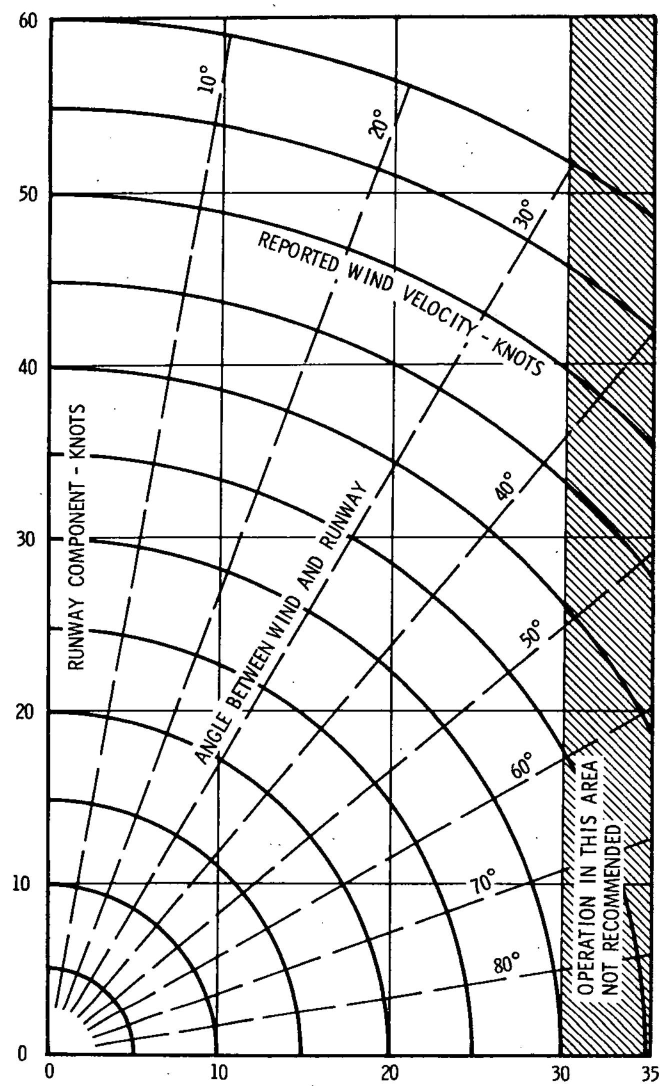
WARNING

Wet runway braking tests have not been completed. Preliminary tests indicate that the aircraft will plane with heavy water conditions on the runway. With this condition, directional control in a crosswind may be difficult.

Icy Runways

Landing on an icy runway is the same as landing on a wet runway except that braking effectiveness is further reduced.

CROSSWIND COMPONENT CHART



NOTE

FOR CROSSWIND COMPONENT ENTER CHART WITH MAXIMUM REPORTED GUST VELOCITY

F201-75

Figure 2-7

MINIMUM ROLL LANDING

a. Make touchdown near the approach end of the runway at minimum airspeed. This is essential for a successful short field landing.

b. Deploy the drag chute as quickly as possible after touchdown. Lower the nosewheel while the chute is deploying.

c. Apply optimum braking immediately after chute deployment. Moderate braking may be used prior to chute deployment.

d. Move throttles to IDLE during flare or immediately after touchdown.

e. Move right engine throttle to OFF after touchdown.

Note

Retarding both throttles to OFF further reduces thrust, but eliminates nosewheel steering and braking. If the brakes are burned out at the end of the runway, and speed will permit a safe turn off, the nosewheel steering system will "save" the landing.

The throttle technique is dependent on the pilot judgement of the particular field conditions.

WARNING

Engine shutdown will result in loss of hydraulic actuating pressure for the following systems:

a. Right engine shutdown - Alternate brakes and nosewheel steering.

b. Left engine shutdown - Normal and anti-skid brakes and nosewheel steering.

GO-AROUND

A go-around may be initiated anytime during the approach, or during landing roll when sufficient runway remains for takeoff.

1. Drag chute - Jettison, if deployed.
2. Throttles - MILITARY thrust, MAXIMUM thrust if required.
3. Landing gear lever - UP after positive climb angle established.
4. Trim - As necessary.

AFTER LANDING

1. Pitot heat - OFF.
2. SAS channel engage switches - OFF (before taxiing).

*3. Lighting switches - As required.

4. Suit ventilation boost valve lever - Set at 2/3 of lever travel from NORMAL to EMERG.

ENGINE SHUTDOWN

1. Wheel chocks - Installed.

[2.] INS - As briefed.

CAUTION

INS must be off prior to opening canopies to prevent possibility of excessive temperatures of INS components.

*3. Canopy seal pressure levers - OFF.

*4. Canopy - Open.

Note

In event of engine fire during shutdown, the engine can be motored with fuel OFF to blow out fire if starter unit is connected. Refer to Section III.

*5. Recorders - OFF.

GO AROUND

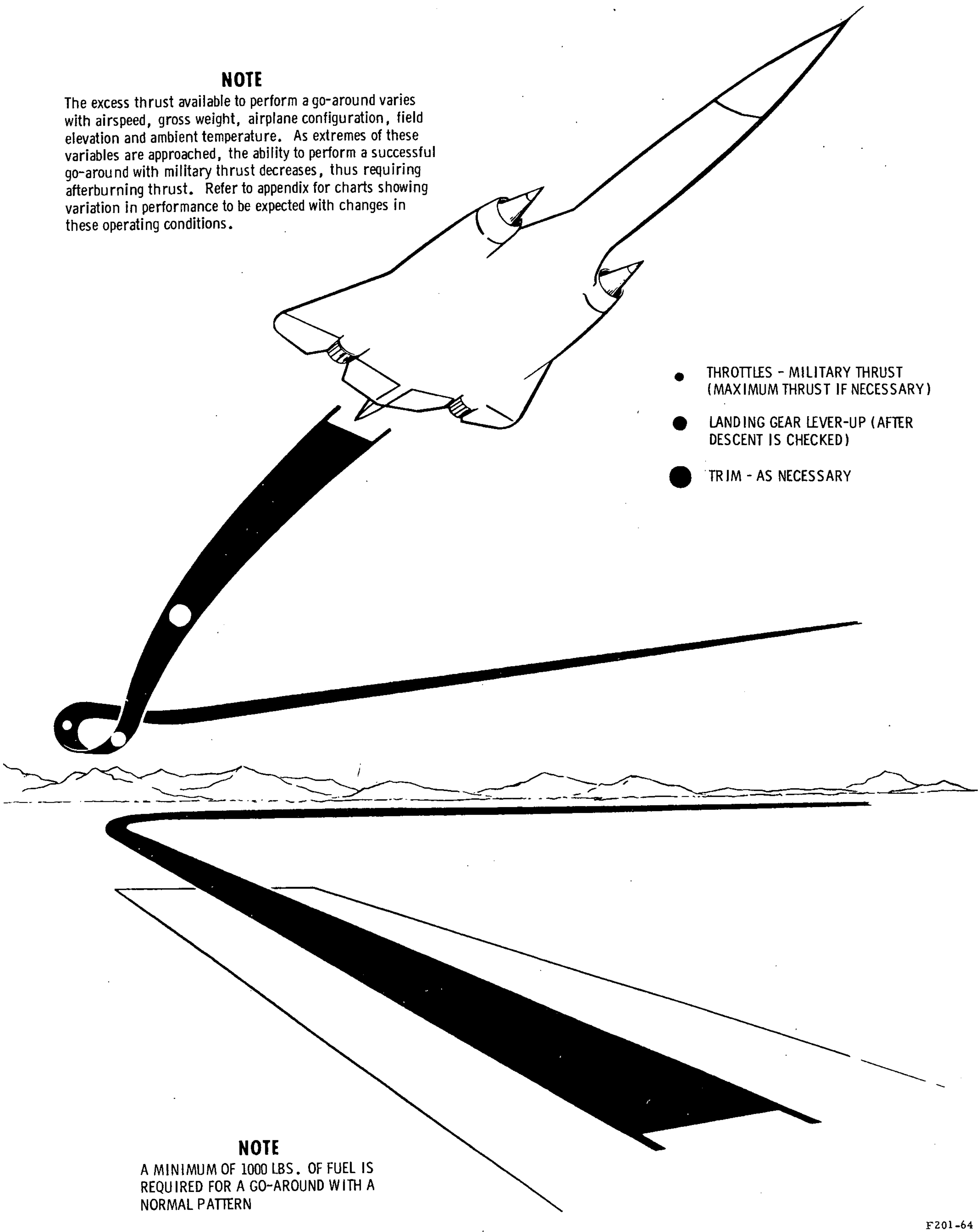


Figure 2-8

*6. All appropriate electrical switches - OFF.

7. All inverter switches - OFF.

8. Generator switches - TRIP (momentary).

9. Throttles - OFF.

10. Battery switch - OFF.

11. Seat and canopy safety pins - Installed.

STRANGE FIELD PROCEDURES - AS BRIEFED.

ABBREVIATED CHECKLIST

Normal and emergency procedures abbreviated checklists are furnished separately.

SECTION III

EMERGENCY PROCEDURES

TABLE OF CONTENTS

INTRODUCTION

This section includes recommended procedures to be used in the event of emergency or abnormal operating conditions. The procedures ensure safety of the pilots and aircraft under most situations until a safe landing can be made or other appropriate action taken. Multiple emergencies, adverse weather, and other peculiar conditions may require modification of procedures; therefore, it is essential that the pilot determine the correct course of action by using common sense and sound judgement. Critical steps of procedures are presented in capital letters. These steps should be memorized so that they may be performed immediately without reference to checklists.

PROPULSION SYSTEM FAILURE

By definition, propulsion system failure may be total or confined to the components considered as part of the propulsion system, including the main engine, afterburner, inlet, nozzle, tailpipe, fuel controls lubrication and ignition systems.

Complete Engine Failure

Complete engine failure is mechanical failure within the engine characterized by extreme vibration, seizure, or explosion. Other symptoms may be a sharp drop in thrust, rpm, or EGT. Engine should be shutdown immediately after positively determining which engine has completely failed. If complete engine failure occurs, it probably will not permit normal windmilling operation. Shut off the fuel. An airstart should not be attempted since this can result in fire or explosion. Land as soon as possible.

Engine Mechanical Failure

Engine mechanical failure is an engine or engine accessory failure which requires pre-cautionary shutdown to avoid or delay complete engine failure. Mechanical failure situations include uncontrollable oil temperature, EGT, or RPM and abnormal oil pressure, fuel flow, or vibration. Normal windmilling speeds can be expected. A landing should be made as soon as possible, after precautionary shutdown.

Engine Flameout

Engine flameout is characterized by a loss of thrust and a drop in EGT and rpm. Flameout can result from interruption of fuel supply, component malfunction, or compressor stall. Immediate airstarts may be possible provided the attempt is made before compressor rpm has appreciably decreased; the higher the rpm, the quicker and more consistent will be the airstart. In the event an engine flames out at high Mach number, an immediate air start can be attempted after the flamed-out engine is positively identified. It may be difficult to immediately determine the flamed out engine. The pilot should cross-check the turn-and-slip indicator, EGT, fuel flow and the rpm, as an aid in positively determining the failed engine. Probability of a successful airstart is greater if at least 7 psi CIP is attained. Airstarts have been made while in roughness but restoration of stable inlet conditions increases the probability of success. While it is expeditious to use crossfeed to assure adequate fuel supply during an airstart attempt, crossfeed should not be left on after the start is obtained. Turn an additional tank on to the side where flow interruption is suspected before crossfeed is discontinued.

Afterburner Flameout

Afterburner flameout may occur as the result of engine stall. Stall conditions must be corrected before attempting afterburner relight. Reducing altitude, increasing airspeed, or increasing engine thrust will improve the afterburner lighting characteristics, especially at high altitude. If these measures fail, the afterburner igniter recycling period should be varied by allowing shorter or longer intervals between attempts to obtain an afterburner light. A comparison of duct pressures may reveal that a difference in inlet efficiency was responsible for the flameout. Afterburner operation cannot be sustained at levels of turbine discharge pressure below 10 inches of mercury absolute; however, this corresponds to altitudes of 59,000 feet at 0.8 Mach number and 70,000 feet at 1.8 Mach number.

Compressor Stall

Compressor stall is usually indicated by compressor pulsations and afterburner flameout may be expected. Other indications are loss of thrust, rapid reduction or fluctuation of rpm, and failure of rpm to increase during acceleration. Compressor stall may be caused by abrupt or erratic throttle movement, failure of the nozzle to open as soon as the afterburner starts to operate, or unstable inlet conditions.

Single Engine Flight Characteristics

The aircraft design is such that no flight system is dependent on a specific engine; thus, the loss of an engine will not result in subsequent loss of all hydraulic or electrical systems.

The engines are located outboard on the wing, away from the direct influence of the fuselage air flow to obtain optimum performance from the inlet ducts during normal operation. If an engine fails at low speed just after takeoff, the large amount of asymmetric thrust may require full rudder and a mild bank toward the good engine for control. Minimum single engine directional control speeds are shown on the chart in this section. A chart showing maximum weights for single engine climbout is included in the performance data appendix. Acceleration to climb speed and climb to pattern attitude can be accomplished with maximum thrust on the operating engine. Full rudder trim can be used to assist in control. Pitch trim changes while dumping fuel can be expected due to shifting center of gravity as the tanks empty. Directional trim is quite sensitive to changes in airspeed and power settings during pattern operation.

At high speed, engine failure or flameout could cause large amounts of yaw at high rates. The yaw SAS has a large degree of authority to prevent this. Temporary thrust reduction on the good engine (minimum afterburning) helps to counteract the asymmetric thrust condition, and followup rudder action is necessary. If large yaw angles develop, inlet duct airflow disturbances may cause the other engine to stall or flameout.

In the event of engine flameout at high Mach number, an immediate airstart can be attemped after the flamed out engine is positively identified. This may be difficult. The pilot should endeavor to cross check the turn and slip indicator, EGT, fuel flow, and rpm in order to positively determine the failed engine. If encountered, intensity of inlet roughness increases with Mach number. If a start is unsuccessful, or if engine failure has occurred, a descent to intermediate altitudes will be necessary. The bypass doors should be open on the windmilling engine. Descent range can be ex-

MINIMUM SINGLE ENGINE CONTROL SPEEDS

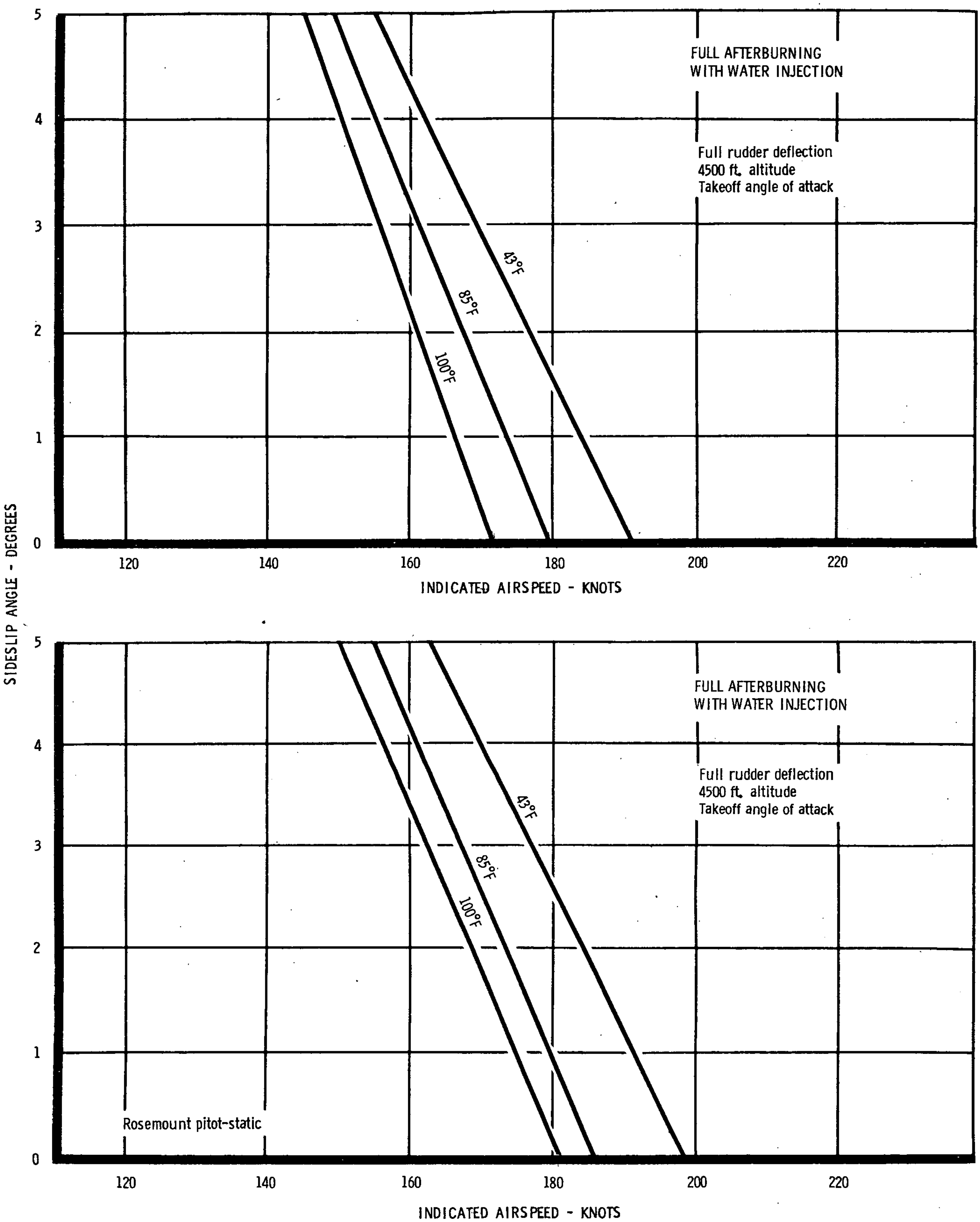


Figure 3-1

tended by decelerating with Military thrust on the good engine. Either a slight bank or yaw with full rudder trim or a bank of 8 to 10 degrees with minimum rudder trim and moderate yaw can be used for cruise.

Fuel management during protracted engine-out operation should be directed toward maintaining optimum center-of-gravity conditions, making all of the fuel available to the operating engine and, when necessary, continuing the fuel cooling of necessary systems. Improper cg conditions will be indicated by abnormal pitch trim requirements. The crossfeed valve should be opened after tanks 5 and 6 are emptied by right engine consumption, or if this is the failed engine, by successive forward transfer operations. This accomplishes the dual purpose of maintaining cg and using all available fuel. Fuel cooling is continued automatically when the inoperative engine is windmilling unless its emergency fuel shutoff switch is actuated. Crossfeed should never be used during forward transfer when fuel remains in tanks 5 or 6. If it were, most of the fuel transferred would come from the operating tank(s) of group 2, 4, or 3 and only a small forward cg shift would result.

Double Engine Failure

The possibility of a double engine failure is greater at high speeds because it is possible for the second engine to flameout as a result of the yaw angles induced by the first engine failure. In this case, first restart the engine that flamed out due to the yaw maneuver.

If a double engine failure occurs at extremely low altitude and sufficient airspeed is available, the aircraft should be zoomed to exchange airspeed for an increase in altitude. This will allow more time for accomplishing emergency procedures. Attempt an air start immediately and repeat as many times as possible.

THRUST FAILURE DURING TAKEOFF, TAKEOFF REFUSED

If either the acceleration check speed is marginal or the thrust of either engine decays or fails and conditions permit:

1. ABORT
   Use abort procedure given in this section for Takeoff and Landing Emergencies.

AFTERBURNER FLAMEOUT DURING TAKEOFF, TAKEOFF CONTINUED

If an afterburner fails before leaving the ground, and a decision is made to continue:

1. AFTERBURNER SWITCH - OFF.

After 5 seconds:

2. AFTERBURNER SWITCH - ON.

If afterburner does not light:

3. AFTERBURNER SWITCH - OFF.

4. Trim - As necessary.

ENGINE FAILURE IMMEDIATELY AFTER TAKEOFF

If an engine fails immediately after takeoff and the decision is made to continue, maintain maximum thrust on the operating engine. Normal takeoff speeds are equal to or faster than minimum directional control speed. Lateral and directional control of the aircraft can be maintained when airspeed remains above the minimum single engine directional control speed. However, the ability to maintain altitude and accelerate or climb depends on weight, drag, altitude, airspeed, and temperature. Refer to Appendix for takeoff climb capability data. When at heavy weight for the existing air temperature, dumping fuel may reduce the gross weight sufficiently to remain airborne:

1. THROTTLES - MAXIMUM THRUST.

2. CONTINUE STRAIGHT AHEAD.

3. LANDING GEAR LEVER - UP.

4. Fuel dump switch - NORM (if necessary).

5. Throttle - Failed engine OFF.

If not mechanical failure:

6. ATTEMPT AIR START (Refer to Air Start Procedure this section).

For obvious mechanical failure:

7. Emergency fuel shutoff switch - FUEL OFF.

DOUBLE ENGINE FAILURE IMMEDIATELY AFTER TAKEOFF

If a double engine failure occurs, proceed as follows:

1. IF GEAR IS DOWN AND CONDITIONS PERMIT - LAND STRAIGHT AHEAD.

2. IF GEAR RETRACTION HAS BEEN INITIATED OR CONDITIONS DICTATE - EJECT.

WARNING

Decay of engine RPM will result in rapid loss of A & B hydraulic system pressure and subsequent loss of aircraft control.

AFTERBURNER NOZZLE FAILURE DURING FLIGHT

Nozzle Failed Closed

Normally, the nozzles open before the afterburners light. If the afterburner nozzle either fails to open or closes during afterburner operation, there may be a compressor stall, a rapid increase in exhaust gas temperature, or a decrease in rpm. If one of these conditions occur:

1. Afterburner switch - OFF.

Nozzle Failed Open

If the nozzle fails open, a maximum of approximately 60% of Military thrust remains available without afterburning. The afterburner can be turned on if necessary and full afterburner thrust will be available.

AFTERBURNER FLAMEOUT

In the event of a flameout of the afterburner:

1. Afterburner switch - OFF. Wait at least 5 seconds.

2. Afterburner switch - ON.

If afterburner fails to light:

3. Afterburner switch - OFF.

AFTERBURNER CUTOFF FAILURE

In the event of an electrical failure, or failure of the afterburner actuator motor during afterburner operation, the afterburner may be turned off as follows:

1. Throttle - Retard below afterburner detent.

WARNING

A pronounced loss of thrust will result when the throttle is retarded below the afterburner detent position.

When the above cutoff procedure has been used to terminate afterburning after electrical failure, a relight cannot be obtained until electrical power has been restored. However, the full range of non-afterburning thrust is available. A relight cannot be obtained if a complete failure of the afterburner motor actuator has occurred, or if the relay in the afterburner electrical control circuit has failed in the afterburning position.

To relight the afterburner, proceed as follows:

1. Afterburner switch - OFF for at least 5 seconds.
2. A/B CONT circuit breaker - Check. Reset if necessary.
3. Throttle - Advance to afterburner range.
4. Afterburner switch - ON.

AIR INLET CONTROL SYSTEM MALFUNCTIONS

A malfunction of the air inlet bypass system can be caused by hydraulic power loss or mechanical failure. System malfunctions and action available to the pilot are as follows:

BYPASS DR NOT OPEN Light On

Illumination of this warning light indicates that the bypass doors are closed with landing gear extended.

1. Inlet air bypass switch - OPEN.
2. BYP DR MAN OPEN light on - Check.

BYP MAN OPEN Light Not On With Bypass OPEN Selected

If the inlet air bypass doors remain closed when OPEN is selected avoid using high thrust settings at low speeds before landing.

COMPRESSOR STALL OR UNSTABLE INLET

1. INLET AIR BYPASS SWITCHES - OPEN.
2. AFTERBURNER SWITCHES - OFF.
3. Airspeed - Adjust toward 350 KEAS.
4. Throttles - Adjust to clear stall.
5. Restart engine if flamed out or shut down.

ENGINE FLAMEOUT PROCEDURE

1. AFTERBURNER SWITCHES - AS REQUIRED.
2. AIRSPEED - ADJUST TOWARD 300 KEAS OR MACH 0.8.

If not obvious mechanical failure:

3. ATTEMPT AIR START.

If obvious mechanical failure or air start is unsuccessful:

4. Failed engine generator - TRIP.
5. Crossfeed - As required.
6. Land as soon as possible.

DOUBLE ENGINE FLAMEOUT

When altitude permits:

1. Use appropriate steps of Engine Flameout or Air Start procedures, as applicable.

When altitude is critical or engines will not start:

2. EJECT.

AIR START PROCEDURES

The cause of a flameout should be determined and corrected prior to attempting an air start. The estimated air start envelope for a windmilling engine is shown in this section. The recommended procedure for air start is as follows:

1. THROTTLE - OFF (affected engine).
2. INLET BYPASS SWITCH - OPEN.
3. CROSSFEED - ON.
4. THROTTLE - IDLE.
5. ENGINE START SWITCH - AIR (hold).

If no evidence of start within 15 seconds:

6. THROTTLE - OFF.
7. EMERGENCY FUEL CONTROL SWITCH - EMER.
8. THROTTLE - ADVANCE TO 800-900 PPH FUEL FLOW.
9. ENGINE START SWITCH - AIR (hold).

After start:

10. Throttle and cockpit switches - As required.

Note

Emergency fuel control switch may be returned to NORM position after start unless flameout was caused by normal fuel control failure.

GLIDE DISTANCE WITH BOTH ENGINES INOPERATIVE

The glide distance chart shows zero-wind glide distances with both engines windmilling. The glide speed is 0.8 Mach number above 30,000 feet and 300 knots EAS below 30,000 feet. This airspeed will provide near-maximum glide distance capability and sufficient engine speed to maintain hydraulic pressure.

With both engines out, the ac generators furnish rated electrical power at windmilling speeds above 2800 rpm. The emergency battery provides SAS operation at lower windmilling speeds. There is sufficient hydraulic flow to operate the control surfaces at satisfactory rates above 3000 rpm and operation at reduced rates is available to a windmilling speed of approximately 1500 rpm.

LANDING WITH BOTH ENGINES INOPERATIVE

Landing with both engines inoperative should not be attempted.

ENGINE OIL SYSTEM FAILURE

Failure of the engine oil system is indicated by the oil pressure gage. If an oil system malfunction causes oil starvation of the engine bearings, the result will be progressive bearing failure, engine roughness, oil seal failure, loss of oil, and subsequent engine seizure. Bearing failure due to oil

ESTIMATED AIRSTART ENVELOPE (Windmilling Engine)

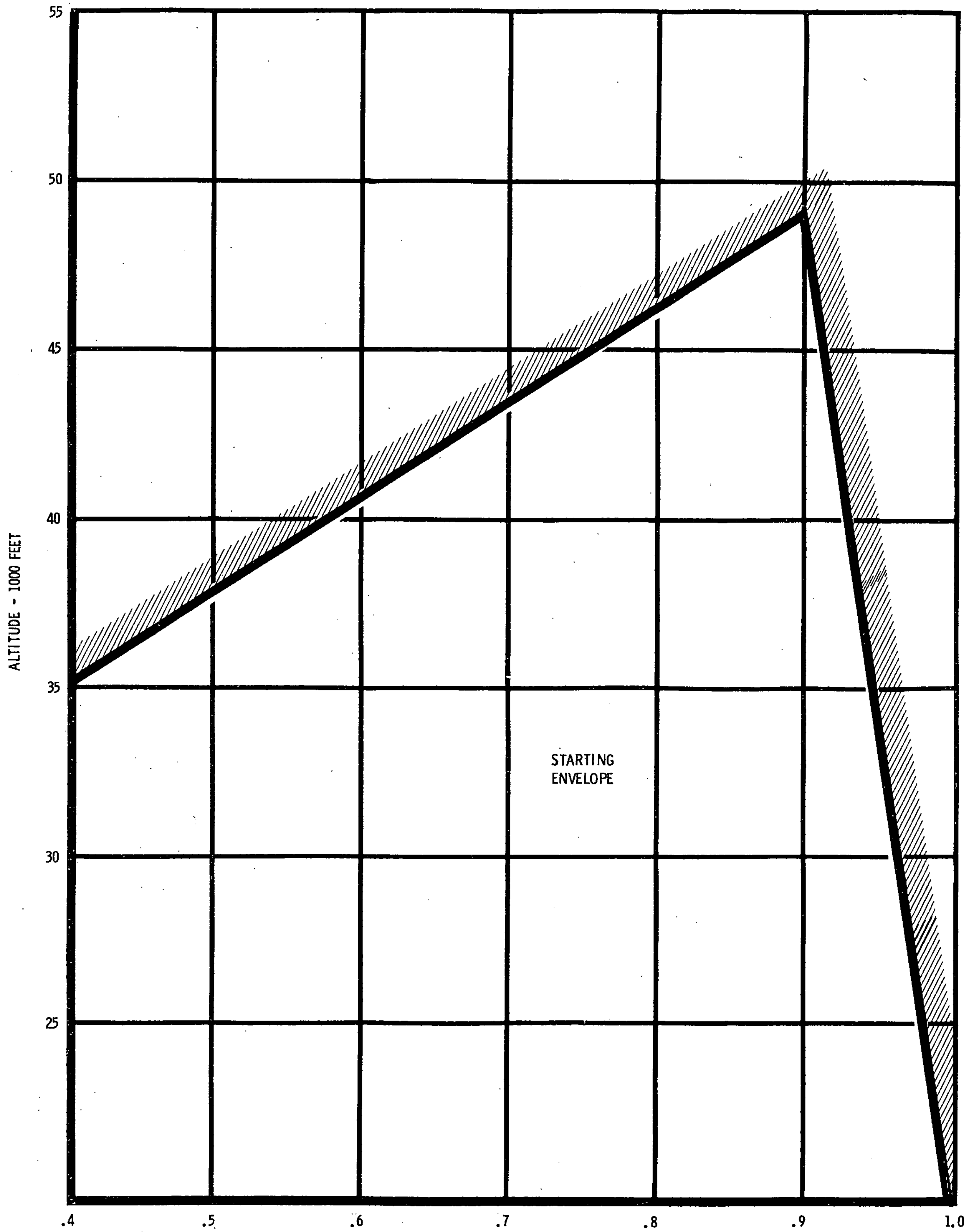


Figure 3-2

DEAD ENGINE GLIDE DISTANCE

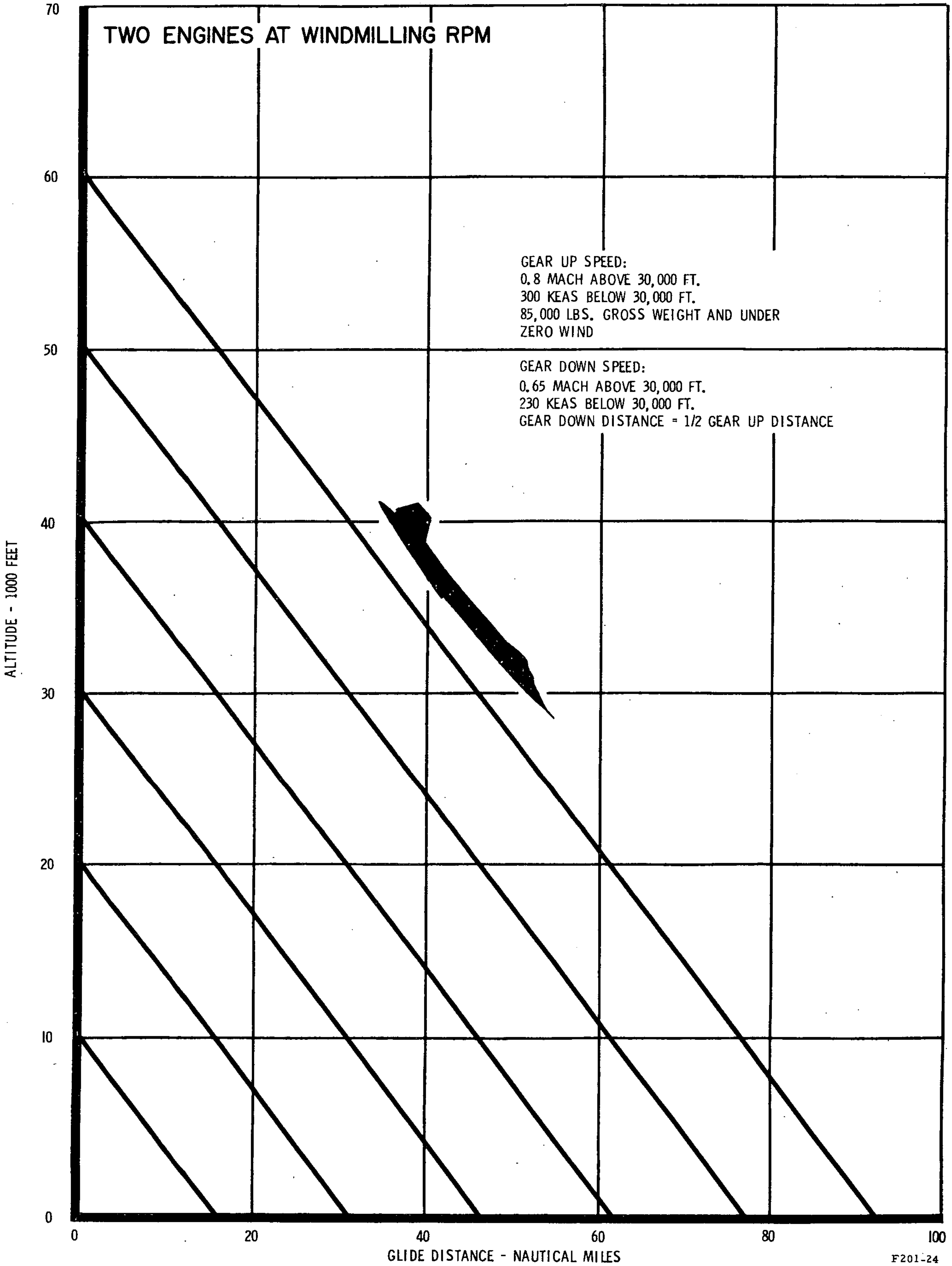


Figure 3-3

starvation is generally characterized by a rapidly increasing vibration. If this is noted, accompanied by a pressure loss on the gage, do the following:

1. Throttle - OFF.

2. Land as soon as possible.

ENGINE FUEL CONTROL FAILURE

When a failure of the normal fuel control is suspected, do the following:

1. Throttle - Adjust for smooth switchover.

2. Emergency fuel control switch - EMER.

After fuel control malfunction, do not return the emergency fuel control selector switch from EMER to NORM for the duration of the flight. To do so might result in an engine flameout. Descents should be made with the throttle advanced to provide no less than 1500 pph fuel flow per engine to prevent excessive fuel temperatures in the fuel control. Careful throttle movement and close monitoring of EGT is necessary as the emergency fuel control only senses compressor inlet pressures and fuel flow is controlled by the throttle. When practicing emergency procedures with a properly functioning normal fuel system, the transfer back to NORM should only be made after first retarding the throttle to 7860 rpm or less to avoid excessive pressure surge in the engine fuel system.

FIRE

ENGINE FIRE DURING GROUND START

If there is evidence of fire during ground start, keep the engine rotating until the fire is extinguished. Apply chemicals from outside the engine as a last resort.

If engine is operating:

1. Throttle - OFF.

2. Have ground crew continue cranking engine.

CAUTION

Never apply ground air supply to engine starter when engine rpm exceeds 3490.

3. Emergency fuel shutoff switch - FUEL OFF.

4. Battery switch - OFF.

5. Abandon aircraft.

ENGINE FIRE DURING TAKEOFF, TAKEOFF REFUSED

If either FIRE warning light illuminates before leaving the ground, do the following:

1. ABORT.
   Use abort procedure given in this section for Takeoff and Landing Emergencies.

2. THROTTLE - OFF (AFFECTED ENGINE).

3. EMER FUEL SHUTOFF SWITCH - FUEL OFF.

4. Shut down other engine after stopping.

5. Seat pin - Insert if time permits.

6. Abandon aircraft.

ENGINE FIRE DURING FLIGHT

Illumination of a nacelle FIRE warning light indicates a nacelle compartment temperature above approximately 1050°F. An immediate check for abnormal EGT, trailing smoke, or any other indication of the presense of fire should be made. In case of doubt, assume that a fire does exist and proceed as follows:

1. THROTTLE - RETARD BELOW AFTERBURNER DETENT (AFFECTED ENGINE).

If light remains on:

2. THROTTLE - IDLE ABOVE MINIMUM CONTROL SPEED.

If light still remains on:

3. THROTTLE - OFF.
4. EMER FUEL SHUTOFF SWITCH - FUEL OFF.
5. CHECK FOR OTHER INDICATIONS OF FIRE.

If fire confirmed:

6. EJECT.

If no fire:

7. Land as soon as possible.

ENGINE FIRE AFTER SHUTDOWN

Use applicable steps of Engine Fire During Ground Start procedure, this section.

ELECTRICAL FIRE

The pilot's ability to detect an electrical fire is somewhat limited when wearing a pressure suit because he is not exposed to the characteristic odor. He must depend on visual detection of smoke in the cockpit.

The method of fighting an electrical fire is different from the customary procedure in that it is not desirable to turn off all electrical power simultaneously. Such action would turn off the SAS and fuel boost pumps; however, the battery and one generator may be turned off with no adverse effect on essential systems.

1. Both generators should not be turned off simultaneously unless absolutely necessary.
2. Turn off all non-essential electrical systems.
3. Turn electrical equipment back on individually in an attempt to isolate malfunction.
4. Land as soon as possible.

ELIMINATION OF SMOKE AND FUMES

The pilot cannot detect fumes when wearing a pressure suit. The helmet oxygen system is independent of the cockpit and suit air supply system. Smoke can be eliminated promptly by dumping cabin pressure unless the smoke enters from the cockpit air conditioning system. With the cockpits pressurized, shutting off the cockpit air systems will not depressurize the cockpits; however, there will be a minimum of ventilating air flow. If the smoke is introduced by the forward cockpit air supply system, switch the cockpit system to CROSSOVER. The defog system should be off at all times when not required.

WARNING

When pressure is dumped, cockpit depressurization will occur at an extremely rapid rate and the pilots will be dependent on their suit pressure for altitude protection.

EMERGENCY ESCAPE

Escape from the aircraft in flight should be made with the ejection seat. The following is a summary of ejection expectations:

a. At sea level, wind blast exerts only minor forces on the body up to 525 knots; appreciable forces from 525 to 600 knots. The aircraft limit airspeed is below these speeds.

b. Ejection at 65 KIAS and above during takeoff roll results in successful chute deployment.

c. The free fall from high altitude down to 15,000 feet with drogue chute stabilization will result in stabilized descent in the quickest manner.

CAUTION

Flight with oxygen mask and regulator are restricted to below FL 500 and below 420 KEAS because of wind blast forces anticipated in the event of ejection. Before actual ejection airspeed should be reduced to subsonic and as slow as conditions permit.

BEFORE EJECTION, IF TIME AND CONDITIONS PERMIT

1. Altitude - Reduce so that the pressure suit is not essential to survival.
2. Airspeed - Reduce to subsonic and as slow as conditions permit.
3. Head aircraft toward unpopulated area.
4. Transmit location and intentions to nearest radio facility.
5. IFF - EMERGENCY position.

EJECTION

A minimum risk ejection can be performed at any height when airspeed is above 65 KIAS with wings level while in level or climbing flight; however, accomplish bail-out above 2000 feet when feasible.

1. If possible, aircraft commander will notify crewmember of decision to eject.
2. Actuate BAIL OUT light switch.
3. Observe forward seat ejection (or AFT SEAT EJECTED light illuminate if aircraft commander in forward cockpit).

WARNING

If forward seat ejects first, do not eject from aft cockpit or jettison canopy until forward seat is observed to go. Ejection of pilot may be determined visually, by noting rocket blast, by feeling aircraft shake, or by hearing seat ejection system fire.

4. Lower visor.
5. GREEN APPLE - Pull.
   Pull green apple if at altitude.
6. EJECTION RING - PULL.

If seat fails to eject after a normal delay, do the following:

7. JETTISON CANOPY. Operate canopy jettison handle. If canopy does not jettison, attempt to blow off by open-into slipstream with canopy latch handle.
8. EJECTION SEAT T-HANDLE - PULL.

WARNING

Do not pull ejection seat T-handle until canopy is gone. There is no safety interlock to prevent ejection by T-handle when canopy is in place.

In the event the ejection seat still fails to eject, continue as follows:

9. Slow aircraft to between 250 and 300 KEAS.

0. FOOT SPURS - RELEASE.

1. PERSONAL LEADS - DISCONNECT.

2. TRIM AIRCRAFT FULL NOSEDOWN, HOLD STICK NEUTRAL.

3. ROLL INVERTED, LEAN FORWARD.

4. SIMULTANEOUSLY RELEASE LAP BELT AND CONTROL STICK.

5. AFTER CLEAR, PULL PARACHUTE ARMING LANYARD (RED KNOB) ON PARACHUTE HARNESS.

6. Survival kit release handle - Pull after parachute opens to reduce landing impact.

EMERGENCY EXIT ON THE GROUND

To exit on the ground in an emergency, proceed as follows:

1. Ejection seat safety pin - Install if time permits.

2. Lap belt and shoulder harness - Release.

3. Personal leads - Disconnect.

4. Parachute harness attachments - Release.

5. Foot spurs - Release manually. (Use cable cutter if unable to release spurs.)

6. Canopy - Unlatch or jettison as applicable.

7. Abandon aircraft.

TAKEOFF AND LANDING EMERGENCIES

ABORT

The abort procedure assumes that a decision to abort will be made before rotation speed is reached. Aborts from above rotation speed are not prohibited, but the risks associated with aborting from such a high initial speed at takeoff weight must be balanced against those of continuing a takeoff when making the decision. In general, after rotation speed is reached, the most reasonable course of action is to continue rather than abort unless the emergency is such that the aircraft can not fly.

Engine Management

Both throttles should be retarded to IDLE and the brakes applied with the nose down as soon as the decision to abort is made. Reaction time and residual thrust will usually cause airspeed to continue increasing until engine rpm begins to decrease. The planned rotation speed may be exceeded as a result; however, the nosewheel should be kept on the runway to take advantage of nosewheel steering in combination with rudder control. Shutdown of one engine will shorten the stopping distance, but shutdown is not necessary unless the drag chute does not operate properly. In the event of chute failure, shutdown the right engine after both areidling, or complete the shutdown of a failed or flamed out engine.

WARNING

Wait until rpm and EGT show that both engines are idling or that one engine is failing before selecting the engine to shutdown. Loss of both engines may result in loss of hydraulic pressure for braking.

Aircraft Attitude, With Decision to Abort

Unless rotation has been initiated, keep the nosewheel on the runway. If a nose up attitude has been established but can be checked short of lift-off, lower the nose immediately if below 140 KIAS. If above 190 KIAS, use an angle of attack of 10° to 12° while decelerating toward 190 KIAS. Lower the nose as 140 KIAS is approached. Energize the brakes simultaneously with nosewheel contact.

When rotation is well advanced, the aircraft may accelerate beyond takeoff speed and liftoff before rotation can be checked. In this case hold the aircraft off sufficiently to regain control and then touchdown without sideslip if possible. Fly the aircraft back to the runway, attempting to regain the center. Lower the nose as 190 is approached.

Chute Deployment

The drag chute requires 4 to 5 seconds for deployment after drag chute actuation. It is permissible to actuate the deploy handle while decelerating in anticipation of reaching 190 KIAS; however, premature deployment can result in destruction of the chute. Actuation of the chute system so as to reach 190 KIAS simultaneously with loading of the chute is not recommended unless the risk is justified by a very marginal distance remaining situation. It is better to actuate the drag chute switch at or below 190 KIAS while decelerating.

Brake Switch

The normal ANTI-SKID ON brake switch setting provides nosewheel steering and braking power from the L hydraulic system and anti-skid protection. It is not necessary to change the switch setting unless the left hydraulic pressure has failed or anti-skid off is desired. Selection of ANTI-SKID OFF or ALT STEER & BRAKE causes the ANTI-SKID OUT warning light on the annunciator panel to illuminate.

ABORT PROCEDURE

WARNING

- Do not unfasten the lap belt or shoulder harness until the aircraft has come to a stop.
- The landing gear should be left in the extended position.

1. THROTTLES - IDLE.

Retard both throttles to IDLE. Do not attempt to shut down either engine immediately unless failure to do so would vitally endanger the aircraft.

2. NOSEWHEEL STEERING - ENGAGE.
3. BRAKES - OPTIMUM BRAKING.

   For dry runway: use moderate to heavy brake pressure.

   For wet runway: use light to moderate brake pressure.

4. DRAG CHUTE HANDLE - PULL.

   The limit airspeed for drag chute deployment is 190 KIAS.

5. BRAKE SWITCH - As required.

Set the brake switch to ALT STEER & BRAKE when the L hydraulic system is below normal pressure due to system or left engine failure.

CAUTION

Selection of ALT STEER & BRAKE changes the source of brake pressure from the L to the R hydraulic system and disables the anti-skid system.

6. Shut down one engine (if necessary).

Shut down of one engine is considered necessary in the event of drag chute failure.

If drag chute fails to deploy, use DRAG CHUTE FAILURE Procedure, this section.

Shut down the right engine if both engines are idling or if the right engine has failed.

Shut down the left engine if it has failed.

WARNING

Positively identify the failed engine before attempting engine shutdown.

DRAG CHUTE FAILURE

If the drag chute should fail to deploy and stopping distance is critical, proceed as follows:

Dry Runway

1. LOWER NOSE IMMEDIATELY.
2. NOSEWHEEL STEERING - ENGAGE.
3. BRAKES - AS REQUIRED UP TO MAXIMUM BRAKING.
4. RIGHT ENGINE THROTTLE - OFF, IF REQUIRED.
5. HOLD AS MUCH UP ELEVON AS POSSIBLE AND STILL KEEP THE NOSEWHEEL ON RUNWAY FOR DIRECTIONAL CONTROL.

Wet Or Icy Runway

1. LOWER NOSE.
   a. LANDING - AT 110 KIAS.
   b. ABORT - IMMEDIATELY AT 190 KIAS.
2. NOSEWHEEL STEERING - ENGAGE.
3. BRAKES SWITCH - NORM.
4. BRAKES - MAXIMUM PRESSURE.
5. RIGHT ENGINE THROTTLE - OFF.
6. HOLD AS MUCH UP ELEVON AS POSSIBLE, BUT KEEP THE NOSEWHEEL ON THE RUNWAY FOR DIRECTIONAL CONTROL.

Note

This wet or icy runway technique will probably blow the tires early in the landing roll; however, directional control can still be maintained and the blown tires will remain on the wheels. Additional pedal pressure will be required as each tire blows. Maximum wing aerodynamic braking is more effective than wheel braking on a wet or icy runway until the nose is lowered but the nose up attitude must not be held to a point that the nosewheel will slam onto the runway. Use of maximum possible up elevon after the nose is lowered while keeping the nosewheel on the runway provides aerodynamic drag and additional down load on the main wheels.

SINGLE ENGINE LANDING

A single engine landing is basically the same as a normal landing, except that the pattern may be entered at any point and is expanded to avoid steep turns. Airspeed is maintained above normal on final approach. The outstanding difference from normal landings is the noticeable change in directional trim with power changes. The most marked trim change will occur as the throttle is retarded during flare. This is reduced by setting the rudder trim to neutral on trim indicator after final approach is established. Directional heading is maintained by rudder pressure until thrust is smoothly reduced during the flare. The landing gear may be lowered after lining up on final approach if the L hydraulic system is operating; however, at least 90 seconds must be allowed for emergency gear extension if the L hydraulic system is inoperative.

1. Fuel - DUMP and TRANSFER as required.

2. Review hydraulic services available.

3. If left engine has failed, brake switch-ALT STEER & BRAKE.

4. Inoperative engine SAS pitch and yaw switches - OFF.

5. SAS roll switches - Both OFF.
6. Operative engine SAS roll switch - ON.
7. Landing gear lever - DOWN.
8. Establish steeper than normal final approach.
9. Maintain 200 KIAS minimum until landing assured.

Note

If it is necessary to land with more than 35,000 pounds of fuel remaining increase minimum approach speed 1 knot for each additional 1000 pounds.

10. Rudder trim - Neutral.

Note

Partial afterburning thrust may be required during final approach.

WARNING

If the throttle is retarded below the afterburner detent or the afterburner switch is turned off while in the partial afterburning range, a significant loss of thrust will result.

11. When landing is assured - Retard throttle.
12. Make normal touchdown.

SINGLE ENGINE GO-AROUND

Make go-around decision as soon as possible on final and prior to flare.

1. Throttle - As required.
2. Afterburner switch - ON, if required.
3. Continue approach until go-around assured.
4. Landing gear lever - UP, when descent is checked.
5. Trim - As necessary.
6. Accelerate to 250 KIAS climb speed.

SIMULATED SINGLE ENGINE LANDING

Directional trim changes will be more pronounced during an actual single engine situation with one engine windmilling.

1. Retard one throttle to IDLE.
2. Follow Single Engine Landing procedure.

FORCED LANDING

At least one engine must be operating if a forced landing is to be attempted. All forced landings should be made with the landing gear extended regardless of terrain. High airspeed or nose-high angle of impact during landings with gear retracted causes the aircraft to "slap" the ground on impact, subjecting the pilot to possible spinal injury. It is recommended that a gear-up landing not be attempted with this aircraft; EJECT instead. If a forced landing is necessary, proceed as follows:

1. Fuel dump switch - NORM, dump as required. Terminate fuel dumping at least 30 seconds prior to contact. Refer to Fuel Dump, this section.

2. Fuel transfer - As required.

3. Landing gear lever - DOWN.

4. Shoulder harness - Lock.

5. Canopy - Jettison during approach if desired.

CAUTION

If crash and rescue personnel are immediately available it may be preferable to retain the canopy until aircraft stops to reduce possibility of burns in case fire occurs during landing.

6. Throttles - OFF at touchdown.

7. Drag chute handle - Pull out to deploy chute.

8. Emergency fuel shutoff switches - FUEL OFF.

9. Battery and generator switches - OFF.

10. Canopy - Manually open or jettison if not accomplished during approach.

11. Abandon aircraft as soon as possible.

LANDING GEAR UNSAFE INDICATION

A landing gear unsafe indication could be caused by low L hydraulic system pressure or malfunction within the landing gear extension or indication system. If the L hydraulic system has failed, refer to Landing Gear System Emergency Operation (Extension) procedure, this section. Upon detecing an unsafe indication, proceed as follows:

1. Landing gear circuit breakers and lights - Check.

2. L hydraulic pressure - Check.

3. Landing gear lever - Recycle to DOWN position; repeat if necessary.

If landing gear still indicates unsafe:

4. Landing gear position - Determine by reference to tower or other aircraft.

If the landing gear appears down and locked:

5. Make normal approach and land on side of the runway away from suspected unsafe gear and observe the following precautions.

    a. Inertia reel lock lever - LOCK.

    b. Hold weight off unsafe gear as long as possible. If nose gear indicates unsafe hold off then lower smoothly at approximately 110 KIAS.

    c. Allow aircraft to roll to a stop straight ahead and do not attempt to taxi or shut down engine until landing gear ground safety pins are installed.

6. If any gear remains fully retracted refer to Landing Gear System Emergency Operation (Extension) procedure, this section.

7. If all gear extended, but not fully, refer to Partial Gear Landing procedure, this section.

Note

- Increasing airspeed may assist in locking a partially extended nose gear.
- Yawing aircraft may assist in locking a partially extended main landing gear.

PARTIAL-GEAR LANDING

A landing with the nose gear retracted or with all gear up should not be attempted. A landing with the nose gear and one main gear locked down is not recommended. Under ideal circumstances, a landing with the nose gear extended and both main wheels retracted may be possible. If this configuration can be accomplished, base a decision to land or eject on whether or not other factors are favorable. An unobstructed runout surface adjacent to the runway is desirable. A dry lakebed landing might be preferable. Wind velocity and direction are important in selection of the landing heading.

If a decision is made to land, conventional final approach and landing speeds and attitudes are recommended. This will result in the tail touching while the nose is at less than normal height. An attempt to hold the aircraft off by using a higher pitch angle is not recommended because of the greater possibility of high impact loads as the nose gear slaps down. An empty tank 1 condition is desired.

1. Accomplish nose-gear-only configuration if necessary, as follows:

   a. Landing gear CONT circuit breaker-Push in.

   b. Landing gear lever - Up.

   c. Landing gear CONT circuit breaker - Pull.

   Note

   Nosewheel steering will not be available.

   d. Manual landing gear release handle - Pull to release nose gear only (first lock releases nose gear). Check nose gear down light - ON.

2. Do not transfer fuel forward.

3. Fuel dump switch - NORM, if necessary to reduce weight.

4. Battery switch - OFF.

5. Inertia reel lock lever - LOCK.

6. Canopy jettison handle - Pull, if desired.

   Note

   If the canopy is not jettisoned prior to landing, it should not be unlocked until the aircraft has stopped.

7. Make normal approach and landing.

8. Drag chute handle - Pull out to deploy chute.

9. Use rudders for directional control.

10. Throttles - OFF, when directional control is no longer possible.

11. Abandon aircraft as quickly as possible.

MAIN OR NOSE GEAR TIRE FAILURE ON TAKEOFF

If takeoff is continued after a tire has failed or is suspected to have failed, do not retract the landing gear until the tire has been visually checked by another aircraft or a control tower. If no fire is evident and the gear is to be retracted, move the brake switch to the NORM position and apply brakes prior to raising the gear. Stopping wheel rotation will prevent tire fragmentation damage in the wheel well. (With the brake switch in the ANTI-SKID position the brakes cannot be applied when the weight of the aircraft is off the main gear.) After the gear has been retracted return brake switch to the ANTI-SKID position. The most likely place to blow a main gear tire is during the latter portion of the takeof run. The following procedure is recommended when a main or nose gear tire fails during takeoff run:

1. IF SPEED AND RUNWAY PERMIT - ABORT. Refer to abort procedure.

2. If rotation speed has been reached, continue takeoff. (Do not retract the gear until a visual check is made.)

MAIN GEAR FLAT TIRE LANDING

Plan the landing for minimum gross weight with touchdown to be made on the side of the runway away from the flat tire. It is possible that only one or two of the three tires has failed. If only one tire has failed, little danger exists when landing at low weight because two tires have sufficient strength to support the aircraft.

1. Touchdown on good tires.

2. Drag chute handle - Pull out to deploy chute as soon as possible.

3. Nosewheel - Lower.

4. Nosewheel steering switch - Engage.

5. Hold weight off flat tire.

6. Brakes - Use differential braking to maintain directional control.

WARNING

Maintain IDLE rpm until fire-fighting equipment arrives. Engine shutdown allows fuel to vent in the vicinity of the wheel brake area, thus creating a fire hazard.

NOSE GEAR FLAT TIRE LANDING

If it is necessary to land with a flat nosewheel tire or tires, proceed as follows after making a normal touchdown:

1. Drag chute handle - Pull out to deploy chute.

2. Nose gear - Hold off.
   Hold the nosewheel off as long as practicable (approximately 110 KIAS) and then lower gently to runway.

3. Brakes - Use differential braking to maintain directional control.

EMERGENCY ENTRANCE

The procedure to be used by rescue personnel when assisting a disabled pilot from the aircraft following a crash landing is as follows:

a. If aircraft is on fire or if external latch control cannot be operated, jettison canopies by pulling canopy jettison T-handle on left chine.

b. Shut off oxygen supply at oxygen control panel.

c. Open helmet faceplate before disconnecting oxygen line.

d. Ensure that seat will not fire accidentally - Safety the ejection ring.

e. Release lap belt and shoulder harness.

f. Disconnect pilot's personal leads and emergency oxygen hose.

g. Disconnect parachute attachments.

h. Pull manual cable cutter ring.

i. Remove pilot gently to avoid aggravating possible internal injuries.

DITCHING

Ditching should not be attempted. All emergency survival equipment is carried by the pilot; consequently, there is nothing to be gained by riding the airplane down. Ejection is the best course of action when the alternative is ditching.

FUEL SYSTEM FAILURE

INCORRECT FUEL SEQUENCING

Incorrect automatic fuel sequencing is indicated primarily by the fuel boost pump lights. (A switch may illuminate out of normal sequence, or fail to illuminate on schedule.) The remedy for this is to sequence manually until either automatic sequencing resumes or a landing is made. It is possible that faulty fuel sequencing may manifest itself by secondary indications, such as a fuel low level light coming on prematurely, or an abnormal adjustment required in pitch trim (due to cg change by faulty fuel distribution). Note that forward cg requires increased power to maintain speed and altitude. If normal sequencing does not resume, and manual sequencing is either inconvenient or impossible, turn crossfeed on or transfer fuel to ensure that any available fuel will get to the engines.

CAUTION

Do not permit a fuel boost pump to continue operating in an empty fuel tank or the boost pump will be damaged.

FUEL PRESSURE LOW WARNING

If one or both low fuel pressure lights illuminate, proceed as follows:

1. Crossfeed - Press ON.

2. Tanks containing fuel - Press ON.

3. Analyze difficult and attempt to restore normal sequencing.

4. Crossfeed - Press OFF.

If normal operation can not be restored:

5. Land as soon as possible.

FUEL BOOST PUMP FAILURE

Loss of all boost pumps can only result from multiple failures. It would be indicated by illumination of both low fuel pressure lights. If this occurs during takeoff, fuel tank pressurization will supply sufficient fuel to the engine driven pumps to maintain engine operation. The takeoff should be aborted if speed and runway length permit.

WARNING

Fuel cannot be dumped with complete boost pump failure. Use caution if heavy weight landing is required.

Partial boost pump failure may not be indicated by the low fuel pressure lights. Improper fuel sequencing and center of gravity shift may be the first indication. Proceed as directed in INCORRECT FUEL SEQUENCING. Crossfeed may be required; however, more fuel will tend to feed from forward tanks that have boost pumps operating when crossfeed is on. This could cause an aft cg shift which might be hazardous when operating with a failed pitch SAS.

FUEL TANK PRESSURIZATION FAILURE

Fuel tank pressurization failure is indicated by the tank pressure gage and warning light and by the liquid nitrogen quantity indicator. The liquid nitrogen quantity low warning light on the annunciator panel indicates impending failure. No corrective action is possible after both liquid nitrogen systems are depleted except to limit rates of descent. In descent, the fuel tank suction relief valve in the nosewheel well opens when slightly negative tank pressures occur. Rates of descent should be limited so that tank pressure does not become less than -1/2 psi. This is the minimum tank pressure limit and is based on structural capabilities of the fuselage tanks.

FUEL DUMPING PROCEDURE

Fuel dumping provides a means of rapidly reducing the aircraft weight in an emergency. All tanks containing fuel except tank 1 will empty in the normal fuel tank usage sequence: Tank 1 fuel cannot be dumped since the boost pumps in this tank are stopped when the fuel dump switch is moved to either the NORM or EMER position. When in the NORM position, dumping will continue until the remaining fuel in tank 3 reaches 5000 pounds. Dumping will then terminate and the boost pumps in tank 1 will automatically start. When in the EMER position, dumping will continue until all fuel except any remaining in tank 1 is dumped. To avoid fuel pressure fluctuations, the boost pumps in tank 1 must be started before tank 3 completely empties, by moving the fuel dump switch to the OFF position. The boost pumps in tank 1 may also be started by pressing the tank 1 boost pump switch; however, this will terminate dumping. To increase the dump rate, manually select boost pumps for all tanks containing fuel, except tank 1. The R FUEL PRESS LOW warning light may illuminate at low engine speeds.

NORMAL FUEL DUMPING

Accomplish normal fuel dumping as follows:

1. Fuel dump switch - NORM.
2. Fuel quantity - Alternately monitor total fuel and tank 3 fuel.
3. Fuel dump switch - OFF when 5000 pounds remain in tank 3.

EMERGENCY FUEL DUMPING

If the fuel level in tank 3 has prematurely reached the 5000 pound level and dumping is required (excessive fuel in tanks 4, 5 or 6) proceed as follows:

1. Fuel dump switch - EMER.
2. Tanks 4, 5 or 6 containing fuel - Press on.
3. Forward transfer switch - FWD TRANS (if required).
4. Fuel quantity - Alternately monitor tanks 1 and 3.

When tank 1 quantity reads 3000 pounds:

5. Forward transfer switch - OFF.

When required amount of fuel remains:

6. Fuel dump switch - OFF.

FORWARD FUEL TRANSFER AND FUEL DUMPING PROCEDURE

Forward fuel transfer and fuel dumping may be accomplished simultaneously as follows:

1. Fuel dump switch - NORM.

2. Forward transfer switch - FWD TRANS.

3. Fuel quantity - Alternately monitor tanks 1 and 3.

When tank 1 fuel quantity reads 3000 pounds:

4. Forward transfer switch - OFF.

5. Fuel dump switch - OFF when 5000 pounds remain in tank 3.

FUEL QUANTITY LOW WARNING

If the fuel-quantity-low warning light comes on with appreciably more than 5000 pounds of TOTAL fuel indicated on the quantity gage, determine total fuel from the individual tank quantities. Monitor tank 3 quantity and land as soon as practicable. Quantity indications are affected by pitch attitude and longitudinal acceleration. Total quantity indication is also affected by the fuel distribution in the individual tanks.

If the fuel quantity low warning light does not come on with less than 5000 pounds of TOTAL fuel indicated on the quantity gage, test warning light and land as soon as possible.

ELECTRICAL POWER SYSTEM FAILURE

SINGLE AC GENERATOR FAILURE

Failure of one ac generator will be indicated by illumination of the L GENERATOR OUT or the R GENERATOR OUT warning light. One generator in normal operation is sufficient to carry the entire aircraft electrical load. In the event of generator failure, proceed as follows:

1. Generator switch - RESET then release.

If the generator fault was momentary the generator will be reconnected to the system and the warning light will extinguish.

If the light remains on:

2. Generator switch - TRIP.

3. Land as soon as possible.

DOUBLE AC GENERATOR FAILURE

If both ac generators fail, the dc monitored bus will be dead. The only souce of power will be the battery which will automatically power the dc essential bus if the battery switch is on. With reduced usage the battery will last approximately 30 minutes with all inverters on. Some dc systems which may not always be essential for flight cannot be turned off by the pilot unless the circuit breakers are pulled. These are difficult to reach when wearing a pressure suit. The UHF radio should be off except when absolutely necessary because its large power requirement will deplete battery power rapidly. With complete generator failure, fuel boost pumps are inoperative. Proceed as follows:

1. Battery switch - Check ON.

2. Generator switches - RESET.

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3. If both generators do not reset - Land as soon as possible; conserve battery power if both generators are inoperative.

TRANSFORMER-RECTIFIER FAILURE

One transformer-rectifier will supply the normal electrical demands. Fixed-frequency ac power systems will continue to operate normally. A double failure of the transformer-rectifers removes power from the dc monitored bus. The battery will operate the dc essential bus. Conserve battery power and land as soon as possible.

INVERTER FAILURE

The No. 2 inverter may be used to supply either the No. 1 or No. 3 inverter bus in addition to supplying its own bus. If both No. 1 and No. 3 inverters should fail, and the respective switches are placed in the EMER position, only No. 1 and No. 2 inverter buses will be powered by the operative No. 2 inverter. Failure of No. 2 inverter will make the standby attitude gyro and B SAS channels in pitch, yaw, and roll inoperative. If the No. 1 or No. 2 inverter fails, proceed as follows:

1. A & B SAS roll channel switches - OFF.

2. No. 2 inverter switch - Check ON.

Check NO. 2 INVERTER OUT light not illuminated:

3. Failed inverter switch - EMER.

Check that NO. 1 INVERTER OUT or NO. 3 (as applicable) INVERTER OUT light extinguishes.

4. A & B SAS roll channel switches - ON.

CAUTION

Both SAS roll channels should be disengaged prior to turning ON a normal or emergency inverter, or switching inverter loads in flight.

5. Illuminated SAS recycle lights - Press.

HYDRAULIC POWER SYSTEM FAILURE

With both engines out, the hydraulic pumps provide sufficient flow for satisfactory flight control system operation at windmill speeds above 3000 rpm. Reduced control system capability is available down to a windmilling speed of approximately 1500 rpm. With one engine windmilling, all primary and most utility services are supplied by the operating engine hydraulic systems. The windmilling engine utility system pressure and flow may be sufficient to supply service until the engine is almost stopped.

PRIMARY HYDRAULIC SYSTEM FAILURE

The loss of either A or B hydraulic system will be indicated by the warning light on both annunciator panels, the master caution light, and the hydraulic pressure gage. Reduce speed to less than 350 KEAS if either A or B system fails.

Disengagement of the failed hydraulic system SAS channels is necessary to maintain full yaw and roll damping capability. As a hydraulic system failure is not sensed by the SAS equipment, it is necessary to double the SAS signal gain of the operating channel to give the equivalent control response in yaw and roll. Airspeed reduction with a single hydraulic system is a precautionary procedure which allows for the reduction in available hinge moment capability. Disengagement of the failed system SAS pitch channel is not mandatory, but it may be more desirable to disengage all three channels than only the yaw and roll switches. Monitor all system operations closely and attempt to determine if a complete failure is imminent. Be prepared for ejection prior to complete failure.

UTILITY HYDRAULIC SYSTEM FAILURE

The loss of L or R hydraulic system will be indicated by the hydraulic pressure gage. If the pressure of the L system falls below 2200 psi, crossover for gear retraction is automatic. The manual release must be used to lower the gear. Items which are affected by the L hydraulic system are normal brakes, UHF antenna retraction, nosewheel steering, forward cockpit air-conditioning, aerial refueling system, and the left inlet control actuator. Items which are affected by the R hydraulic system are the aft cockpit air-conditioning, right inlet control actuator, alternate steer and brake and air refueling system.

A OR B HYDRAULIC SYSTEM FAILURE

1. Reduce speed to less than 350 KEAS.

CAUTION

Do not exceed 350 KEAS with either an A or B hydraulic system inoperative. If either system fails above this speed, reduce speed as soon as possible. Flight control responsiveness will be reduced during single hydraulic system operation at high KEAS and Mach numbers, and flight under these conditions should be held to a minimum.

2. Affected SAS yaw and pitch switches - OFF.
3. SAS roll switches - OFF.
4. Operative roll channel switch - ON.

<u>Note</u>

When one roll SAS channel is disengaged or turned off, the simplified logic circuit will disengage the other roll channel. The desired roll channel switch must be turned OFF and then reengaged to regain single channel roll SAS operation.

5. Reserve hydraulic oil switch - A or B (whichever system is operative).

A AND B HYDRAULIC SYSTEMS FAILURE

1. EJECT.

<u>WARNING</u>

If both the A and B hydraulic systems have failed all flight controls will be inoperative.

FLIGHT CONTROL SYSTEM FAILURE

With both engines out, the ac generators furnish rated electrical power at windmill speeds above 2800 rpm. The emergency battery provides SAS operation lower windmill speeds. There is sufficient hydraulic flow to operate the control surfaces at satisfactory rates above 3000 rpm and operation at reduced rates is available to a windmilling speed of approximately 1500 rpm.

Note

During single engine operation a windmilling engine may not develop sufficient system hydraulic pressure to maintain operation of its associated SAS servo channels. To avoid nuisance disengagement of SAS channels, turn off all three SAS channel switches for the windmilling engine hydraulic system when lower than normal pressure is indicated. Pitch and Yaw SAS damping will continue on one channel. The operative engine SAS roll channel must be cycled OFF then ON to maintain damping in the Roll axis.

FLIGHT CONTROL SYSTEM EMERGENCY OPERATION

If either the A or B hydraulic system fails, the control forces will not change. Either system will operate the control surfaces, but at a slower rate and with some reduction in control responsiveness at high KEAS and Mach numbers.

If control difficulties are encountered:

1. Check A and B hydraulic system pressures. If either A or B hydraulic system has failed proceed as directed for A and B hydraulic system failure this section.
2. Disengage autopilot and check control.
3. Check SAS warning lights. If SAS failure has occurred, proceed as directed under SAS Emergency Operation this section.

SAS EMERGENCY OPERATION

SAS emergency operating procedures and the applicable flight limitations should be used whenever there has been a channel disengagement or a reduction in SAS effectiveness. Disengagements may result from failures of any of the following systems or components: SAS gyro or electronics circuitry, flight control servos, or electrical power supply. Disengagement or loss of effectiveness may occur as a result of complete or partial loss of A or B System hydraulic power. Disengagement of any channel is indicated by illumination of the master caution light, the SAS CHANNEL OUT light on the annunciator panel, and one or more of the recycle indicator lights on the SAS control panel.

When a malfunction is indicated in any SAS axis, initiate the following preliminary actions:

a. A & B hydraulic system pressures - Check normal. If hydraulic system failure is indicated, follow A and/or B Hydraulic System Failure procedure, this section.

b. INVERTER OUT Warning Lights - Check.
If illuminated, use Inverter Failure procedure, this section.

c. Proceed to appropriate Pitch and Yaw axis or Roll Axis Failure procedures, this section.

A single failure or sequence of failures in the pitch and yaw axes which leaves one A or B channel operating in each of these axes does not change the aircraft flight characteristics. However, some undesirable cross-coupling in the pitch and yaw axes may result from failure of one roll channel. Characteristics which change as a result of failures affecting both the A and B channel servos in an axis are described as second condition failures with the appropriate procedures. Refer to the SAS Warning Lights charts which illustrate the probable causes of failure indications, remaining capabilites, procedures, and limits which apply after channel disengagement.

Pitch and Yaw Axis Failures

A "first" condition failure exists after attempts to extinguish one or more recyle lights are ineffective and either an A or B channel is operating (light Off) in each of the pitch and yaw axes. A "first" condition failure exists with a single A, B, or M channel light illuminated or in some cases after simultaneous or progressive illumiation of two or more of these lights, as illustrated by the SAS Warning Lights Chart.

Note

> Consider that no failure exists when all pitch and yaw recycle lights have been extinguished, regardless of previous combinations of illumination, if normal operation of the recycle lights is verified by depressing the SAS Lights Test button.

Flight may be continued without restriction when a first condition failure exists except that maximum airspeed is limited to 350 KEAS in the case of combined channel failures due to low hydraulic system pressure.

A "second" condition failure is defined as existing whenever the A and B recycle lights in one axis remain illuminated after attempts to extinguish them are ineffective. When a "second" condition failure exists, flight speed is restricted to Mach 2.8 and 350 KEAS. Transfer fuel as required to obtain either 2° nose up trim or 3000 pounds in tank 1.

Note

> Each instance of recycle light illumination presents a new situation and, if the light(s) can not be extinguished, the condition must be determined as being a "first" or "second" condition of failure in accordance with the definitions provided above.

Logic override procedures are usable after a "second" condition failure when the sequence of light illumination indicates that a channel with operative servos is available. Refer to After Second Failures, SAS Warning Lights Chart. When use of logic override is effective, flight characteristics are the same as with SAS fully operational. However as a precaution against subsequent hardover failure signals, the autopilot must not be engaged in that channel and second condition failure limits apply.

WARNING

- If logic override is recommended, use it only in the channels specified and only after decelerating to second condition failure limit speeds in order to prevent excessive structural loads which could result from a hardover failure at higher speeds.
- Neither logic override nor BUPD operation should be attempted with either channel known to have a failed servo.

BUPD plus logic override procedures are available after a "second" condition failure in the pitch axis. The BUPD is optimized for operation at air refueling speeds, and it should not be operated above 330 KEAS or 0.85 Mach. It may or may not improve flight characteristics at other flight conditions.

SAS FAILURE WARNING LIGHTS CHART

PITCH OR YAW RECYCLE LIGHTS ON

INDICATIONS AFTER FIRST FAILURE

PITCH OR YAW Light(s) on (◎ 1st ❷ 2nd)									
A	◎	○	○	◎	○	◎	○	❷	○
B	○	◎	○	○	◎	○	◎	○	❷
M	○	○	◎	◎	◎	❷	❷	◎	◎
SEQUENCE OF ILLUMINATION — FIRST	A servo	B servo	M gyro	A gyro	B gyro	A servo	B servo	M gyro	M gyro
SEQUENCE OF ILLUMINATION — SECOND						M or A gyro	M or B gyro	A servo	B servo
CHANNELS REMAINING OPERABLE	B	A	A and B	B	A	B	A	B	A
ACTION: First try to press light(s) off	then ➡ No further action when first failure lights stay on A or B light is off								
LIMITS	NONE								

INDICATIONS AFTER SECOND FAILURE

PITCH OR YAW (◎ 1st ❷ 2nd)							
A	❷	◎	❷	◎	❷	◎	❷
B	❷	❷	◎	❷	◎	❷	◎
M	◎	◎	◎	❷	❷	○	○
SEQUENCE OF ILLUMINATION — FIRST	M gyro	A gyro	B gyro	A servo	B servo	A servo	B servo
SEQUENCE OF ILLUMINATION — SECOND	A or B gyro	B or M gyro or B servo	A or M gyro or A servo	B gyro	A gyro	B servo	A servo
FUNCTIONS OPERABLE	A or B Channel	A servo's possibly B channel	B servo possibly A channel	B servo	A servo	NONE	
ACTION First try to press lights off then ➡ If A and B lights stay on	pitch or yaw: Try Override — A or B first	pitch or yaw: Try Override — B / A; Unless subsonic then BUPD plus pitch override — A / B		If pitch Try BUPD plus override — B / A; If Yaw No Action		NO ACTION; UNUSABLE pitch or yaw SAS	
Note: Use of Logic Override is not mandatory	To use pitch or yaw Logic Override: A and B Channels off. Select A or B override. Beep Channel switch ON. To use BUPD: A and B channels OFF. BUPD - ON Select A or B Override. Beep one Channel on. Channel off if no improvement.					Do not use Logic Override or BUPD	
LIMITS	Mach 2.8 and 350 KEAS maximum. Fuel transfer is necessary for 2° noseup trim up to 4000 lb. With override - No autopilot that axis With BUPD - Mach 0.85 and 330 KEAS						

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Figure 3-4 (Sheet 1 of 2)

SAS FAILURE WARNING LIGHTS CHART

COMBINATIONS OF PITCH, ROLL AND YAW DISENGAGE LIGHTS INVERTER OUT AND A OR B HYDRAULIC LOW WARNING LIGHTS ON

INDICATION	ELECTRICAL FAILURE				HYDRAULIC FAILURE		
PITCH A / YAW A ROLL B / B M / M	○ ○ ○ ○ ○ ◍ ◍	◍ ◍ ◍ ○ ○ ◍ ◍	○ ○ ◍ ◍ ◍ ◍ ◍	● ● ● ● ● ● ●	⊛ ⊛ ⊛ ○ ○ ○ ○	○ ○ ⊛ ⊛ ⊛ ○ ○	No lights on but operation poor
CHECK	INV 3	INV 1	INV 2	ANY TWO	A System	B System	BOTH A and B
ACTION	1 Check circuit breakers a Inv 3 ØB-SAS pitch-yaw mon b Ess DC bus-SAS M 2 Inverter Switch - EMER 3 Press recycle lights off 4 Recycle roll channel switch if light is on 5 Do not use logic override	1 Check circuit breakers a Inv 1 ØB-SAS yaw A b Ess DC bus-SAS A	1 Check circuit breakers a Inv 2 ØB-SAS yaw B b Ess DC bus-SAS B NOTE: INV 2 load cannot be xfrd to EMER	1 Check circuit breakers a Inv 1,2,3 b Ess DC bus-SAS A,B,M NOTE: M Channels will be inoperative	Channel off if pressure is low With normal pressure: 1 Cycle roll channel switch 2 Press recycle lights off NOTE: Any combination of A, B, and/or roll lights may occur ⊛ Lights may illuminate simultaneously or progressively		
LIMITS	NONE			2nd Failure	350 KEAS maximum		

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Figure 3-4 (Sheet 2 of 2)

If logic override procedures are not effective or possible after a second condition failure in the yaw axis, tests at high Mach numbers indicate that neutral to slightly positive stability exists but that there is little damping of yaw oscillations after they commence.

1. Illuminated recycle light(s) - Depress and release.

If light(s) stays on or reilluminates, no further action is required unless a second condition failure exists.

2. Channel switch - OFF.

If another failure should occur in the same axis:

3. Illuminated recycle lights(s) - Depress and release.

4. If lights do not extinguish with second condition failure - Comply with limits.

If SAS lights indicate a good servo is available:

5. A or B logic override - Engage as indicated by servo availability.

   a. Pitch or yaw logic override switch - A or B position depending on failure analysis.

   Note

   Refer to SAS Warning Light Chart.

   b. Appropriate A or B channel switch - Beep ON.
   Recycle light should extinguish.

c. If control does not improve - Channel switch - OFF.

d. Logic override switch - OFF.

For pitch axis second condition failure; when speed is below 330 KEAS and 0.85 Mach:

6. BUPD - Engage as required.

a. Pitch SAS A and B channel switches- OFF.

b. BUPD switch - ON.

c. Pitch logic override switch - A or B position as indicated by servo availability.

d. Appropriate A or B pitch SAS channel - Beep ON. Recycle light should extinguish.

e. If control does not improve - Channel switch OFF.

f. Logic override switch - OFF.

g. BUPD switch - OFF.

h. Depending on failure analysis this procedure may be repeated using other SAS channel if indicated.

Roll Axis Failures

Illumination of the roll channel disengage light shows that both roll channels and the roll autopilot are disengaged. When there is no apparent fault in the hydraulic systems or electrical power supply which would cause disengagement, check for a transient disengagement as follows:

1. A or B channel switch - OFF, then ON.

A transient or intermittent fault existed if the light remains off. If the light does not extinguish, or reilluminates while maneuvering, a first condition failure exists in the roll mode.

For a first failure:

2. A and B channel switches - OFF.

Unless the failure can be associated with a specific hydraulic or electrical power supply, regain the use of one channel by the following arbitrary step sequence:

3. A Channel switch - ON.

Note

- Be prepared to move the switch to OFF immediately if a hardover signal results, indicating that the failed channel was inadvertently selected.
- Operation with only one roll channel engaged results in overriding of logic circuitry. There is no automatic protection against inadvertent selection of a failed channel, or against subsequent failure of a properly operating channel which has been engaged.

If a hard-over signal is obtained on engagement or during subsequent operation, or if no improvement is noted in flight characteristics:

4. A Channel switch - OFF.

5. B Channel switch - ON.

Note

Be prepared to disengage the channel immediately if a hardover signal results.

[redacted]

If a hard-over signal is obtained on engagement or during subsequent operation, or if no improvement is noted in flight characteristics, a dual or second condition failure exists.

For a second condition failure:

6. Roll channel switches - Both OFF.

Some undesirable cross-coupling may occur during single roll SAS channel operation. This appears as small amplitude oscillations in the pitch and yaw axes, as the elevons on only one side of the aircraft respond to roll signals during single channel operation and compensation for the asymmetric roll signals is provided by pitch and yaw axis control operation.

Scheduled activity may be continued for the remainder of the flight with a single roll SAS channel operating. The roll autopilot may be engaged and the automatic navigation feature of the INS used as desired.

Notes

Operation with both roll channels disengaged is permitted if cross-coupling about the pitch and/or yaw axes prevents precise aircraft control with one roll channel engaged.

In the event of single engine failure at low speed, or during single engine landing, failure of one roll SAS channel and simultaneous automatic disengagement of the other roll channel may occur due to loss of hydraulic power from the windmilling engine.

To avoid changes in control characteristics at a critical time during single engine landings, either make the approach with both roll SAS channels disengaged or with the roll channel which is powered by the inoperative engine disengaged.

A second roll SAS channel failure while at high speed will probably be indicated by abnormal pitch transients and small roll transients without illumination of either pitch or roll SAS indicator lights. The symptoms may be difficult to attribute to roll channel failure. When pitch transients occur with one roll channel engaged, disengage both roll SAS channels and check for control improvement. If no improvement is noted, the single roll channel may be reengaged if desired.

Failure or intentional disengagement of both roll SAS channels is expected to increase pilot fatigue, reduce mission effectiveness, and will disable the roll autopilot; however, no hazard to safety should result and there are no flight restrictions on continued operation.

TRIM FAILURES

Pitch, yaw or roll trim malfunctions maybe of the inoperative type or the runaway type. Runaway trim failures in pitch may occur at slow speed (0.15°/sec change in elevon deflection) if due to autopilot/Mach trim motor operation or at fast speed if due to manual trim motor operation (1.5°/sec change in elevon deflection). A low speed runaway type of malfunction will be apparent by the need for constant manual pitch trimming. The runaway yaw trim rate if approximately 1.5° per second trim change. The roll trim rate is approximately 1°/sec. Runaway yaw trim will be accompanied by rudder pedal deflections as the surfaces move. Runaway pitch or roll trim will not be accompanied by stick movement due to surface movement.

In the event trim runaway failure is suspected, proceed as follows:

1. TRIM POWER SWITCH - OFF.

If circumstances permit:

2. Reduce speed to below 350 KEAS and 2.5 Mach.

With runaway nose up pitch trim:

3. Transfer fuel forward to reduce forward stick force requirement.

WARNING

Do not transfer fuel if nose down pitch trim has occurred.

When initial speed is above Mach 2, decreasing Mach normally requires increasing nose up pitch trim.

When time and conditions permit:

4. Autopilot - ON. Check for control improvement.

5. Affected trim circuit breakers - Pull.

Note

Both A & C phase circuit breakers must be pulled on the suspected circuit.

Trim Malfunctions:

a. If runaway slow speed pitch trim - Pull auto pitch trim circuit breakers.

b. If runaway high speed pitch trim - Pull manual pitch trim circuit breakers.

c. If inoperative manual pitch trim - Pull the Mach trim dc circuit breaker.

Note

If Mach trim dc circuit breaker is pulled, the normal Mach trim speed stability augmentation in the transonic region will not be available.

d. If runaway roll or yaw trim - Pull roll or yaw circuit breakers.

6. Trim power switch - ON.

With manual pitch trim inoperative and auto trim available, engagement of the pitch autopilot will gradually correct an out of pitch trim condition. This will relieve the pilot of a need for maintaining stick deflection to maintain attitude. The pitch autopilot can also be used when the auto trim motor is inoperative, but automatic pitch trim synchronization will not be available.

CAUTION

Disengagement of the pitch autopilot when not in trim may be accompanied by a considerable transient.

If the trim malfunction is a runaway in the roll axis, right or left stick deflection will be required for the rest of the flight but stick force will not be more than normally required for the same amount of deflection. If the malfunction was a runaway in the yaw axis, rudder pedal force will be required to maintain neutral rudder pedal position.

LANDING GEAR SYSTEM EMERGENCY OPERATION

RETRACTION

There is no emergency system for retracting gear in flight; the gear lever is the only control retracting the gear. If the gear lever cannot be moved to the UP position after takeoff, do the following:

1. Ground retract button - Depress and hold.

2. Landing gear lever - UP.

This procedure overrides a solenoid, normally actuated by the landing gear switch, and permits the landing gear lever to be moved.

EXTENSION

The manual landing gear release handle unlocks the landing gear uplocks and allows the landing gear to fall free to the down-and-locked position. If L or R hydraulic system pressure is available the landing gear lever must be placed in the DOWN position or the landing gear CONT circuit breaker must be pulled to permit emergency extension. Approximately 90 seconds is required for emergency gear extension. The manual landing gear release handle must be pulled approximately 9 inches for actuation of all gear uplocks. If it is not pulled all the way out one or more gear may fail to extend. If the L hydraulic system has failed, or normal gear extension is unsuccessful, proceed as follows:

1. Landing gear lever - DOWN.

2. Manual landing gear release handle - Pull.

3. Verify gear down and locked.

If landing gear remains retracted:

5. Aft cockpit landing gear switch - DOWN.

If gear still retracted:

6. Landing gear CONT circuit breaker - Pull.

7. Repeat steps as necessary.

Note

When the landing gear CONT circuit breaker is pulled nosewheel steering will be inoperative.

WHEEL BRAKE SYSTEM FAILURE

Without antiskid brakes operating, proper braking technique is required to prevent a skid. A skid is hard to detect in this aircraft because of its size, weight, and landing gear geometry. At high speed a skid will usually blow the tires before corrective action can be taken. Proper braking technique is achieved by applying a steady, constantly increasing pedal pressure as aircraft speed decreases.

BRAKE SYSTEM EMERGENCY OPERATION

If normal braking is not effective, or L hydraulic pressure is not available and R hydraulic pressure is, proceed as follows:

1. Brake switch - ALT STEER & BRAKE.

If both engines are shut down during ground roll, the brake switch should be left in the ANTISKID or NORM position and steady pedal pressure applied until the aircraft comes to a complete stop.

AIR DATA COMPUTER FAILURE

If malfunction or failure of the air data computer (ADC) is suspected, proceed as follows:

1. Cross-check TDI instrument against pitot-static-operated airspeed and altimeter.

If cross-check shows TDI to be inaccurate:

2. Revert to use of pitot-static-operated instruments for aircraft control.

3. Mach trim - Pull MACH TRIM circuit breaker.

4. Autopilot - OFF.

PITOT-STATIC SYSTEM FAILURE

Under some conditions the two normal ADC and pitot-static operated systems may become inaccurate or inoperative from a common malfunction. Failure of the pitot heater may simultaneously affect both normal systems in icing conditions. The pitot probe could also be plugged by a foreign body. If both normal systems fail, the pilot should proceed as follows:

1. Attempt to restore operation by selecting alternate source.

2. Maintain aircraft control by use of attitude and power indicating instruments.

3. Request escort aircraft for letdown and landing.

AIR CONDITIONING AND PRESSURIZATION FAILURES

LEFT ENGINE OR FORWARD COCKPIT SYSTEM INOPERATIVE

At any time the left engine is shut down:

1. Forward cockpit system switch - CROSSOVER.

FORWARD COCKPIT AND VENTILATED SUIT OVERTEMPERATURE

1. Defog switch - OFF.

2. Cockpit temperature indicator - Check.

If temperature indication is too high:

3. Forward cockpit auto temperature rheostat - Rotate toward COLD.

Note

The hot and cold valves are motor-operated and travel from full hot to full cold in approximately 7 to 13 seconds.

If auto temperature control is not effective and forward cockpit temperature remains too high:

4. Forward cockpit temperature control switch - Hold in manual COLD.

Note

In this position the motor-driven valves take 12 to 24 seconds to travel from full hot to full cold.

If no decrease in temperature occurs in 30 seconds:

5. Forward cockpit system switch - CROSSOVER.

WARNING

Aft cockpit system switch must be ON.

If suit temperature cannot be controlled by the above steps:

6. Suit flow valves - OFF.

7. Reduce altitude and speed.

AFT COCKPIT OVERTEMPERATURE

If the aft cockpit temperature indication is too high, proceed as follows:

1. Aft cockpit auto temperature rheostat - Rotate toward COLD.

<u>Note</u>

The above step should be accomplished in increments as there will be a lag in the temperature indication.

If auto temperature control is not effective and aft cockpit temperature remains too high:

2. Aft cockpit temperature control switch- Hold on manual COLD

<u>Note</u>

The manual cold valve will take from 12 to 24 seconds to travel to FULL COLD.

COCKPIT DEPRESSURIZATION

Cockpit depressurization above approximately 35,000 feet will be indicated by pressure suit inflation. If suit inflates, proceed as follows:

1. Cockpit altitude - Check.

2. Canopy seal levers - Check ON.

3. Cockpit pressure dump switch - Check OFF.

WARNING

During this time, the pilots will be depending on the pressure suit only for altitude protection.

If cockpits still do not repressurize:

4. Suit ventilation boost lever - EMER.

5. Descend as soon as possible.

ABBREVIATED CHECKLIST

The emergency abbreviated checklist is furnished separately.

SECTION IV

AUXILIARY EQUIPMENT

TABLE OF CONTENTS

CONTROL TRANSFER PANELS

Control transfer panels, located on the left console in each cockpit, allow either pilot to assume control of the TACAN and UHF equipment, the fuel boost pumps, the fuel quantity gage, and the air-conditioning system. (See figure 4-1.)

FORWARD COCKPIT CONTROL TRANSFER PANEL

The forward cockpit control transfer panel has seven switches and seven transfer lights. The ADF switch and transfer light is inoperative.

Communications Equipment Switches and Transfer Lights

Two 2-position toggle switches, labeled TACAN/INSTR, UHF, and two transfer lights, located on the upper left portion of the panel, permits the pilot to assume control of the TACAN, flight instruments, and UHF equipment. Control is obtained by moving the respective toggle switch fore or aft. Control transfer is made when the transfer light illuminates.

Fuel Switches and Transfer Lights

Two 2-position toggle switches, labeled FUEL CONT and FUEL QTY, and two transfer lights, located on the lower left portion of the panel, allow the pilot to assume manual control of the fuel boost pumps and also to obtain readings on the fuel quantity gage. Control of the fuel boost pump panel and the fuel quantity gage is obtained by moving the respective switch either fore or aft. Control transfer is made when the transfer light illuminates.

Air-Conditioning Switches and Transfer Lights

Two 2-position toggle switches, labeled AIR COND CONT TRANS, and two transfer lights, labeled FWD and AFT, are located on the right side of the panel. The switch labeled FWD CKPT and NORM is the mode control switch. The unlabeled switch is the control transfer switch.

When the mode control switch is in the FWD CKPT position one cockpit has control over the air-conditioning of both cockpits and one transfer light (FWD or AFT) will be illuminated, indicating which cockpit has control. Moving the control transfer switch in either cockpit to the alternate position will transfer control to the other cockpit.

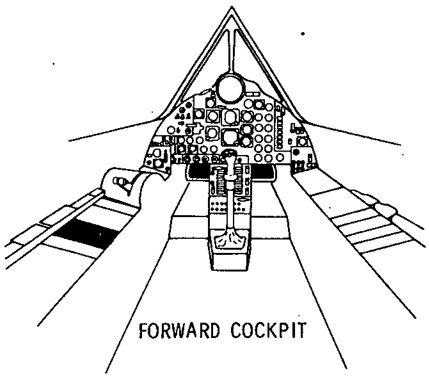
When the mode control switch is in the NORM position either the aft cockpit has control of air-conditioning for both cockpits (AFT light on) or each cockpit has control over its own air-conditioning (both lights out). Moving the control transfer switch to the alternate position reverses these functions.

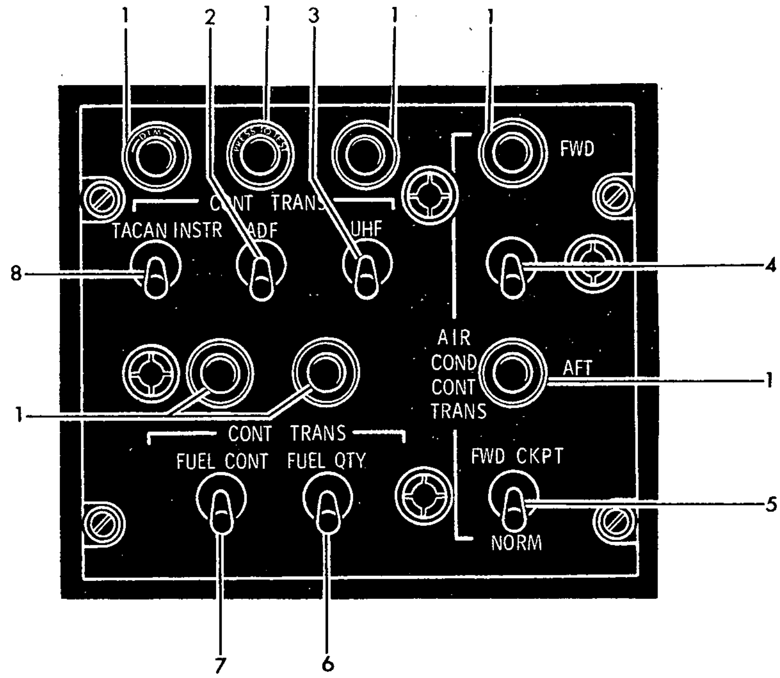
The FWD light will not light in either cockpit if the mode control switch is in the NORM position.

The following chart summarizes the function of the cockpit air-conditioning system:

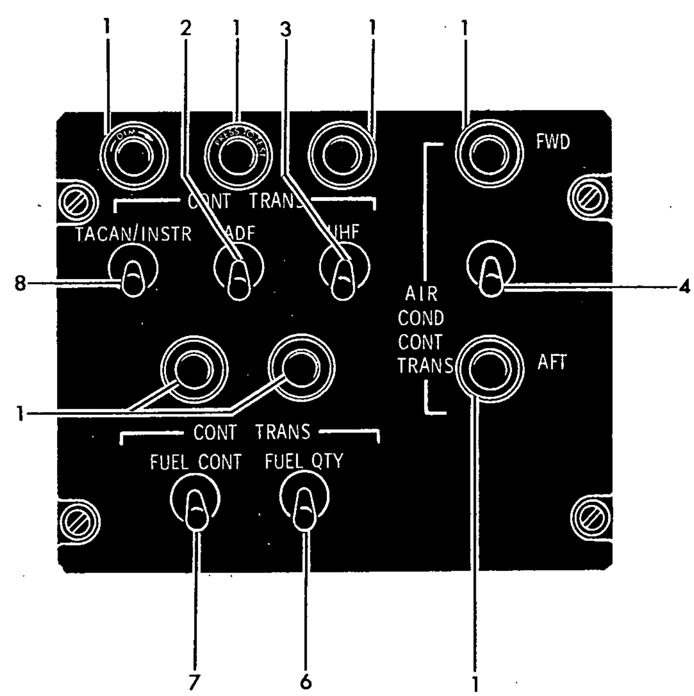
Transfer Lights	Control Function
● FWD O AFT	Fwd ckpt has control of air-cond of both ckpts. Mode control sw in FWD CKPT position.
O FWD ● AFT	Aft ckpt has control of both ckpts. Mode control sw in FWD CKPT or NORM position.
O FWD O AFT	Aft and fwd ckpts have control of their own air-cond. Mode control sw in NORM position.

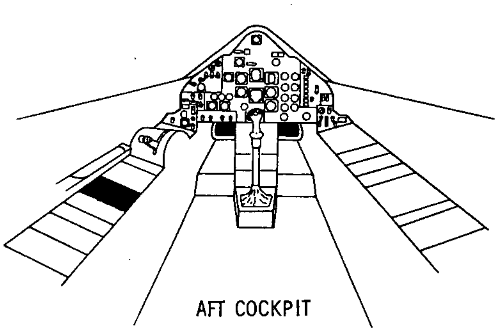
CONTROL TRANSFER PANELS





1 TRANSFER LIGHT
2 ADF CONTROL TRANSFER SWITCH
3 UHF CONTROL TRANSFER SWITCH
4 AIR CONDITIONING CONTROL TRANSFER SWITCH
5 AIR CONDITIONING MODE CONTROL SWITCH
6 FUEL QUANTITY GAGE CONTROL TRANSFER SWITCH
7 FUEL BOOST PUMP CONTROL TRANSFER SWITCH
8 TACAN AND FLIGHT INSTRUMENT CONTROL TRANSFER SWITCH





F201-35(a)

Figure 4-1

AFT COCKPIT CONTROL TRANSFER PANEL

The aft cockpit control transfer panel is identical in appearance and function with the forward control transfer panel except that there is no air-conditioning mode control switch. The ADF switch and transfer light are inoperative.

COMMUNICATIONS AND NAVIGATION EQUIPMENT

UHF COMMAND RADIO, AN/ARC-51

The AN/ARC-51 UHF command radio provides two-way communications on 1750 different frequencies extending from 225.0 through 399.9 megacycles. Any of these frequencies may be selected manually; however, the radio is preset on the ground to the 18 frequencies most commonly used during normal operation. In addition to the main receiver, the set utilizes a second guard receiver which can cover a frequency range between 238.0 and 248.0 megacycles, but which is normally pretuned to 243.0 megacycles. Power for the set is furnished by the essential dc bus. Refer to Control Transfer Panels, this section, for further information.

AN/ARC-51 Control Panels

A control panel is installed on the left console in each cockpit. The panels contain a function switch, rotary channel selector switch, volume control and four manual tuning knobs.

Channel Selector Switch

A rotary channel selector switch labeled CHAN permits selection of any one of 18 preset channels, the guard (G) frequency channel or the manually (M) set frequency channel.

Function Switch

The function switch has four positions labeled OFF, T/R (transmit-receive), T/R + G (transmit-receive + guard) and ADF (inoperative). In the T/R position both the receiver and transmitter are tuned to the preset or manually selected channel. When the switch is in the T/R + G position, the radio will receive signals simultaneously from the main and guard channels of the receiver.

Frequency Selector Knobs

Four frequency selector knobs permit manual selection of any of the 1750 frequencies for transmit-receive operation. The manual frequency windows indicate a direct reading in megacycles and tenths of a megacycle.

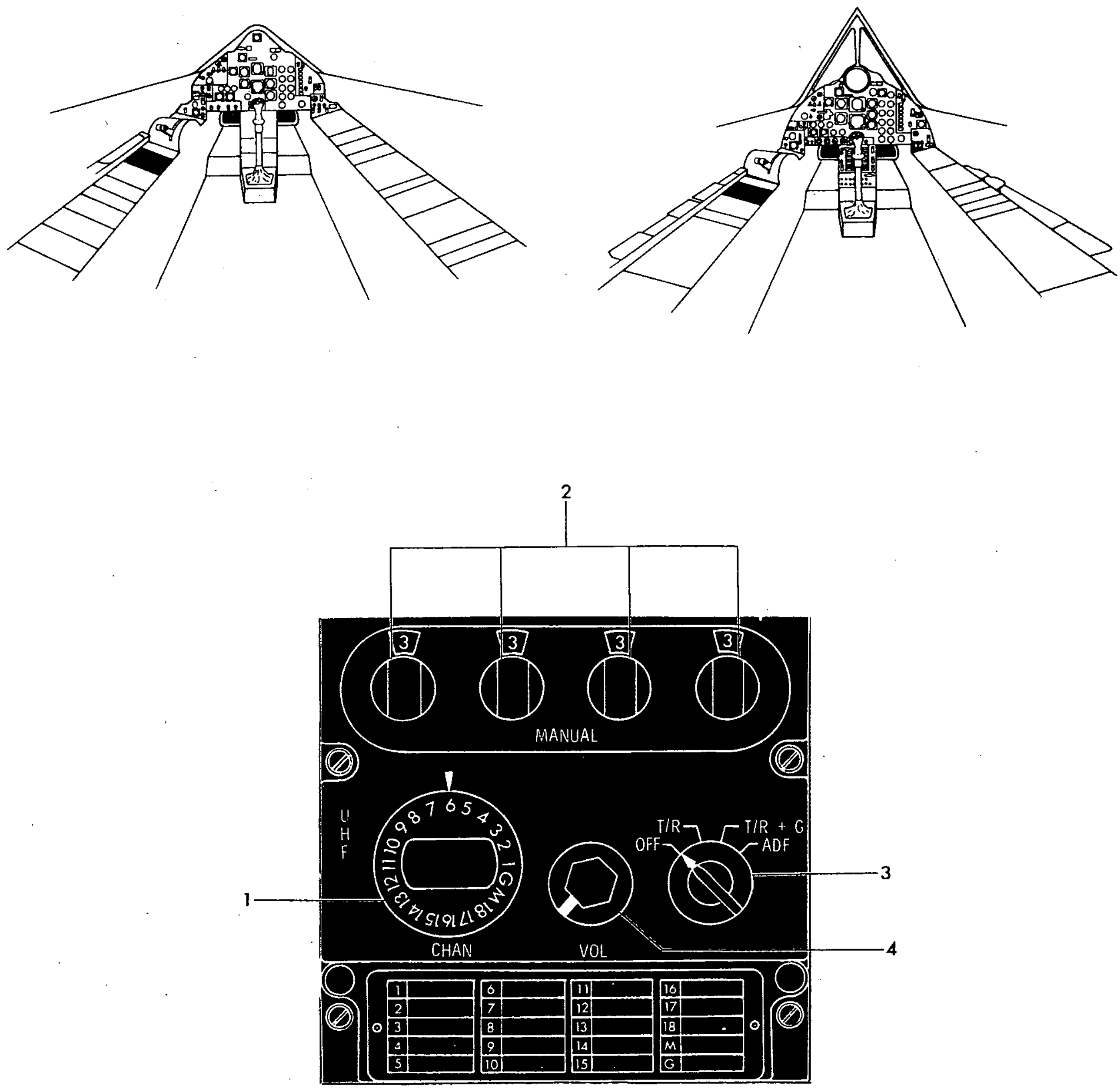
Volume Control

Audio level may be increased by rotating the volume (VOL) control knob clockwise.

UHF Antenna

L hydraulic system pressure extends and retracts the UHF antenna. The antenna will extend from its stowed position in the right chine when the function selector switch is moved to an operating position. The antenna will retract when the function selector switch is moved to OFF. The antenna is spring-loaded and extends if L hydraulic pressure is lost.

UHF COMMAND RADIO CONTROL PANEL (Both Cockpits)



1 CHANNEL SELECTOR SWITCH
2 MANUAL FREQUENCY SELECTOR KNOBS
3 FUNCTION SWITCH
4 VOLUME CONTROL

F201-36 (a)

Figure 4-2

UHF Command Radio Operating Procedures

1. Obtain control of set with the UHF switch on the control transfer panel and check transfer light illuminated.
2. Function switch - As desired.
3. Channel selector switch - As desired.
4. To select a frequency other than one of the preset channels:
   a. Channel selector switch - M.
   b. Manual tuning knobs - Position to set desired frequency. A digital readout of the selected frequency will be shown in the windows at the top of the control panel.
5. To transmit as well as receive on guard channel:
   a. Channel selector switch - G.
   b. Function switch - T/R or T/R + G.

ADF RECEIVER

The ADF radio receiver is an automatic or manual direction finder and a low and broadcast range aural receiver. The equipment consists of a radio receiver, control panel (aft cockpit only), flush sense antenna, flush fixed loop antenna, and HSI. The receiver covers a frequency range of 0.19 to 1.75 megacycles in three bands. Power for the equipment is furnished by the essential dc bus and the No. 1 26V instrument transformer.

ADF Control Panel

The ADF control panel is installed on the right console of the aft cockpit. The controls are described below.

Function Switch

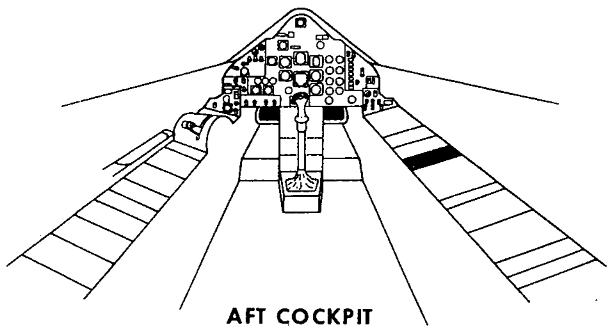
The function switch is the larger of the two concentric knobs on the inboard side of the panel. The labeled positions are OFF, ADF, ANT, and LOOP. In the ADF position the equipment functions as an automatic direction finder with a continuous indication of the bearing to the radio station, shown on the HSI. In this position also, the sense and loop antennas are connected to the receiver. In the ANT position, received signals are obtained only from the sense antenna, and the equipment functions as a conventional aural radio receiver. In the LOOP position received signals are obtained only from the loop antenna and the equipment functions as a manual direction finder to enable the pilot to determine the bearing to the radio station by aural null procedures.

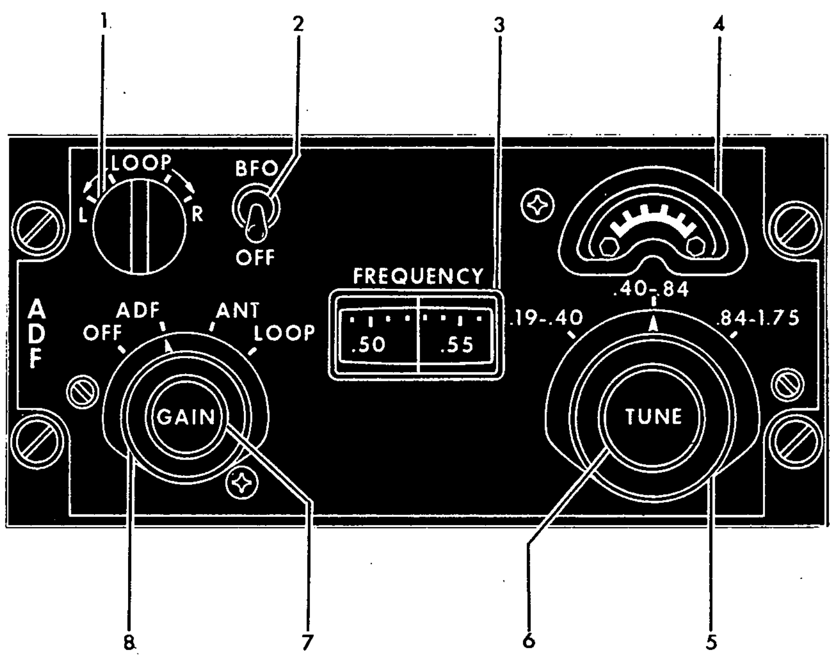
Band Selector Switch

The band selector switch is the larger of the concentric knobs in the outboard side of the control panel and is used to select the desired frequency band. The correct frequency scale will also appear in the frequency indicator window for the band selected as follows:

Band Frequency	Coverage
190 - 400 KC	FAA low frequency band
400 - 840 KC	International distress frequency and lower standard broadcast band
840 - 1750 KC	Upper standard broadcast band

ADF CONTROL PANEL (Aft Cockpit Only)





1 LOOP CONTROL
2 BFO SWITCH
3 FREQUENCY INDICATOR WINDOW
4 TUNE-FOR-MAX INDICATOR
5 BAND SELECTOR SWITCH
6 TUNING CONTROL
7 GAIN CONTROL
8 FUNCTION SWITCH

F201-38(b)

Figure 4-3

Tuning Control

The tuning control is the smaller of the outboard concentric knobs and tunes the receiver within the frequency band selected. The tuned frequency is indicated on the scale of the frequency indicator. The control is also rotated slightly for maximum reading on the tuning indicator.

Loop Control

The control labeled LOOP is used to accomplish the electrical equivalent of rotating the loop antenna. The control is labeled L and R and the left or right rotation effect will be apparent in the headset and the tuning indicator. The speed of the rotating effect may be slowed by turning the loop control approximately half way to the L or R labeled position.

Gain Control

The gain control is the smaller of the inboard concentric knobs and is provided to adjust the receiver audio level.

BFO Switch

The BFO switch provides a beat frequency oscillation to aid in tuning the receiver or to receive coded transmissions.

Operating the ADF Receiver as a Conventional Radio Receiver

1. Function switch - ANT.
2. Band selector switch - Select desired band.
3. Tuning control - Rotate to desired frequency.
4. Volume - Adjust as desired.
5. The BFO switch can be used to tune in continuous-wave signals or to zero-beat modulated signals.

Operating the ADF Receiver as an Automatic Direction Finder

1. Tune receiver as above and positively identify the station.
2. Function switch - ADF.
3. Tuning control - Tune for maximum reading on tuning meter.
4. HSI bearing select switch - ADF.
5. Read bearing to station on HSI bearing marker.

Operating the ADF Receiver as a Manual Direction Finder (Aural Null)

1. Tune receiver as above and positively identify the station.
2. Tuning control - Tune for maximum reading on tuning meter.
3. Function switch - LOOP.
4. Loop control - Turn to R or L as necessary to acquire null.
5. HSI bearing select switch - ADF.
6. Read bearing to station on HSI bearing marker.

FLIGHT INSTRUMENT CONTROL PANEL

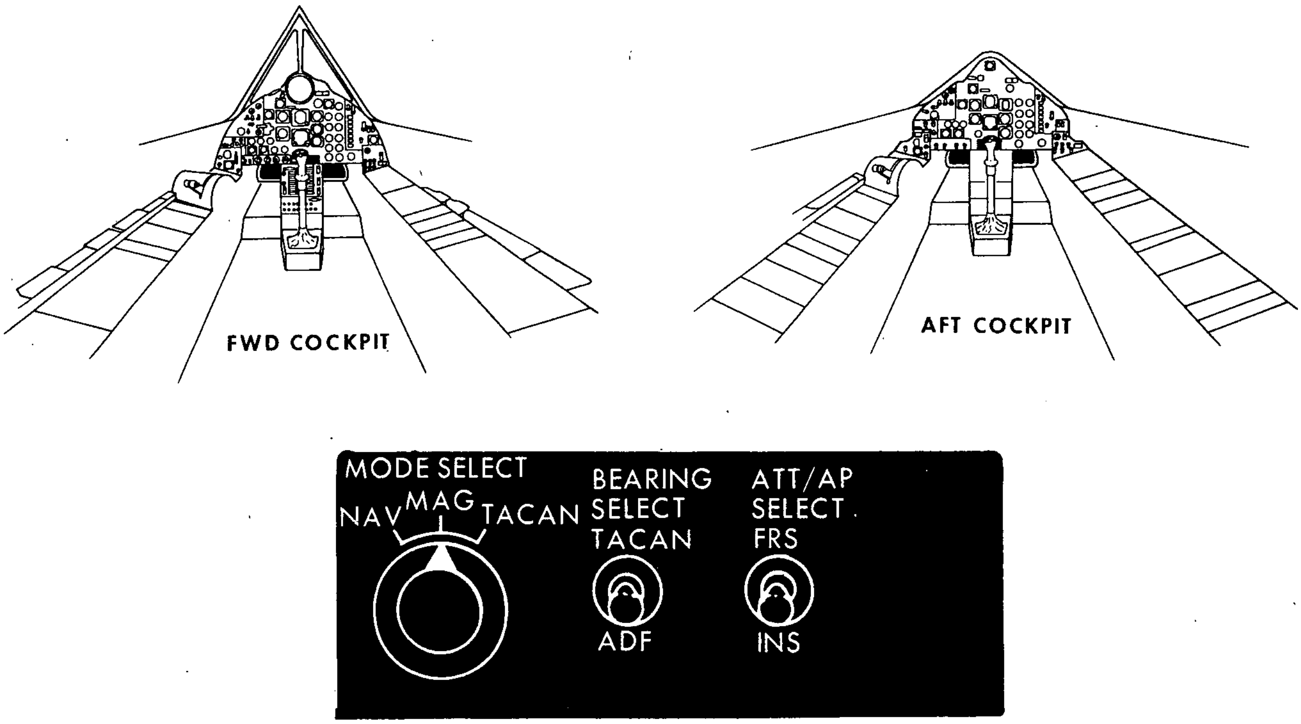


Figure 4-4

F201-76

FLIGHT INSTRUMENT CONTROL PANEL

A flight instrument control panel is centrally located at the bottom of the instrument panel in each cockpit. There are three selector switches on each panel, labeled MODE SELECT, BEARING SELECT and ATT/AP SELECT. The flight instruments in both cockpits will have identical indications at all times and only one cockpit has control. Control is transferred from one cockpit to the other by using the TACAN/INSTR control transfer switch on the left console in either cockpit.

Mode Select Switch

The MODE SELECT switch affects the HSI indication only. This is a rotary switch with three positions; NAV, MAG, and TACAN. When the switch is in NAV or MAG position the heading marker indicates the command steering course from the NAV system, the course arrow is servoed to the lubber line and the course deviation bar is centered. When the switch is in TACAN position the heading marker is manually set, the course arrow is manually set to the desired tacan course and the course deviation bar is operative. When this switch is in NAV position, the compass card indicates true heading, and in MAG or TACAN position the compass card indicates magnetic heading.

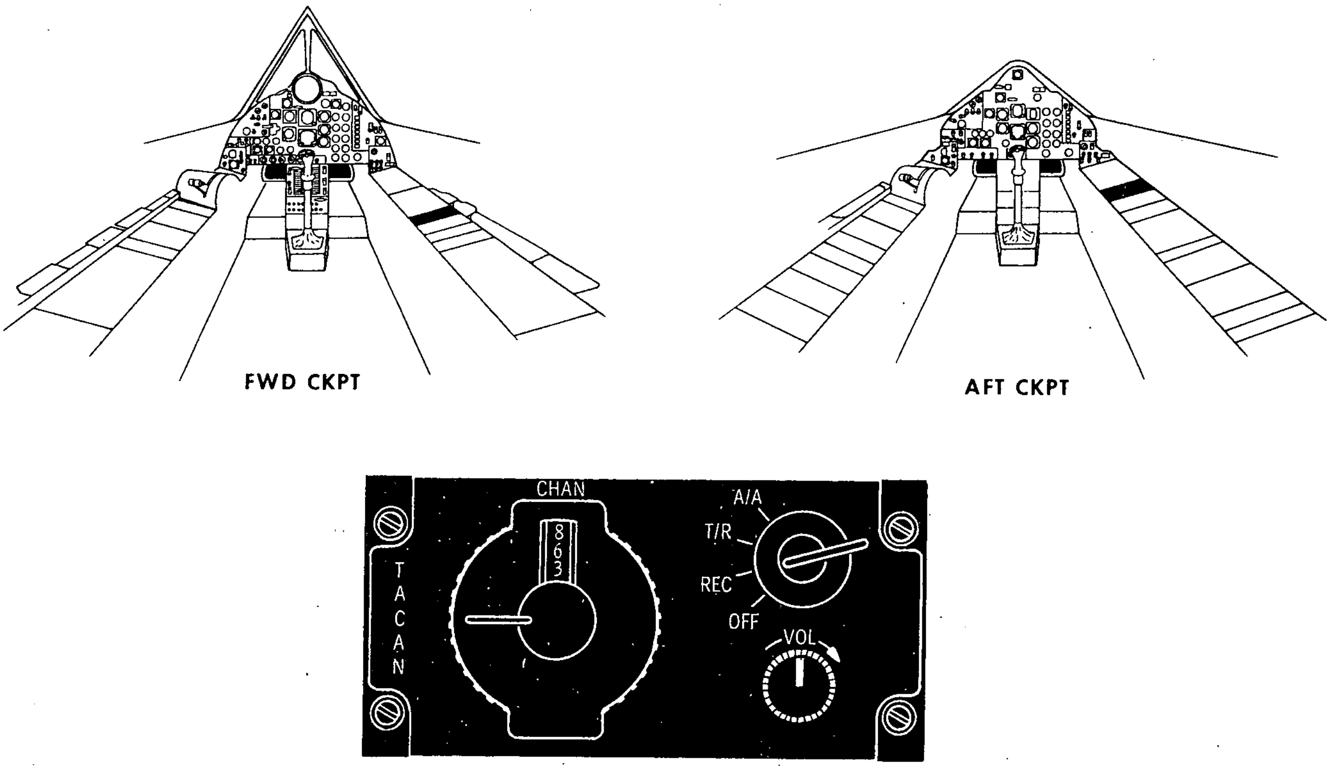
Bearing Select Switch

The bearing select switch has two positions labeled TACAN and ADF, and is used to select the source for the HSI bearing pointer indication, regardless of mode select switch position.

ATT/AP Select Switch

The ATT/AP select switch has two positions labeled FRS and INS and is used to select the reference source for the attitude indicator and the autopilot. The INS position must be selected for AUTO-NAV operation.

TACAN CONTROL PANELS



F201-74

Figure 4-5

TACAN SYSTEM, AN/ARN-52

The Tacan System provides continuous indications of bearing and slant distance to a selected surface beacon and range only to another aircraft containing the necessary transponder equipment. The system transmits interrogation pulses which trigger responding pulses from the selected ground station or aircraft. Slant distance to the station or aircraft is computed from the elapsed time. Both bearing and distance are visually displayed on the Horizontal Situation Indicator which is located on each instrument panel. The system is capable of operation on any one of 126 channels and has a range of about 300 nautical miles. The transmitting frequency range is 1025 to 1150 megacycles. Frequency ranges for reception are; low band normal, 926-1024 megacycles, air to air 1088-1150 megacycles, high band normal, 1151-1213 megacycles, air to air 1025-1087 megacycles. Power for the set is furnished by the essential dc bus.

AN/ARN-52 Control Panel

A control panel is installed on the right console in each cockpit. The panel contains a channel selector switch, mode selector switch and a volume control. The cockpit having control is determined by use of the control transfer switches.

Channel Selector Switch

A channel selector is used to select any one of 126 available channels. Channel selection is accomplished by setting the desired channel number in the window using the concentric knobs. The outer knob selects the first two digits and the inner knob selects the third digit of a desired channel.

Volume Control Knob

Audio level of the Tacan station identification signals is increased by rotating the volume (VOL) control clockwise.

Mode Selector Switch

The function selector switch has four positions.

OFF - The set is de-energized.

REC - The set is energized and presents bearing and course information on the HSI.

T/R - Same as the REC position and also presents range in nautical miles to a Tacan station.

A/A - Presents slant range only in nautical miles to another cooperating AN/ARN-52.

Operation of the Tacan System

1. Obtain tacan control on the control transfer panel.
2. Display MODE SELECT switch - TACAN.
3. BEARING SELECT switch - TACAN.
4. TACAN mode selector switch - REC.

   (Allow 90 seconds for warmup.)
5. Channel selector switch - Desired channel.
6. Verify station identification.
7. Observe bearing pointer and to-from indicator on HSI.
8. Tacan mode selector switch - T/R or A/A.
9. Observe range to station or aircraft on HSI.

TRANSPONDER (IFF) - 914-X-1

The 914-X-1 transponder provides reception, detection, decoding, encoding and transmission of signals in the IFF Mark X (SIF) system and has a locally installed MODE X discrete operating function. The transponder will also recognize a Mode 4 interrogation; however, the set will not decode or encode a reply without accessory equipment. Any one of numerous coded replies available for Modes 1, Mode 3 or X can be selected by rotating the appropriate selector switches on the panel. The set is capable of transmitting an emergency reply regardless of the interrogation mode. A provision is also incorporated to identify position of the aircraft. Power for the set is furnished by the essential dc bus. Addition of the Mode X capability deletes the Mode 2 function from the transponder. Controls are provided in the forward cockpit only.

TRANSPONDER (IFF) CONTROL PANEL

The transponder control panel is installed on the upper left console of the forward cockpit. The panel contains two code selectors for Mode 1 and Mode 3/X codes, Mode 1 and Mode 3 toggle switches, an I/P switch, IFF power selector switch and an emergency switch bar.

Power Switch

The IFF power switch has three positions: Off, LO, and ON. When the switch is placed at LO, only local (strong) interrogations are recognized and answered. With the switch in the ON position, there is full sensitivity for recognition and reply. The IFF power switch activates Mode X when in the ON or LO position. Response to Mode 1 and Mode 3 interrogations is dependent on the position of the Mode 1 and 3 toggle

IFF/SIF CONTROL PANEL

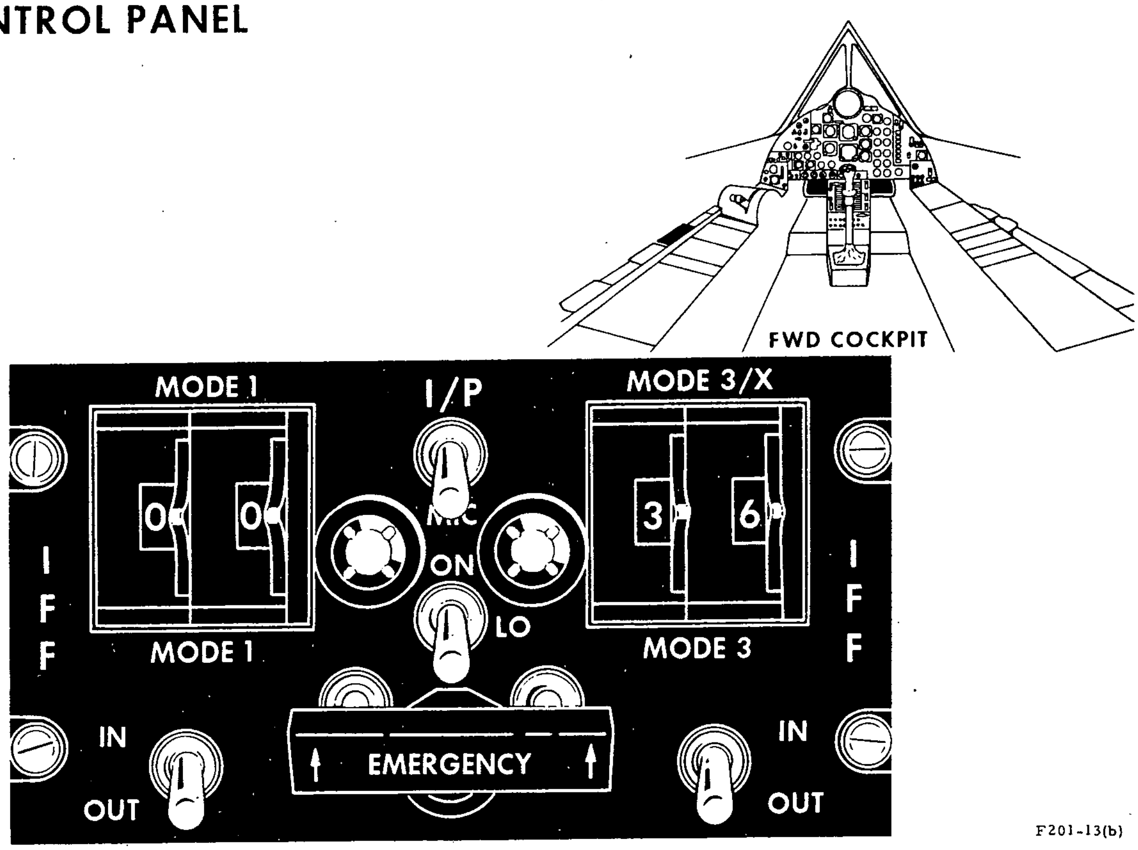


Figure 4-6

switches. When the Emergency switch bar is up, the power switch is forced to the ON position. A 30 second time delay is incorporated in the power switching before the equipment is operative.

Mode Switches

Two two-position mode switches, one for Mode 1 and one for Mode 3, control transmission of Mode 1 and Mode 3 replies. Correctly coded interrogations will be answered when a mode has been made active by selecting the IN position. When a Mode 1 or Mode 3 switch is in the OUT position, that mode is not active and does not transmit upon interrogation except in Emergency. Mode X is active at all times when the power switch is in the ON or LO position and is not affected by the Mode 1 or Mode 3 toggle switch position.

Code Selectors

Two rotating type code selectors are provided. The code selector for Mode 1, consists of two rotary digital/indicating switches. The first digit window will indicate 0, 1, 2, 3, 4, 5, 6, or 7. The second digit window will indicate 0, 1, 2, or 3. The Mode 3/X code selector will indicate 0, 1, 2, 3, 4, 5, 6, or 7 for each digital window. The mode 3 code selection also controls the Mode X code transmission.

Emergency Switch Bar

The emergency switch bar, when placed in the EMERGENCY up position, operates two toggle switches that controls emergency response and also pushes the IFF power switch to the ON position if it is in the off or LO position. When the emergency bar is in the up position an emergency indicating pulse group (code 7700) is transmitted on Mode X each time an interrogation is made on Mode X. Mode 1 and 3 are also turned on by the emergency bar irrespective of the position of the Mode 1 and 3 In-Out switches. In the EMERGENCY position Mode 1 will respond on the code selected but Mode 3 will respond on code 7700 irrespective of code selected.

Note

The ground radar scope indication from this transponder is coded in a different manner than the normal AN/APX-46 transponder.

Identification of Position (I/P) Switch

The identification-of-position (I/P) switch is used to control transmission of I/P pulse groups. The switch has three positions; MIC, OUT and a spring-loaded I/P position. When the switch is momentarily in the I/P position, the I/P timer is energized for 30 seconds. If an interrogation is recognized on any active mode within this 30 second period, I/P replies will be made. When the switch is in the OUT position, transmission of the I/P pulse groups is withheld. The MIC position is inoperative at present.

OPERATION OF THE IFF SYSTEM

1. Power switch - ON or LO.
2. Emergency bar - Down.
3. Mode 1 and Mode 3 IN-OUT switches - As required.

Note

Mode X operation is continuous when the power switch is in the LO or ON position. For secure IFF operation, both the Mode 1 and Mode 3 toggle switches must be in the OUT position.

4. I/P switch - As required.
5. Code selectors - As required.

To make an emergency response to Mode 1, Mode 3 and Mode X interrogations:

6. Emergency bar - Push up.

INTERPHONE CONTROL PANELS (AN/AIC-10)

An AN/AIC-10 interphone control panel for each cockpit is installed on a shelf behind a lower hatch under the aft cockpit. Each panel contains a call button and a NORMAL-AUX LISTEN switch. No ON-OFF switch is provided and the equipment is operative whenever the essential dc bus is energized. A remote volume control is located on the right console in each cockpit.

Call Button

The call button is inoperative.

Normal-Aux Listen Switch

The NORMAL-AUX LISTEN switch has two positions, NORMAL and AUX-LISTEN. The normal position allows all audio signals to pass through the AN/AIC-10 amplifier. Selecting the AUX LISTEN position bypasses the amplifier, and audio intensity must be adjusted with the individual equipment volume control. The switch is safety-wired in the NORMAL position.

Transmitter-Interphone Control Switch

A momentary contact, center-off slide switch on the control stick grip permits the microphone circuit to be connected to the UHF transmitter (TRANS position, up) or to the interphone circuit (INPH position, down). An interphone jackbox, connected to the common interphone circuit, is mounted in the load center bay for ground crew use.

Throttle Microphone Button

A microphone button is provided on the inboard throttle in each cockpit for use during taxi, takeoff, and landing when the pilot's left hand must be on the throttles. These are pushbutton switches which must be held for radio transmission.

FLIGHT REFERENCE SYSTEM

The flight reference system supplies information for indication and control of aircraft heading and attitude. The system consists of a flight reference platform, induction compass transmitter, heading and attitude couplers, a control panel in each cockpit and the rotating compass card of each HSI.

The two modes of operation, magnetic slaved mode and directional gyro mode, provide accurate directional reference for all latitudes. The directional gyro mode is the more reliable at latitudes near the magnetic poles, since the magnetic slaved mode is subject to severe magnetic distortion near the poles. When in the magnetic slaved mode, the system is basically a gyro stabilized compass slaved to the induction compass transmitter. This mode provides magnetic heading without northerly turning error or oscillations. The directional gyro mode may be used at all latitudes, but is most useful when the magnetic field is weak or distorted or when navigating in the polar regions. When in the directional gyro mode, the system is free of magnetic influence and operates as a directional gyro, indicating an arbitrary gyro heading as selected by the pilot. In directional gyro mode, with the proper latitude selection made on the control panel, the gryro is made to precess the correct amount required to overcome gyro drift at the selected latitude. In either mode, heading information is furnished to the autopilot and HSI provided that the ATT/AP SELECT switch is in the FRS position, and the display MODE SELECT switch is in the MAG position.

MANUAL FAST SLAVING

Before Takeoff

The normal slaving rate of the system is about 1 1/2° per minute. When the compass system is energized before takeoff, the gyro may be as much as 180° from the proper heading. About 1 1/2 hours would be required to slave to the correct heading at normal slaving rates. Manual fast slaving is provided by actuating the set heading switch, which increases the rate to 720° per minute. This corrects a 180° error in 15 seconds.

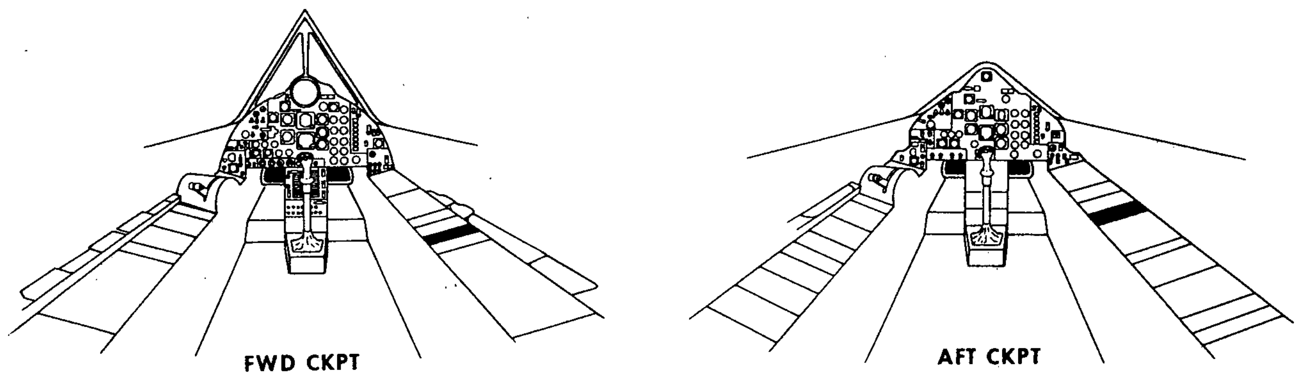
In-Flight

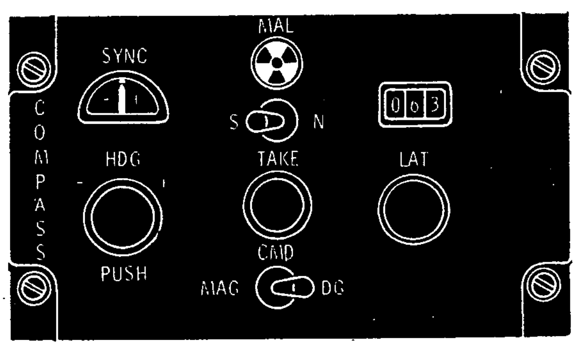
Normally, if the compass is properly slaved before takeoff, no in-flight manual fast slaving is required unless free directional gyro operation is selected. When operating as a free gyro, the desired heading can be established by using the set heading switch.

Note

The autopilot must be turned OFF during manual fast slaving when the FRS is being used as a heading reference.

FLIGHT REFERENCE SYSTEM (FRS) CONTROL PANEL





F201-73

Figure 4-7

FRS CONTROL PANELS

A control panel is installed on the right console in each cockpit. The panel contains a function selector switch, set heading switch, latitude selector knob, synchronization indicator, malfunction indicator and hemisphere selector switch, and take command button.

Latitude Selector Knob and Indicator

The latitude selector knob may be rotated to select and display the desired latitude in degrees and tenths of degrees in the indicator window. The knob is operable in the DG mode only and selects the latitude in which the airplane is operating. When in DG operation, with the operating latitude selected, the directional gyro will be corrected for apparent drift due to the earth's rotation.

Note

> The proper corrections will be made only if the hemisphere selector switch is indicating the correct hemisphere.

Take Command Button

A combination button and light on the console panel provides for transfer of control by depressing the button and observing the light.

Malfunction Indicator

The malfunction indicator monitors the power supply plus other prime system functions. Any deviation from normal operation that would cause the system to render erroneous information will cause the indicator to display 3 white triangles.

Hemisphere Selector Switch

The hemisphere selector switch is used to select the hemisphere in which the aircraft is operating.

FRS SYSTEM OPERATION

1. ATT/AP switch - FRS.
2. Hemisphere selector switch - As required.
3. Functions selector switch - As desired.
4. Latitude selector knob - Set to proper latitude when operating on free gyro.
5. Set heading switch - Fast slave compass card of HSI to proper heading.
6. Synchronization indicator - Center needle when operating as a magnetically slaved system.

INERTIAL NAVIGATION SYSTEM (INS)

The inertial navigation system is self-contained and operates in all modes without the use of electromagnetic radiation or external references. The system consists of a gyro-stabilized platform, platform electronics, coupler and power supply, repeater and converter power supply, control panels, and distance-to-go, groundspeed, and a direction indicator.

In operation the system displays present position, groundspeed and the direction and distance to go to any of 42 preselected positions as continuous readouts. When operated in autopilot AUTO NAV, and INS STORED AUTO mode, the aircraft will be steered automatically to each point in the flight plan sequentially, with no pilot action required. If the flight plan is being flown in sequence in the STORED AUTO mode, the destination select light will illuminate if the destination displayed on the destination select panel does not agree with the destination towards which the aircraft is flying. This light is extinguished when the pilot sets the selector panel to the number of the stored destination being approached.

The destination select panel provides selection of destination numbered 0 through 41. The first 27 preselected positions are assigned to preplanned mission destinations, fix points, targets, rendezvous points, or other points occurring sequentially during the mission. The computer computes and stores the great-circle courses between each pair of these numerical points, and the aircraft will adhere to these great circle courses. Turns from one course to another will be made with bank angle optimized with a maximum bank of 30 degrees) for the groundspeed and heading change required. The heading marker of the HSI will point toward the optimum path to follow to place the aircraft on the next course. If the pilot switches to a subsequent destination in STORED MAN before completing the route segment he is on, the turn will be made in accordance with computer program directions.

Positions 27 to 41 provide ADF type steering for courses to these points and are not meant to be used in the STORED AUTO mode. These positions are available for alternate destinations or may be used to employ an alternate flight path to a position included in the first 27. A sufficient number of alternate destinations is available to provide adequate coverage throughout the mission. Duplication of any of the first 27 positions in this group provides a steering indication on the HSI heading marker, resembling that of ADF navigation, i. e., the pointer points directly to the next destination within a 45 degrees needle deflection.

The basic reference of the inertial navigation system is provided by three single-axis accelerometers mounted at right angles to each other on a gyro-stabilized platform. The platform employs three floated integrating gyros, also mounted at right angles. The platform is initially aligned with a coordinate reference frame, represented by a plane tangent to the surface of the earth and oriented to any convenient azimuth at the point of origin. The platform stable element is isolated from the airframe through a system of three gimbals which provides 360 degrees freedom of rotation in yaw and roll, and pitch angles of ± 60 degrees. All platform outputs are changed to digital form before entering the computer. In normal operation the platform also provides attitude outputs in analog form through resolvers and synchros to the autopilot and the attitude indicator. Conversion of present position to latitude and longitude readout is accomplished continuously by the digital computer when in operational mode. Cooling air, necessary to the system, is supplied by the aircraft air-conditioning and pressurization system. A self-contained heating system is incorporated in the platform to ensure that gyros and precision sensing components are maintained at temperature within an optimum operating range. The system is powered by the No. 3 inverter, the LH generator, and the monitored dc bus.

Note

> Accuracy of INS information will be slightly degraded if pressure altitude data supplied by the air data computer is lost or is inaccurate.

The INS is controlled from two control panels, the navigation panel and the destination select panel. See figure 4-

NAVIGATION CONTROL PANEL

The navigation control panel, located on the right console, consists of a DEST/FIX selector switch, STORE pushbutton, MODE selector switch, FIX ADJ knob, two sets of geographic coordinate digital readout windows, labeled PRESENT POSITION and DEST/FIX POSITION, a VARIABLE INPUT indicator labeled LAT and LONG, with thumb-wheels for manual insertion of geographic coordinates and a switch for selection of N or S latitude. The controls and indicators are as follows:

Mode Selector Switch

The INS MODE selector switch is a rotary switch with five positions and is labeled OFF, RST, ALGN, NAV and FRS. The FRS position is inoperative.

Note

During flight the INS MODE selector switch must not be switched to any position other than NAV, otherwise the INS will be deactivated and will not function until the switch is moved through OFF, RST, and ALGN positions in conjunction with the ground operating equipment and normal INS preflight procedure.

CAUTION

Do not move the INS MODE selector switch from the OFF position in flight, if the INS has not been cycled from OFF to the NAV mode prior to flight, otherwise, the INS system will be damaged.

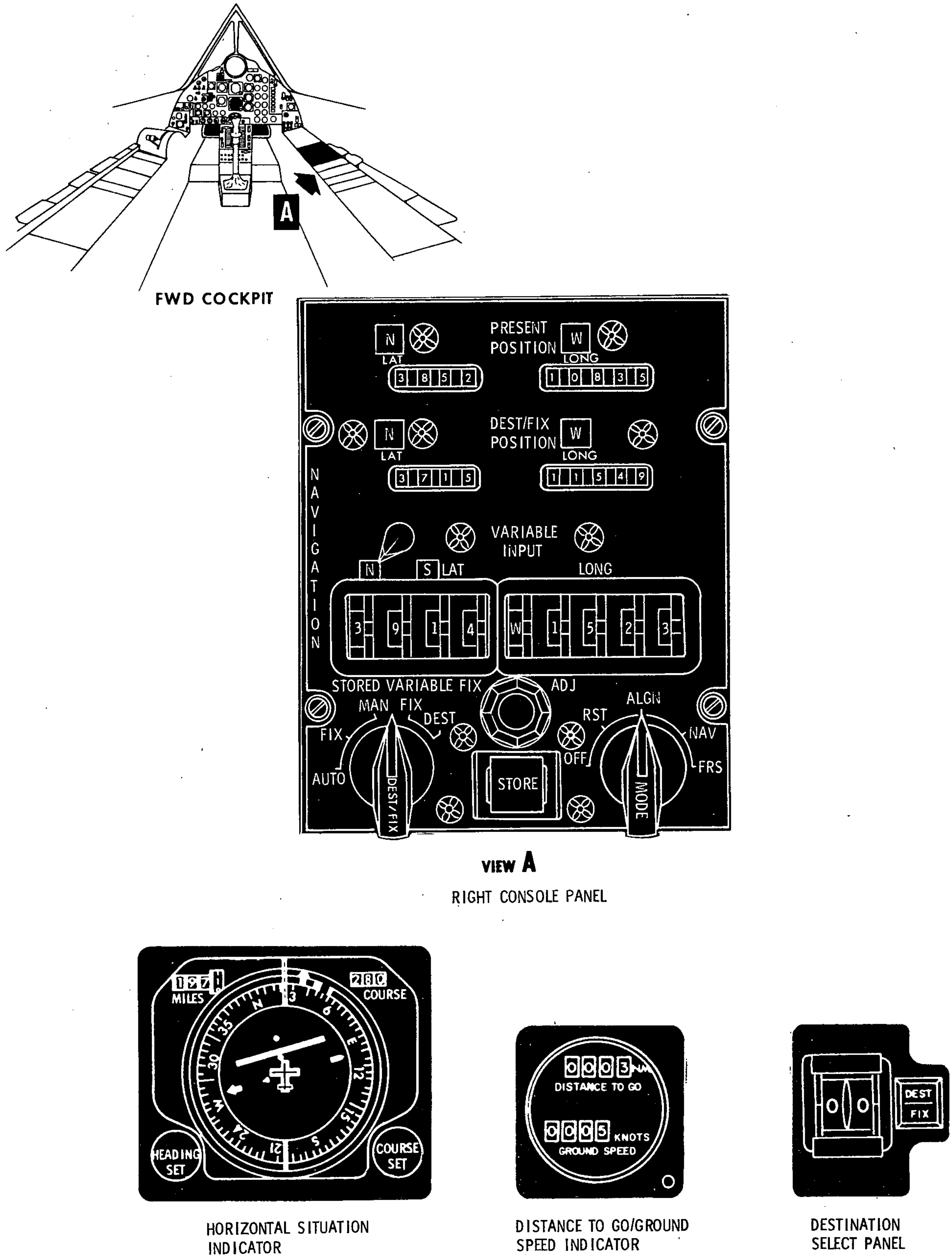
RST Mode

The RST (reset) mode is used only on the ground during INS preflight when the platform has reached operating temperature. It permits the GOE operator to check correct power switchover from ground to aircraft power, start the gyro spin motors, and make the computer ready for use.

ALGN Mode

The INS must be completely warmed up, stabilized, and aligned to a coordinate reference frame before it can be operated. This is necessary to minimize the drift of the stable reference platform once it is aligned to the coordinate reference frame. The complete warmup and alignment procedure at normal ambient conditions takes about 1 and 1/2 hours. During this period the destination loading operation is accomplished, normally by use of a punched tape. However, the coordinates of the present location and 42 destinations or targets may be set in manually by the VARIABLE INPUT thumbwheels and N-S selector and entered into the computer memory by pushing the STORE or DEST FIX pushbutton for each position. After a period of gyro stabilization, the platform is torqued to the coordinate reference frame and the gyros are drift-trimmed. The two transverse horizontal accelerometers are used to sense the local vertical and their outputs are used in the servo loops that torque the platform and measure the amount of gyro drift. The presence of output signals from each accelerometer indicates that the platform is not level in that axis. While level alignment of the platform is being accomplished automatically, platform azimuth is aligned with a selected reference which is transferred to the platform by the ground operator. The platform is drift-trimmed at the reference points thus established, and the drift reduced to certain preestablished

INS PANEL AND INDICATORS



F201-33(c)

Figure 4-8

rates before the system can be operated. The MODE selector switch has a detent between NAV and ALGN positions and cannot be moved either way between these two positions until it is first depressed.

NAV Mode

Switching to the NAV mode permits the GOE to be disconnected, and places the platform in the operational mode. The gyros are essentially memory devices that memorize the coordinate frame established. The system operates using these memorized coordinates to perform the navigation problem, and the accelerometers measure translations of the platform caused by movement of the aircraft. The accelerometer outputs are integrated once to provide velocity on each axis, and a second time to establish their displacement from the point of origin. These displacements (distances flown) are translated into geographical position coordinates by the computer. In addition to indicating position coordinates to the pilot, this position is also used to torque the platform to the local vertical and azimuth as the aircraft changes position. The coordinate frame thus rotates about the earth to maintain its orientation on a plane tangent to the surface of the earth at the position of the aircraft.

FRS Mode

The FRS mode position is inoperative. The reference source for the HSI rotating compass card is selected with the display MODE SELECT switch on the flight instrument control panel.

WARNING

If the INS should fail, the DISPLAY MODE selector switch should be moved to the MAG or TACAN mode without delay in order to retain a heading indication on the HSI display.

DEST/FIX Switch

The DEST/FIX switch is a five-position rotary selector switch with positions as follows:

STORED

AUTO, FIX, MAN

VARIABLE

FIX, DEST

STORED AUTO. The INS will automatically sequence consecutively through the 42 prestored destinations as each is reached when the switch is in the STORED AUTO position.

STORED FIX. To use a prestored destination as a fix point, the switch is set to the STORED FIX position, the destination select panel is set to the desired destination number, and the STORE or DEST FIX pushbutton is depressed when the fix point crosses the horizontal line on the periscope screen.

STORED MAN. To select any of the 42 prestored coordinate positions as a destination, out of the automatic consecutive sequence, the switch is set to the STORED MAN (manual) position, the destination select panel is set to the desired destination number, and the STORE or DEST FIX pushbutton is depressed.

VARIABLE FIX. To use a variable (unstored) fix point as a point of reference, the switch is set to the VARIABLE FIX position, the VARIABLE INPUT thumbwheels are set to the desired coordinates, and the STORE or DEST FIX pushbutton is depressed when the fix point crosses the horizontal line on the periscope screen.

VARIABLE DEST. To select a variable (unstored) destination, the switch is set to the VARIABLE DEST position, the VARIABLE INPUT thumbwheels and N-S selectors are set to the desired coordinates, and the STORE or DEST FIX pushbutton is depressed.

FIX ADJ Knob

The fix-adjust knob, labeled FIX ADJ, controls a flight cursor on the periscope and is used to update the INS by means of visual fixes on known coordinate points. It is not necessary to fly directly over the fix point to obtain useful data. Viewing the fix point on the screen, the pilot positions the cursor with the FIX ADJ knob to coincide with the fix point as it crosses the horizontal reference line on the display. Refer to discussion of fix-taking for further information.

STORE Pushbutton

The STORE pushbutton is used to store in the computer memory, either selected destination information or position information which has been selected by the VARIABLE INPUT thumbwheels and N-S selector. It also initiates the computations required to navigate to the coordinates selected.

Note

> The DEST/FIX pushbutton on the destination select panel is identical in function to the STORE button on the navigation panel. They may be used interchangeably. Do not push either button unless a course change or fix is desired.

N-S Hemisphere Selector

The N-S selector switch may be placed in either the N or S position, depending upon which hemisphere the desired destination or fix is located. This switch is used only in conjunction with the variable input thumbwheels to manually insert a destination or fix point in flight.

VARIABLE INPUT Indicator

The VARIABLE INPUT indicator has thumbwheels that are used to manually insert any desired reference coordinates in to the system, thus giving the pilot added flexibility of operation in flight. It is good practice to put the DEST/FIX switch in the VARIABLE DEST or VARIABLE FIX position prior to setting the coordinates in the indicator. To insert variable destination coordinates into the system, select VARIABLE DEST with the DEST/FIX switch, then insert the desired destination coordinates with the VARIABLE INPUT thumbwheels; select desired hemisphere with the N-S selector and depress the STORE or DEST FIX pushbutton. The DEST/FIX POSITION indicator will read out the new coordinates immediately after the STORE or DEST FIX button is depressed, and the INS will navigate the aircraft to the new destination using ADF type steering. Variable update fix is inserted in the computer in the same way as a destination, except that VARIABLE FIX is selected with the DEST/FIX switch.

PRESENT POSITION Indicator

The PRESENT POSITION indicator is set at the geographical coordinates of the flight origin site prior to takeoff. In flight it continuously indicates the coordinates of the aircraft position as computed by the INS.

DEST/FIX POSITION Indicator

The DEST/FIX POSITION indicator normally displays the latitude and longitude coordinates of the destination to which the INS is navigating. This display may be the coordinates of any selected destination from the 42 prestored positions or the coordinates of any selected variable destination. This coordinate display normally changes at such times as the computer calculates a new course to a newly selected destination. For STORED MAN or VARIABLE DEST modes, this change will occur when the DEST FIX or the STORE pushbutton is depressed. For sequential or out of sequence destination selections in STORED AUTO mode, the destination coordinate display will change coincident with roll out to the new destination course. The minutes counter portion of the latitude display may also change whenever a fix is taken. When either a STORED FIX or VARIABLE FIX is taken, the calculated correction (in nautical miles) is displayed on the latitude minutes display, without changing longitude, or the degrees portion of latitude on the DEST/FIX POSITION indicator. The portion of the latitude display used for the fix distance indication is blocked off in white on the indicator (see Figure 4-9). The calculated fix correction is displayed up to a maximum value of 59 nautical miles whether position is updated or whether the fix is rejected. The calculated fix correction will continue to be displayed until another fix is taken or until a new destination is selected and displayed. When a new destination is selected, the latitude minutes counters will revert to a display of destination latitude until such time as another fix is taken.

DESTINATION SELECT PANEL

The destination select panel, labeled NAV, is located on the instrument panel. The panel has a two-place digital counter, controlled by thumbwheels, and a self-illuminated pushbutton switch which reads out DEST FIX when lighted. The number of a stored destination or fix (0 through 41) may be set on the counter manually and inserted into the INS computer by depressing either the DEST FIX or the STORE pushbutton when the DEST FIX switch is in the STORED MAN or STORED FIX position.

Note

> Positions 42 through 49 can be displayed, but are inoperative.

Except when flying out of sequence in the STORED AUTO mode the DEST FIX pushbutton illuminates when the destination number on the panel and the destination approached by the aircraft are not the same. When they are again the same (thumbwheels must be rotated), the light will go out. In all modes the light will come on when pilot action is required. When the DEST/FIX switch is placed in either STORED or VARIABLE FIX, the light will come on. When the STORE or DEST/FIX pushbutton is depressed the light will go out. In any mode, in which a new destination is selected by depressing the STORE or DEST/FIX pushbutton, the light will go out when the system accepts the new destination. In STORED MAN, the light will come on if a destination is passed by 15 miles without selecting a new destination.

DISTANCE-TO-GO AND GROUNDSPEED INDICATOR

A distance-to-go and groundspeed indicator is installed on the instrument panel. Digital indicators display the distance between the aircraft position and the destination, and the groundspeed, in units of 1 nautical mile and knots, respectively. When a new destination is selected either automatically or manually the indicator will change to show the new distance-to-go. The distance-to-go indication will decrease toward zero while approaching the destination, then increase after passing the destination if flight is continued on the same course. Distance-to-go will not read zero at destination if the computed cross-course distance is greater than 1/2 nautical mile, since readout resolution is to the nearest nautical mile.

HORIZONTAL SITUATION INDICATOR (HSI)

The INS computes true heading and steering information which can be displayed by the HSI on each instrument panel. The rotating compass card of each HSI receives the true heading signals when the controlling display mode selector switch is in the NAV position. When the display mode selector switch is in the MAG or TACAN position the compass card is driven by the FRS signals to indicate magnetic heading although the INS system is still generating true heading information. The heading marker is driven by the steering signal from the INS when NAV or MAG modes are selected, and is manually set when TACAN mode is selected. The bearing pointer points to either an ADF or tacan station, whichever is selected with the controlling BEARING SELECT switch, regardless of display MODE SELECT switch position.

Note

The aircraft will automatically fly the course computed by the INS and selected by the pilot only if the autopilot is in the AUTO NAV mode.

COURSE SELECTION

The INS is capable of providing steering information to any selected destination when the path from source to destination is greater than 30 nautical miles but less than 21,500 nautical miles (from 1/2 degree to 179 degrees of great circle arc). The sequence in which courses are provided depends upon the position of the DEST/FIX switch on the navigation control panel. In STORED AUTO position, course directions will be provided to stored destinations automatically in their numerical sequence; however, an out of sequence deviation can be made in STORED AUTO by selecting the desired out of sequence destination number on the destination select panel and depressing either the DEST FIX or STORE pushbutton. After the out of sequence deviation, other destinations will then continue to be automatically selected in numerical sequence. In the STORED MAN or VARIABLE DEST positions, steering directions to individual destinations are supplied after each destination is selected by depressing either the DEST FIX or STORE pushbutton. For STORED AUTO or STORED MAN modes, the steering information provided by the computer is a great circle flight path only if the destination selected is one of the first 27 sets of stored coordinates (00 through 26). ADF type steering will be commanded for STORED destination selections numbered 27 or greater and for all VARIABLE DEST mode selections. In STORED MAN mode, the computed course starting point is determined as follows:

a. The position of the current destination is selected by the computer as the starting point for the new course if the aircraft computed position is within 100 miles of this point when the STORE button is depressed.

b. The computed position of the aircraft is selected by the computer as the starting point for the new course if the distance to go is more than 100 miles from the current destination.

INS STEERING CHARACTERISTICS
DISTANCE TO GO FOR START OF TURN-AUTO NOW STEERING

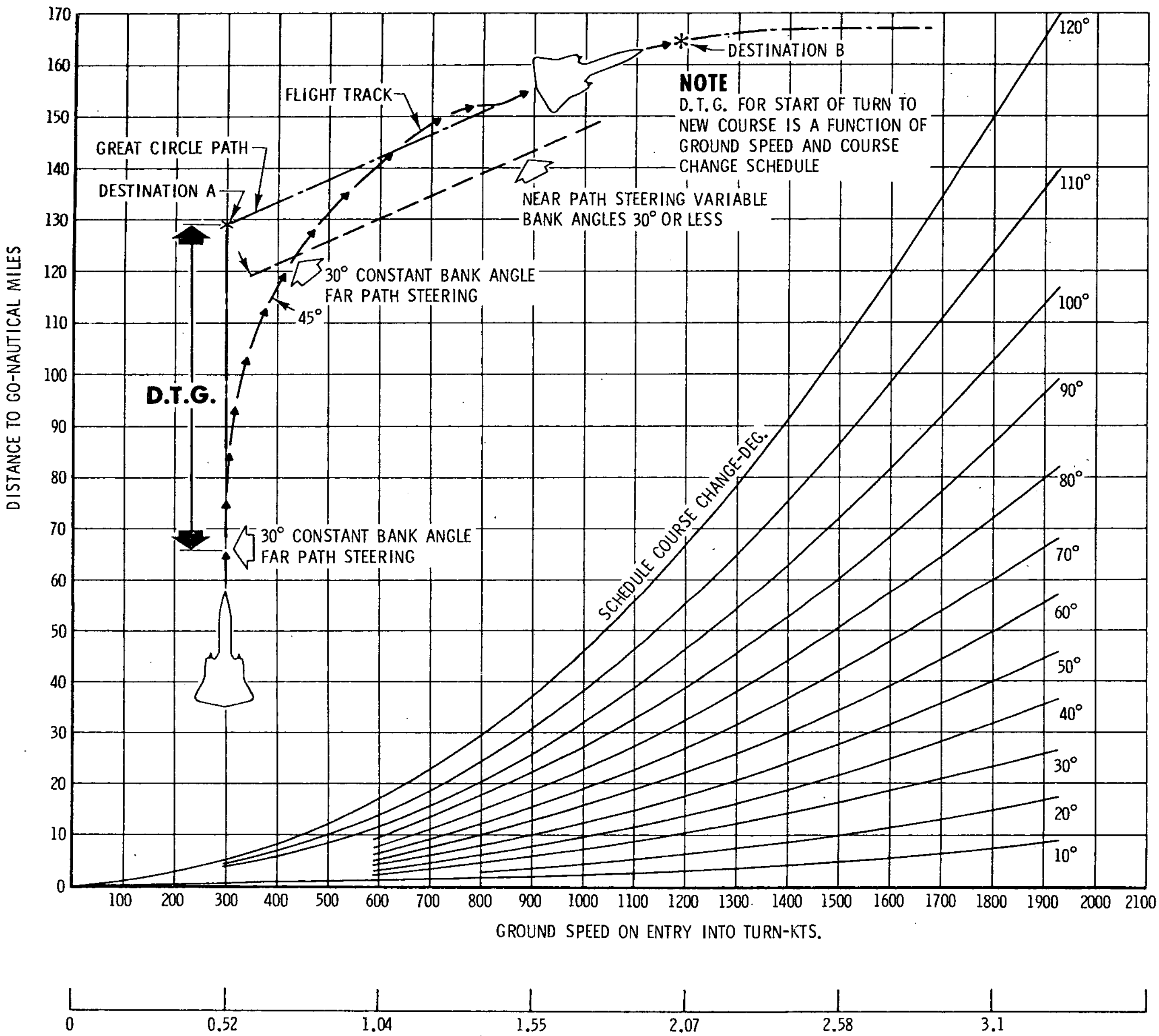
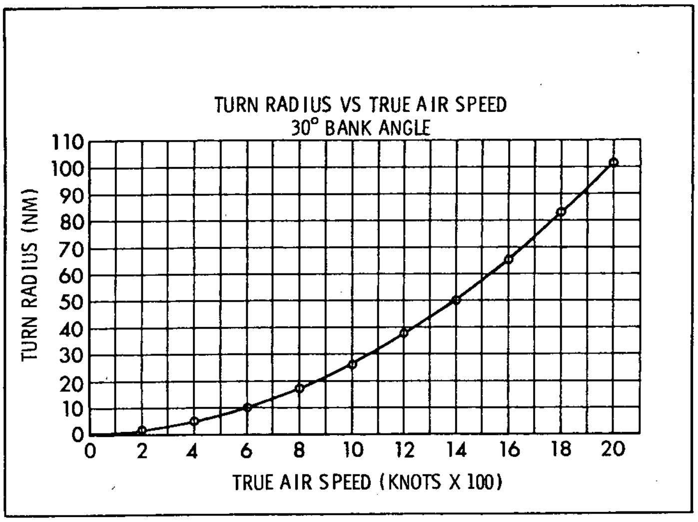
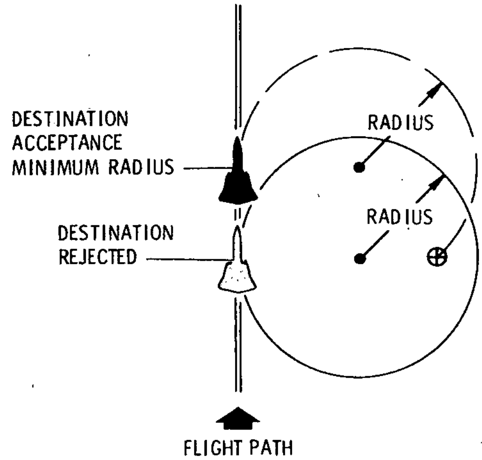
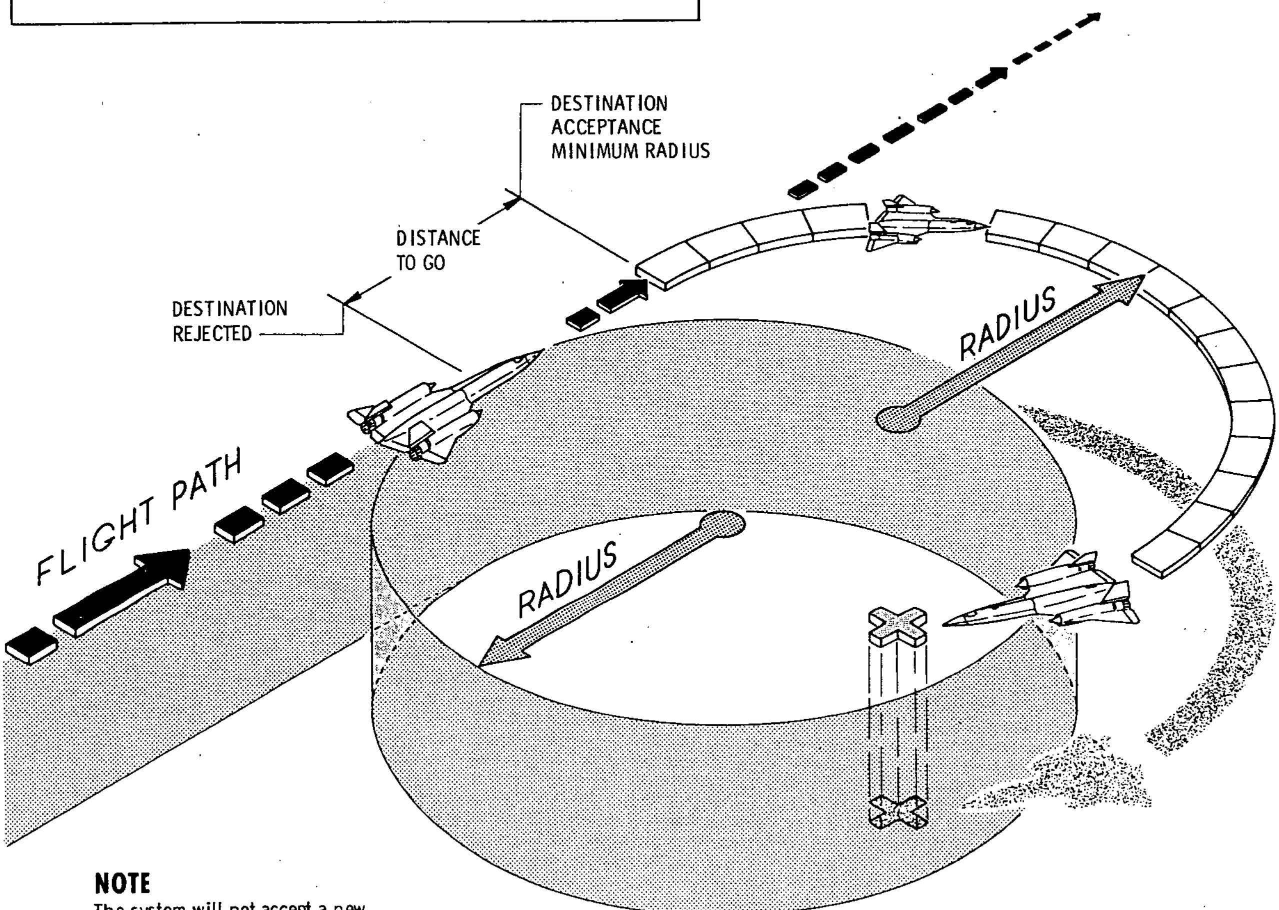


Figure 4-9

DESTINATION REJECT PATTERN







NOTE

The system will not accept a new destination at any time it is within the minimum turn radius circles which move along with the aircraft. The radius is a functional of aircraft velocity for a 30° bank angle. $R \simeq 2.6 \times 10^{-5} V^2$ Where R is the turn radius in nautical miles and V is velocity in knots.

F201-66(a)

Figure 4-10

INS POSITION AND AZIMUTH ERROR

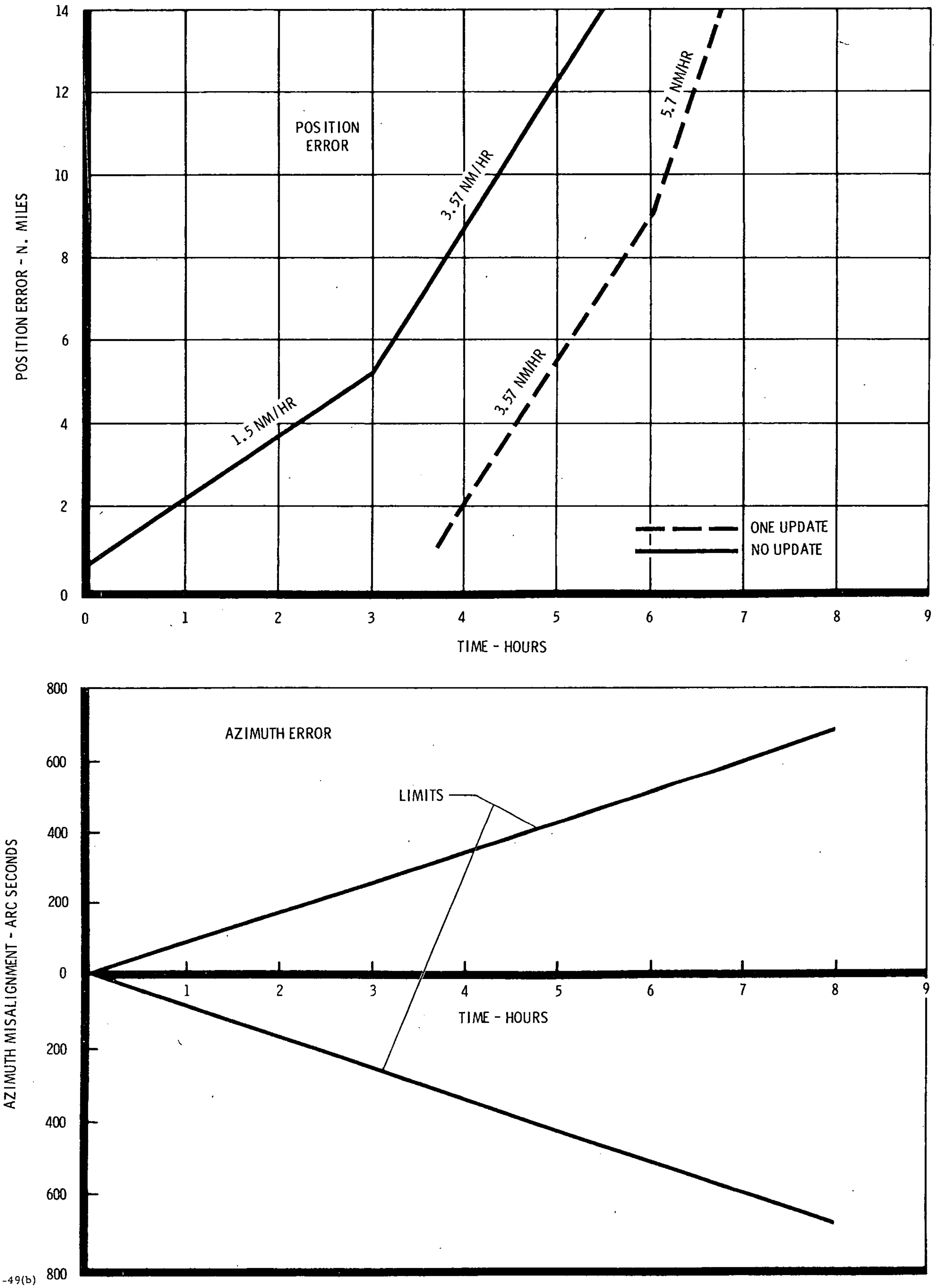


Figure 4-11

After a course has been selected and calculated and either great circle or ADF type steering provided to navigate toward the course destination point, the INS will continue to navigate to that point regardless of any change of position of the DEST/FIX switch until a new destination is selected by either automatic sequencing in the STORED AUTO position or by depressing the STORE pushbutton in the STORED MAN or VARIABLE DEST positions. If a destination selection is made in which the new destination is aft of the present course direction by an angle greater than 135°, the initial steering direction is indeterminant and the aircraft may roll out either right or left in turning around to the new course.

Fixed-Path Flight Plan

A preselected-path flight plan will be flown in AUTO mode. Consecutive destinations 00 through 41 will be selected automatically. The point-to-point paths will be segments of great-circle arcs for destinations 01 through 26, and direct for destinations 27 through 41. The use of STORED AUTO mode results in smooth entry turns at required bank angle up to a maximum of 30 degrees to the next course. Turns will be initiated before reaching the destination and the turn point will depend on aircraft groundspeed and the degree of course change required.

Deviation from Fixed-Path Flight Plan Using Stored Destinations

Stored destinations may be selected manually in any arbitrary sequence, and a destination can be selected any number of times during a mission. Any partial sequence of the stored destination fixed-path plan can be used by manually selecting the first destination of the sequence, then switching to STORED AUTO mode until the desired sequence is accomplished. Then, manual selection of a new stored destination causes a new course to be computed as described above.

Note

> In the STORED MAN mode, if the aircraft flys over the destination in great circle steering without selecting a new destination, the DEST/FIX light comes on and the aircraft will alternate between right and left steering signals. The DEST/FIX light operates similarily in ADF steering; however, the aircraft will fly in circles, always coming back over the selected destination.

Deviation from Fixed-Path Flight Plan Using Stored Auto

One or more destinations can be skipped by selecting the destinations desired on the digital counters of the destination select panel and depressing the STORE or DEST FIX pushbutton with the DEST/FIX switch in the STORED AUTO position. The INS will complete the track in progress when the STORE or DEST FIX pushbutton is depressed but the next automatic sequence will select the course to the desired destination.

In the STORED AUTO mode, the destination select light is extinguished when the number on the destination select panel agrees with the stored destination which is presently selected. The stored destination which extinguishes the light will be the same as the stored destination toward which the aircraft is flying except when selecting a destination out of sequence in the STORED AUTO mode.

Example: The aircraft is flying toward destination 02 in the STORED AUTO mode and 02 is selected on the destination select panel. The destination select light is extinguished. The pilot decides to skip destination 03 and fly from destination 02 to 04. He selects 04 on the panel and depresses the the STORE or DEST FIX pushbutton. The light will now be extinguished only on destination 04 even though he is still flying towards 02. This indicates to the pilot that 04 has been accepted as the next destination.

Use of the VARIABLE INPUT Indicator For Unstored Destinations

Use of destination coordinates set on the VARIABLE INPUT indicator and N-S selector requires that the DEST/FIX selector switch be set to the VARIABLE DEST position. ADF-type steering to the point selected is provided when the STORE or DEST FIX pushbutton is depressed. The initial ADF-type steering heading is based on computed present position. Coordinates of stored destinations can be duplicated.

LIMITATIONS OF DESTINATION SELECTION

Maximum Path Length

The maximum great-circle arc between source and destination is 179 degrees to permit definition of direction. This constitutes a distance of approximately 21,500 nautical miles from point of origin to destination.

Minimum Path Length

A course cannot be selected when the distance from the start point (either a stored destination or the aircraft's present position) to the next destination is less than 30 nautical miles. The computer will ignore any attempt to select such a destination, whether the selection is automatic or manual. In STORED MAN and VARIABLE DEST modes, destination selections are also restricted by comparing the desired destination's relative location with the aircraft's minimum turn radius capability. (The minimum turn radius is computed as a function of groundspeed.) The destination is accepted if it is outside the minimum turn radius path (and also meets the 30 mile criteria). If the desired destination is inside the minimum turn radius flight path, the aircraft will continue on it's same course until the location falls outside the minimum turn radius path. At such time, the destination will be accepted if it also meets the 30 mile distance criteria. (See Figure 4-11.)

Minimum Distance Between Destinations

A course cannot be selected when the distance from the start point (either a stored destination or the aircraft's present position) to the next destination is less than 30 nautical miles.

FIX TAKING

Since all rotating gyros are subject to some drift, alignment of the coordinate reference frame established by the gyro platform tends to depart from the true coordinate frame after a period of time. This introduces errors in position and azimuth which increase with time. (See figure 4-12.) The indicated position can be updated by taking visual fixes when the coordinates are known. These fixes are taken by use of the periscope and are inserted into the INS as follows:

1. Either select the desired prestored destination on the destination select panel or set the coordinates of the fix point in the VARIABLE INPUT indicator and N-S selector.

2. Turn the DEST/FIX selector switch to the appropriate STORED or VARIABLE FIX position. Use STORED FIX position if the fix to be made is at a prestored coordinate point.

3. Pull the MIRROR SELECT handle to the aft position for surface viewing and select the narrow view magnification with the PERISCOPE control. When the fix point is identified visually, position the periscope cursor with the FIX ADJ knob so that it will intersect and track the fix point. Continue tracking until the fix point crosses the periscope horizontal reference line.

4. Depress the STORE or DEST FIX pushbutton at the instant the fix point crosses the intersection of cursor and horizontal reference lines. At high speeds, a 2-second delay in depressing the STORE or DEST/FIX pushbutton will result in a position fix error of approximately 1 nautical mile. The computer will make the fix correction as follows:

   a. Correcting the inserted fix position to represent the position of a point immediately below the aircraft at the instant of STORE or DEST FIX pushbutton depression.

   b. Comparing the fix position with the inertially computed position at the instant of STORE or DEST FIX pushbutton depression, and displaying the updated position on the PRESENT POSITION indicator.

   c. If the difference is greater than 15 nautical miles, the computer program will not make the fix. Indication that a fix was not made is indicated by illumination of the INS FIX REJECT light on the annunciator panel in the forward cockpit.

   d. The difference will be displayed, up to a maximum value of 59 nautical miles, on the latitude minutes counter of the DEST/FIX POSITION indicator (section of the counter inside the white outline block). The fix difference will be displayed whether the fix updates or is rejected. The display will remain until either another fix is taken or another destination is selected.

Note

The fix correction only updates the coordinates displayed in the PRESENT POSITION windows and does not realign the platform. The rate of error buildup accrues from the time the INS system was switched to the NAV mode.

A stored destination may be used as a fix by selecting the destination number on the destination select panel, moving the DEST/FIX selector switch to STORED FIX position, and depressing the STORE or DEST FIX pushbutton.

Fix Sequence

No position fix should be taken before at least 2 hours have elapsed (including ground operating time) in the NAV mode of operation. A fix should be taken as soon thereafter as practicable. The optimum time to take the first fix is between 2 and 2-1/2 hours after selecting NAV operating mode. Subsequent fixes should be taken at intervals not exceeding 1-1/2 hours.

Fix Limit

For all fixes except those taken on stored positions 38 and 39, the maximum position fix corrections that will be accepted are

15 nautical miles of latitude correction and/or 15 nautical miles of longitude correction. An attempt to make a position fix that exceeds these values will cause the master caution light and the INS FIX REJECT light on the annunciator panel in the forward cockpit to illuminate. The INS FIX REJECT light will remain on until a subsequent acceptable fix is taken, or until the DEST/FIX selector switch is moved to a non-fix position. Inability to obtain an acceptable fix correction can be due to incorrectly stored fix point coordinates, incorrect fix point identification, or degraded INS accuracy. More than one attempt to achieve fix corrections should be made before concluding that the INS is not reliable. STORED FIXES 38 and 39 do not use the 15 nautical mile update limit for fix reject, but use a variable limit which is loaded to the desired value during preflight preparation. This variable limit capability can be used for INS performance prediction prior to a specific mission. For example, if it is known that INS had to be accurate within a certain limit to accomplish a specific mission, a STORED FIX on either 38 or 39 just previous to entering the mission area would give a criteria for mission abort. Position 38 or 39 fixes are the same as normal stored fixes except for the variable fix rejection criteria.

INS ACCURACY

Maximum position error will accrue at an average rate of 1-1/2 nautical miles per hour during the first 3 hours, and at an average rate of 3.6 nautical miles per hour thereafter.

INS Reliability Check

STORED FIXES 40 and 41 are designed to check INS performance before takeoff in an attempt to predict INS accuracy during the flight. The aircraft is accurately positioned over a known spot and a STORED FIX is taken as follows:

1. Stop aircraft at designated runway position.
2. Destination select switch - Pos. 40.
3. DEST FIX selector switch - STORED FIX.
4. STORE or DEST FIX pushbutton - Press.
5. INS FIX REJECT light - OFF.

This procedure updates the INS to a point 0.1 nautical mile or less from the starting point coordinates.

Acceptance of the position 40 fix indicates that the INS error is 0.4 nautical miles or less in error in either latitude or longitude and that computed north and east velocities are each less than 3 feet per second. These INS performance criteria are based on an anticipated time duration of 20 minutes from NAV entry until the position 40 or 41 fix.

If INS FIX REJECT light comes on - INS accuracy may be marginal.

6. DEST FIX selector switch - STORED MAN.
7. Destination select switch - As briefed.
8. STORE or DEST FIX pushbutton - Press.
9. INS FIX REJECT light - Off.
10. DEST FIX selector switch - STORED AUTO.

Effects of No. 3 Inverter Failure on INS

The No. 3 inverter supplies power to the INS. Consequently, a No. 3 inverter failure may have catastrophic results on the INS. The system performance may be degraded after switching to the emergency inverter. The degradation of system performance will directly depend upon the elapsed time between the No. 3 inverter failure and switch over to the emergency inverter. If the No. 3 inverter fails and the INS outputs are no longer meaningful, the pilot should turn the MODE switch on the Navigation Panel to OFF. This will lessen the possibility of damage to the system.

PERISCOPE

The periscope viewing system provides the pilot with a means of observing or making visual fixes on terrestial objects which cannot be seen directly from the cockpit. It can also function as a sky compass, and includes a display unit which projects maps and selected data on the presentation screen in the cockpit. The periscope windows, viewing optics, and projection equipment are located forward of the cockpit pressure bulkhead.

GROUND OBSERVATION

The downward-looking optical system utilizing a fixed lens two-field system. The wide-angle lens system provides a coverage of approximately 85 degrees forward of nadir and is intended to be used for observations of large prominent ground objects. INS update fixing is possible when the wide angle field of view is used. The narrow angle lens system provides a coverage of approximately 47 degrees forward of nadir and is intended to be used for update fixing of the INS system by fixing on pre-selected ground objects. The forward look distance possible with either field of view is dependent upon the altitude and attitude of the aircraft at the time of the observation. Figure 4-13 gives the forward look range as a function of the aircraft attitude and altitude. The resolution of the optical system in all modes is better than that of the unaided eye; however, due to the minification imposed by a fixed lens system, the pilot is only expected to identify prominent ground objects such as a coast line, lake or town. Also, due to the extreme slant viewing angle, there will be some apparent distortion when an object appears near the top of the reticle plate, especially when using the wide angle field of view.

PROJECTOR DISPLAY

The periscope mirrors can be shifted so that a 35-mm strip film projector displays maps or other selected data on the presentation screen. The pilot may regulate the projector light intensity and advance or reverse the film as necessary in order to refer to the desired information.

PRESENTATION SCREEN

A six inch presentation screen is installed at the top center of the forward cockpit instrument panel. The ground area displayed depends on the lens system selected; wide angle or narrow angle. When using the wide angle lens, the circle drawn near the center of the reticle plate indicates what will be visible with the narrow angle lens. The nadir point of the wide angle view is indicated by the intersection of the chord drawn across the lower half of the narrow angle view circle and the center vertical line on the reticle plate. The nadir point of the narrow angle view is indicated by the intersection of the horizontal line and center vertical line on the reticle plate. The nadir point, as indicated on the reticle plate, has

PERISCOPE

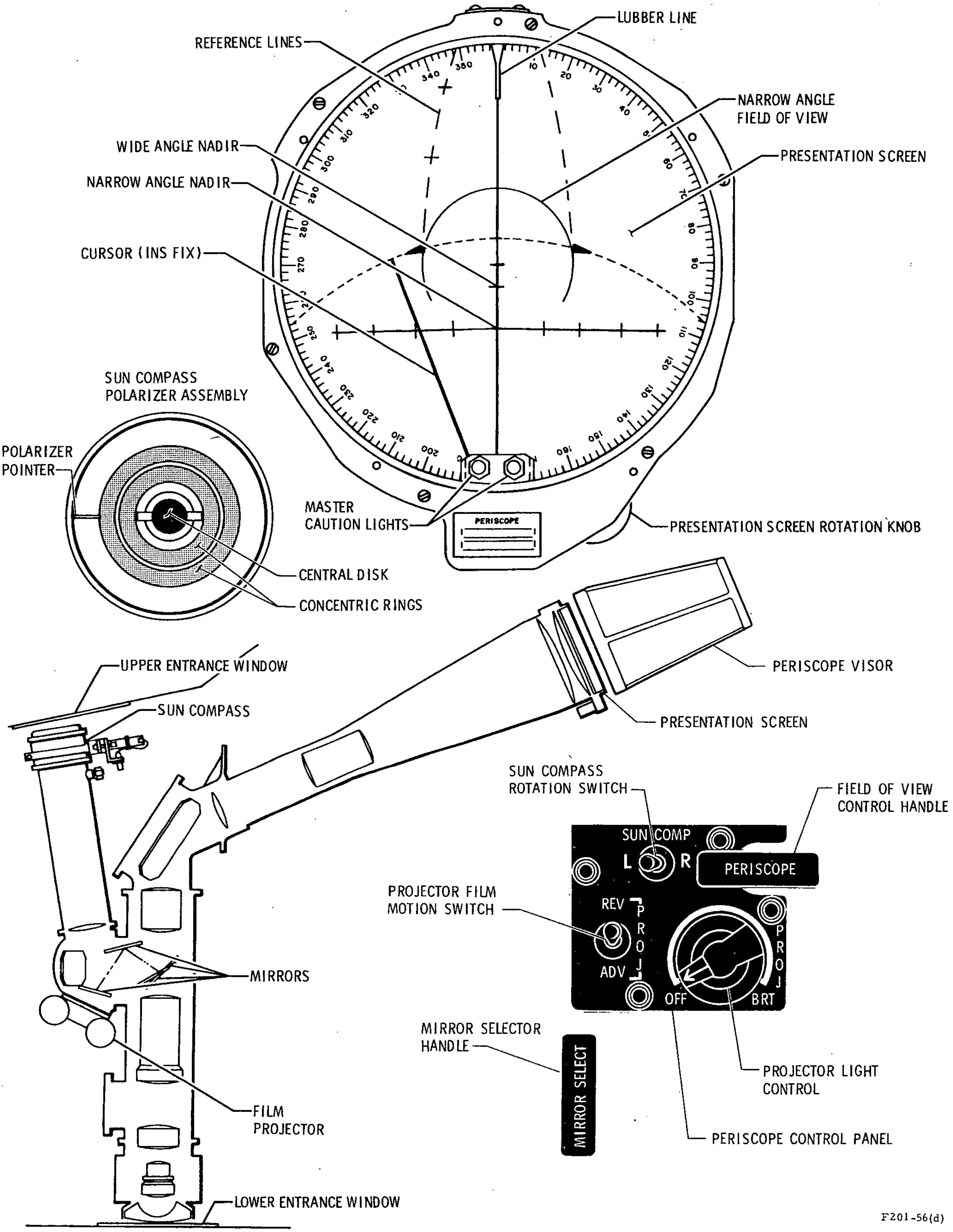


Figure 4-12

PERISCOPE DATA

Representative capabilities of Periscope in Ground View Mode. Airplane Angle of Attack Nominal 7°.

ALTITUDE ABOVE TERRAIN	NARROW ANGLE FIELD OF VIEW			WIDE ANGLE FIELD OF VIEW		
(Feet)	Forward (NM)	Lateral (NM)	Time * (SEC)	Forward (NM)	Lateral (NM)	Time* (MIN)
20,000	3.7	1.5	-	53	6	-
30,000	5.6	2.6	-	80	10	-
40,000	7.3	3.5	-	107	14	-
50,000	9.4	4.3	-	134	18	-
60,000	11.3	5.2	-	161	21	-
70,000	13.2	6.1	26	188	25	6.2
80,000	15.1	7.2	30	215	29	7.1
90,000	17.	7.9	34	242	32	8.

* The approximate time required for an object to appear at the top of the reticle plate and move down to the nadir fix line. Mach 3.1 and an attitude of + 7° is assumed.

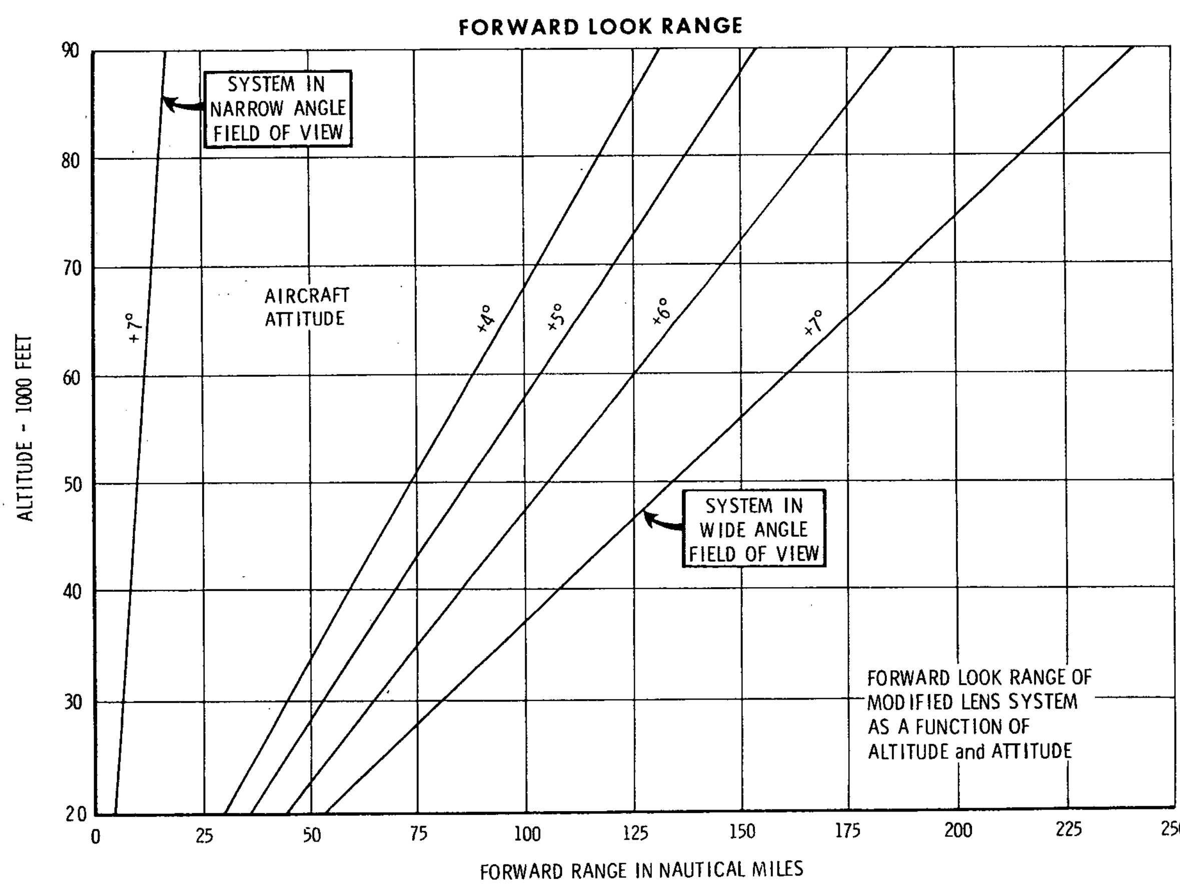


Figure 4-13

been compensated to correct for the angle that the optical axis has been shifted forward due to the normal level flight attitude of the aircraft and the physical placement of the periscope system in the aircraft.

A compass rose is incorporated in the reticle plate; the numbers appear around the edge of the plate and are back lighted when the system is in the sun compass mode.

A pair of vertical dashed lines are provided to show the path of a ground object as it moves from top to bottom on the presentation screen. The dashed lines are tangent to the narrow angle circle and show the pilot what will be visible in the narrow angle view as soon as the object appears in the wide angle view.

A movable cursor, remotely controlled from the INS navigation control panel, is used with the narrow angle "nadir" line to correct the INS for position error. The reticle plate or cursor is not illuminated. A serrated thumb knob in the lower right side of the presentation screen is used to rotate the reticle plate.

Periscope Lens Control Handle

A handle, labeled PERISCOPE, is located on the left side of the forward cockpit instrument panel. It is used to select either the wide or narrow angle view. The wide-angle lens is selected by pulling out the handle to the aft position and the narrow-angle lens is selected by pushing in the handle to the forward position.

Mirror Selector Handle

A T-handle, labeled MIRROR SELECT, controls the mirrors within the basic periscope system. The handle positions and functions are as follows:

a. Forward position - selects film projection.

b. Mid detented position (approximately 1/3 distance to out) - selects the sun compass for overhead viewing.

c. Aft position - selects the surface viewing periscope.

Projector Light Switch

A rheostat switch, labeled PROJ, controls the film projector light intensity. The projector light is OFF when the switch is at the full counterclockwise position. The projector light is turned on by rotating the rheostat toward the BRT position. Intensity of the image on the presentation screen is increased by clockwise rotation. Power for the light is furnished by the essential dc bus.

Projector Film Switch

A momentary three-position toggle switch, labeled PROJ, controls movement of map and data film. When the switch is held in the ADV position the film will advance. When the switch is held in the REV position, the film strip will rewind. The center position is off. Power for the switch is furnished by the essential dc bus.

SUN COMPASS

The sun or sky can be observed with the periscope by shifting the mirrors for upward viewing. A midpoint detent is provided in the mirror selector control for positioning the periscope optics in this position. A knurled thumb knob, located at the lower right of the presentation screen, is used to rotate the reticle plate. A toggle switch, labeled SUN COMPASS with L and R positions, is located on the periscope control panel and controls an electric motor which rotates the polarized disk. The sun compass is used as a backup to other heading devices when in locations where other devices might not function accurately. It is used to make 180 degree turnarounds or emergency heading determinations. It is also used to make periodic cross checks of other heading devices at any point along the flight path.

The sun compass utilizes the recomputed azimuth (Zn) of sun and the sun's image on the presentation screen. Accuracy is within 2 degrees when the sun's elevation is +6 to 50 degrees. At elevation values above 50 degrees, the heading error becomes greater. It also utilizes the precomputed azimuth of sun and the sky polarization phenomenon. Accuracy is within 2 degrees when the sun's elevation is -8 to +20 degrees.

The following definitions are applicable to the sun compass procedures:

Polarizer pointer - The red pointer on the electrically driven polarizer disk. It takes the place of the sun when the sun is too low in the sky.

Lubber line - The fixed pointer at the top of the presentation screen.

Compass Rose - A set of numbers around the periphery of the manually rotated reticle plate.

Zn - Azimuth of Sun - True bearing of the sun relative to a particular position on the ground at a specific time.

RB - Relative Bearing of Aircraft - The horizontal angle between the true heading of the aircraft and the true bearing of the sun.

TH - True Heading of Aircraft - The heading of aircraft relative to the north pole.

Zn = TH + RB

Sun Image - Reflection of direct sun image as it appears at the edge of the reticle plate.

Polarized Sky Light - The characteristic of the atmosphere to polarize sun light by scattering. The maximum polarization appears at a direction 90 degrees from the sun.

Sun Compass Switch

A three-position momentary toggle switch, labeled SUN COMP, on the periscope panel controls the rotation of the sun compass polarizer disk. The switch positions are labeled L and R. In the L position the polarizer disk will rotate in a counterclockwise direction. In the R position the polarizer disk will be rotated in a clockwise direction. Power is provided by the essential dc bus.

NORMAL OPERATION

DIRECT SUN (+6 to 50 degrees)

A. True Heading Method

1. Determine the precomputed value for azimuth of sun (Zn).
2. Manually rotate compass rose until Zn value is over the sun's image.
3. Read True Heading (TH) of aircraft on compass rose, indicated by the lubber line.

B. Relative Bearing Method

1. Manually rotate compass rose so the lubber line indicates zero.
2. Determine the precomputed Relative Bearing (RB).

3. Read the Relative Bearing of aircraft on compass rose at point indicated by sun's image.

POLARIZED SKY LIGHT (-8 to 20 degrees)

A. True Heading Method

1. Determine the precomputed azimuth of sun (Zn).
2. Electrically turn polarizer pointer toward the visible sunlight.
3. Adjust the central disk as dark as possible when the concentric rings are of equal brightness.
4. Manually rotate compass rose until Zn value is in line with the polarizer pointer.
5. Read the True Heading (TH) of aircraft on compass rose, as indicated by Lubber line.

B. Relative Bearing Method

1. Manually rotate compass rose so that lubber line indicates zero.
2. Determine the precomputed Relative Bearing (RB).
3. Electrically turn polarizer pointer toward the visible sunlight.

Note

If pointer is not positioned toward sun, 180 degrees ambiguity will be encountered.

4. Adjust the central disk to be as dark as possible when the concentric rings are of equal brightness.
5. Read the Relative Bearing of aircraft on compass rose, as indicated by the polarized pointer.

REAR VIEW PERISCOPE

A small rear view periscope is mounted in the top of each canopy to enable the pilots to see the engine nacelles, rear fuselage and rudder area. The periscope, normally retracted, is manually extended by pushing the plastic handle to the left to unlock and then pushing it upward for rear viewing.

LIGHTING EQUIPMENT

EXTERIOR LIGHTING

Landing and Taxi Lights

Two lights are mounted on the nose gear strut, one on each side. The landing light is tilted down 15 degrees and is rated at 1000 watts; the taxi light is rated at 450 watts. Both lights receive power from the left generator bus.

Landing and Taxi Lights Switches

A luminous (three-dot) LAND AND TAXI LT switch, located on the lower left side of each instrument panel, has three positions, LAND LT (up), TAXI LT (down), and OFF (center). Operating the switch to the LAND LT position illuminates the landing and taxi lights. When the switch is in the TAXI LT position only the taxi light illuminates.

Beacon Lights

Two red beacon lights are located on the top fuselage, just aft of the aft cockpit, and two on the bottom midpoint of the fuselage. When turned on, the illuminated red lights and reflectors rotate at 45 rpm to give an effect of 90 flashes per minute. The lights and rotating mechanism are powered from the essential dc bus.

Beacon Light Switches

A beacon light switch is located on the right console in each cockpit. Each switch has three positions labeled BEACON LTS, OFF, and FUS LTS. The FUS LTS position is inoperative. Placing either switch in the BEACON LTS position will illuminate the lights.

INTERIOR LIGHTING

Cockpit Lighting System

The instruments and consoles are illuminated with edge and internal lighting. In addition, two flood lights are provided on each side of the cockpits and a utility spotlight is mounted above each side console. The spotlights are detachable and may be moved about the cockpit. Rheostats on the aft end of the spotlights are used to vary their intensity. In addition, each spotlight is provided with a pushbutton switch which enables the pilot to obtain maximum brilliance without use of the rheostat. Red or white light may be selected by rotating the lens color selectors on the front of the lights. The instruments have blue-white internal lighting. Power for the instrument and console lights is furnished from the left generator bus. Power for the floodlights and utility spotlights is furnished from the essential dc bus.

Cockpit Light Switches

Three rheostat-type switches are provided on the right console in each cockpit labeled INSTR LTS, PANEL LTS, and FLOOD LTS. Ten rotary positions are available to vary light intensities from OFF to BRT.

FLIGHT RECORDER

An automatic, continuously operating flight recorder is normally mounted in the right chine of the aircraft to record airspeed, altitude, vertical acceleration, heading and elapsed time on an aluminum foil tape. The recorder has its own pitot-static system which may also be used only as an alternate for the normal pitot-static system in the forward cockpit. Heading information for the recorder is furnished by the FRS or the INS, whichever is selected by the display MODE SELECT switch. Ac electrical power from the No. 1 inverter is used to keep a spring motor wound so that all information except heading will be recorded for approximately 10 minutes after electrical power is interrupted. There is no provision for the pilot to monitor the recorder operation.

Flight Recorder Switches

Toggle switches located on each right console have labeled positions, ON (forward) and OFF (aft). When either switch is moved to the ON position, the recorder will operate. The recorder continues to run for several minutes after the switches are turned OFF.

AUTOPILOT SYSTEM

The provision of the autopilot portion of the AFCS relieves the pilot of the necessity to manually control the aircraft continuously, and provides a means for automatic navigation when coupled to the output of the INS. The autopilot functions are as follows:

1. Pre-engage synchronization.
2. Attitude hold in roll and pitch.
3. Pitch and turn wheel inputs.
4. Automatic pitch trim.
5. Heading hold.
6. Mach hold.
7. Auto navigation.

The autopilot is optimized for the basic mission cruise speed and altitude but may be used at other flight conditions.

CAUTION

> Below 25,000 feet, use of the pitch autopilot is limited to speeds less than 300 KEAS.

There are no restrictions on the use of the roll autopilot. The autopilot authority is limited to prevent severe maneuvers resulting from an autopilot malfunction. The maximum pitch authority is 2 degrees up elevon to 2 degrees down elevon. The maximum roll authority is 4 degrees differential elevon. The autopilot signals are summed with SAS signals and produce control surface motion through the SAS electronics and servos.

Autopilot control of the elevons is not reflected in control stick movement. Automatic pitch trim is operative when the autopilot pitch channel is engaged. The slow-speed pitch trim motor operates to correct for long-period pitch trim changes and there should be no pitch transient at disengagement. Preengage synchronization of autopilot pitch and roll trim operates when the pitch or roll channels are disengaged.

AUTOPILOT CONTROLS AND INDICATORS

The autopilot controls and indicators are on the SAS panel which is located on the right console in the forward cockpit. Both control sticks are equipped with control stick command and emergency disengage switches. The circuit breakers are on the right and center console circuit breaker panels in the forward cockpit.

Autopilot and Attitude Indicator Reference Selector Switch

An autopilot and attitude indicator reference selector switch labeled ATT/AP SELECT, is located on the lower edge of the center instrument panel in each cockpit. Control with this switch is transferred from one cockpit to the other by use of the TACAN/INSTR transfer switch on the left console of each cockpit. Each ATT/AP SELECT switch has two positions labeled FRS in the up position and INS in the down position, and is used to select the reference source for the autopilot and attitude indicator.

Autopilot Pitch Engage Switch

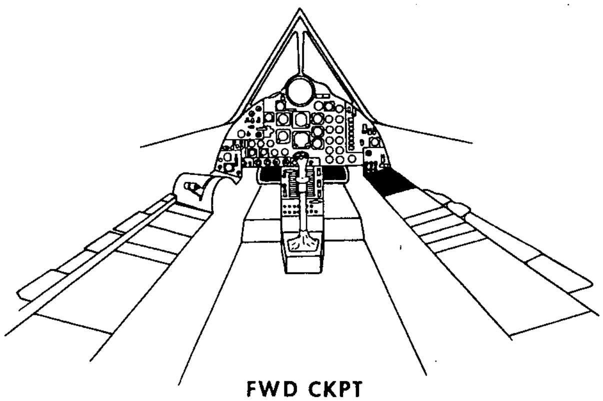
A two-position pitch engage switch is located on the inboard side of the autopilot control panel. In the ON (forward) position, the pitch autopilot is engaged in the attitude-hold mode.

Note

> At least one active SAS pitch channel must be engaged and bank angle must be less than 50 degrees before the pitch autopilot can be engaged.

The switch is solenoid-held in the ON position. The pitch channel may be disengaged by moving the switch to the OFF position, by using the disengage switches on either control stick, or by moving the ATT/AP SELECT switch from one reference to the other.

AUTOPILOT CONTROL PANEL



1 A/P HEADING HOLD SWITCH
2 A/P ROLL ENGAGE SWITCH
3 A/P ROLL TRIM SYNCHRONIZATION INDICATOR
4 A/P AUTO NAV SWITCH
5 A/P TURN CONTROL SWITCH
6 A/P PITCH TRIM SYNCHRONIZATION INDICATOR
7 A/P PITCH ENGAGE SWITCH
8 A/P PITCH CONTROL WHEEL
9 A/P MACH HOLD SWITCH

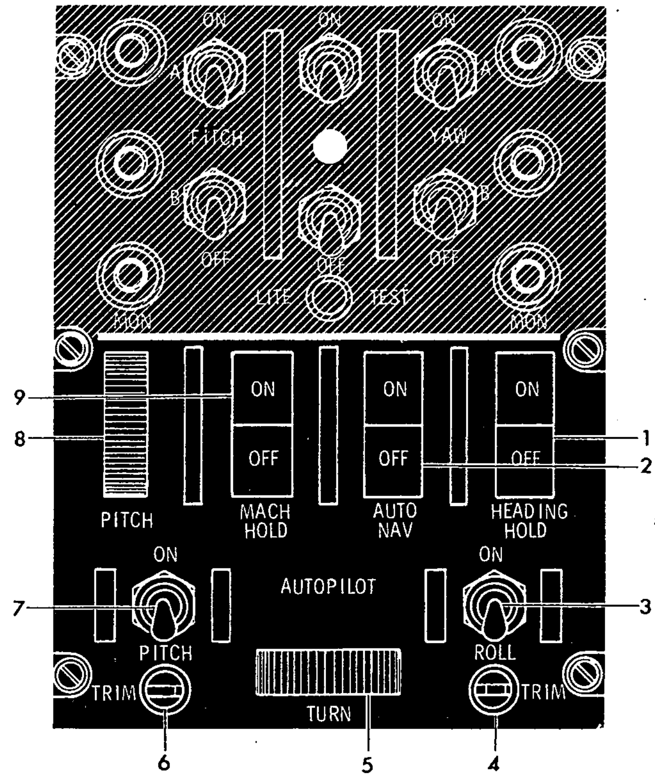


Figure 4-14

F201-18(b)

Autopilot Pitch Trim Synchronization Indicator

The pitch trim sychronization indicator is located just aft of the pitch engage switch. The indicator shows the amount of pitch signal existing prior to engagement. An up or down displacement of the pointer indicates the direction of the transient which will occur when the pitch channel is engaged.

Note

> The pitch trim synchronization pointer will normally be centered within one pointer width. Engagement of the autopilot pitch channel with more than one pointer width of misalignment is not recommended.

Autopilot Pitch Control Wheel

A serrated pitch control wheel is located just forward of the pitch engage switch. The wheel is used to make pitch attitude corrections when the autopilot is engaged in the attitude-hold mode. Forward rotation of the wheel commands nose down and aft rotation commands nose up. Pitch attitude changes 1 degree for 20 degrees of wheel rotation.

Autopilot Roll Engage Switch

A two-position roll engage switch is located on the outboard side of the autopilot control panel. In the ON (forward) position, the roll autopilot is engaged in the attitude-hold mode.

The switch is solenoid-held in the ON position. Autopilot signals are supplied by either the FRS or the INS, depending on the position of the ATT/AP SELECT switch. The roll channel may be disengaged by moving the switch to the OFF position, by using the disengage switches on either control stick, or by moving the ATT/AP SELECT switch from one reference to the other.

Note

At least one SAS roll channel and one active SAS yaw channel must be engaged before the roll autopilot can be engaged. Bank angle must be less than 50 degrees.

Autopilot Roll Trim Synchronization Indicator

The roll trim sychronization indicator is located just aft of the roll engage switch. The indicator shows when a roll signal exists prior to engagement. The pointer always deflects to the right and does not indicate the direction of the transient which will occur at engagement.

Note

Roll engagement is not recommended if the pointer is deflected to the side of the dial, indicating a hardover signal.

Autopilot Turn Control Wheel

A serrated turn control wheel is located on the autopilot control panel, between the pitch and roll trim indicators. It allows the pilot to make roll attitude corrections when engaged in the attitude-hold mode. Right rotation of the wheel commands right roll and left rotation commands left roll. Roll attitude changes 1 degree for 10 degrees of wheel rotation. The pilot can command up to 50 degrees of bank angle in the attitude-hold mode. Above 50 degrees of bank the roll autopilot automatically disengages to prevent the steady pitch rate from bottoming the pitch servos and eliminating pitch damping capability.

Mach Hold Switch

A rocker-type Mach hold switch is located on the inboard side of the autopilot panel. The Mach-hold mode is engaged when the forward part of the switch is pressed ON, provided the pitch autopilot is engaged. The ON portion of the switch illuminates and the switch is held in by a solenoid. The autopilot then controls the pitch attitude to maintain the same Mach number that existed at the time of engagement. When Mach hold is engaged, pitch attitude hold is discontinued and the pitch control wheel function is inoperative. Mach hold reference signals are supplied to the autopilot from the air data computer.

CAUTION

Do not use Mach hold mode when the triple display indication is known or suspected to be inaccurate.

Auto Nav Switch

A rocker-type auto-nav switch is located between the Mach hold and heading hold switches. The auto nav mode is engaged when the forward part of the switch is pressed ON, provided the roll autopilot is engaged. The ON portion of the switch illuminates and the switch is held in by solenoid action. Steering signals are furnished by the INS and the autopilot controls the aircraft to follow the selected course. If the heading hold mode was previously engaged, it will be disengaged when auto nav is selected. The bank angle is limited to 35 degrees in the auto nav mode.

Heading Hold Switch

A rocker-type heading hold switch is located on the outboard side of the autopilot panel. The heading hold mode is engaged, provided the roll autopilot is engaged, when the forward part of the switch is pressed ON. The switch illuminates and is held in by a solenoid. Heading signals from either the FRS compass or INS control the roll axis of the aircraft to maintain the heading existing at the time of engagement. Heading hold may be engaged while in a bank; the autopilot will roll the aircraft to a wings-level attitude and lock on the heading at time of engagement. The bank angle is limited to 35 degrees in the heading hold mode. The heading hold and auto nav switches are interlocked to permit only one to be engaged at a time. The auto nav switch will be released and the light will extinguish when the heading hold switch is depressed.

Note

When in heading hold mode the drift rate is similar to a free gyro rate and will be approximately 8 derees per hour increasing to 15 degrees per hour in polar regions.

Control Stick Command Button

A pushbutton labeled NWS/CSC (control stick command) is located on each control stick grip to disconnect the autopilot while making manual attitude changes in the aircraft. While the switch is depressed, both the roll and pitch autopilots revert to the pre-engage synchronization mode, allowing attitude and heading to be changed without opposition from the autopilot. When the switch is released, both the roll and pitch axes are engaged in the attitude hold mode, regardless of the mode that was engaged prior to depressing the CSC switch. (The NWS, nosewheel steering, function of the switch is operable on the ground only.)

Autopilot Emergency Disengage Switch

A trigger-type switch located on the forward side of each control stick will disengage the autopilot completely when depressed. The switch is nonreversible in that the autopilot will not re-engage when the switch is released.

NORMAL OPERATION

Engagement

The autopilot is engaged as follows:

1. Check SAS engaged, recycle lights out.
2. Check pitch and roll trim preengage synchronization indicators aligned.
3. Pitch and roll engage switches - ON. These switches may be engaged together or separately as operation of the two is completely independent.

Note

Bank angle must be less than 50 degrees.

4. Heading hold - As desired.

If auto nav mode is required:

5. ATT/AP SELECT switch - INS.
6. Auto nav switch - ON.

WARNING

Do not operate manual roll or pitch trim when the autopilot is engaged.

Disengagement

To disengage for attitude or heading change:

1. CSC switch - Depress.

After attitude and/or heading change:

2. CSC switch - Release.
3. ATT/AP SELECT switch - As desired.
4. Heading hold or auto nav - As desired.

To disengage autopilot do one of the following:

1. Autopilot disengage switch - Press.
2. Pitch and roll engage switches - OFF.

Mach Hold Engagement

Prior to engagement of Mach Hold the pilot will accomplish the following:

1. Attain desired KEAS, altitude and Mach number.
2. Throttle - As required.
3. Trim - As required.
4. Autopilot pitch - ON.
5. Maintain stabilized straight and level conditions for 60 seconds.

Note

Do not engage Mach Hold during turns or other maneuvers as undesirable transients will be produced. Mach Hold may however be left engaged during turns if already on.

6. Mach Hold switch - ON.

CAUTION

The pitch control wheel must not be used during Mach Hold operation to prevent rapid pitch motion on disengagement.

To minimize altitude excursions during turns:

7. Throttle - Gradually advance during roll in.
8. Throttle - Gradually retard during roll out.

If changing flight conditions, retrim or power settings are changed more than 5%:

9. Mach Hold - OFF.

SECTION V

OPERATING LIMITATIONS

TABLE OF CONTENTS

Introduction

This section provides the engine limits and aircraft restrictions that must be observed during normal training operations. Training safety margins are provided by restricting the aircraft to an operational flight envelope which is less than the demonstrated capabilities. The present operating restrictions with J-75 engines and the demonstrated flight envelope are as follows:

Condition	Restriction	Demonstrated
Airspeed	400 KEAS	427 KEAS
Max Mach Number	2.0	2.03
Max Altitude	55,000 Ft.	56,000 Ft.
Max Takeoff Weight	85,000 Lb.	100,550 Lb.
Max Load Factor	2.0 g	2.65 g
Aft CG Position	28%	29.5%

INSTRUMENT MARKINGS

The instrument markings are shown in Figure 5-2. Most markings are self-evident. Refer to Figure 5-1 for additional information on engine limitations. Certain limits shown in the Instrument Markings Diagram are not repeated elsewhere in this section.

MINIMUM CREW REQUIREMENT

The aircraft may be flown solo. The pilot shall occupy the forward cockpit during solo flight.

ENGINE LIMITATIONS

Thrust definitions and J-75 engine operating limits are as shown in Figure 5-1.

FUEL FLOW

A minimum fuel flow of at least 1500 PPH per engine must be maintained during idle descent.

OIL PRESSURE

Normal oil pressure is 40 to 50 psi. Except at IDLE, oil pressure between 35 and 40 psi is undesirable and should be tolerated only for the duration of the flight, preferably at a reduced throttle setting. Oil pressure below 40 psi should be reported as an engine discrepancy and should be corrected before the next takeoff. Oil pressure below 35 psi is unsafe and requires that a landing be made as soon as possible, using the minimum thrust required to sustain flight.

AIRSPEED AND ALTITUDE RESTRICTIONS

The present airspeed, altitude, and Mach number restrictions are shown in Figure 5-3.

WARNING

Do not exceed 400 KEAS.

J75-P-19W(S)A ENGINE OPERATING LIMITS

OIL: TURBO OIL 15 (ESSO, HUMBLE, PENOLA)
TURBO OIL TJ-15 (ESSO, HUMBLE)
1823 SYNTHETIC AIRCRAFT TURBO OIL 15 (CALTEX, TEXACO)

FUEL: PWA 523B
ALTERNATE DESIGNATION
PF-1

		TAKE-OFF	ACCELERATION		MAXIMUM	MILITARY	IDLE	START
THRUST CONDITION		A/B PLUS WATER INJ.	WET	DRY	A/B NO WATER INJ.	NO AFTERBURNER		
ALTITUDE AIR TEMP		UP TO 10,000 FT. AT LEAST 5° C.		NO ALTITUDE OR AIR TEMPERATURE LIMITS				
TIME LIMIT MINUTES		2 1/2	1/2	2	60 PER FLT.	NO LIMIT		MOMENTARY
EGT LIMIT °C		660	675	650	635	635		400
CIT LIMIT °C		—		194 (SEE TABLE BELOW)		—		—
RPM LIMIT		106.5%		106.5% (LOG OVERSPEEDS FOR OVERSPEED INSPECTION)				
OIL PRESS. PSI	MAX.	80			50 CONTINUOUS, 80 TRANSIENT AND CLIMBS			—
	NORM.	40-50			40-50		35-50	—
	MIN.	40	40	35	35 MINIMUM TOLERABLE FOR COMPLETION OF FLIGHT UNSAFE BELOW 35.		35	—
OIL TEMP °C	MAX.	120°	120°					—
	NORM.	40°-120°	40°-120°					—
	MIN.	21°	40°, EXCEPT 21° MINIMUM FOR TAKE-OFF					—

(OVERSHOOT — between WET and DRY acceleration)

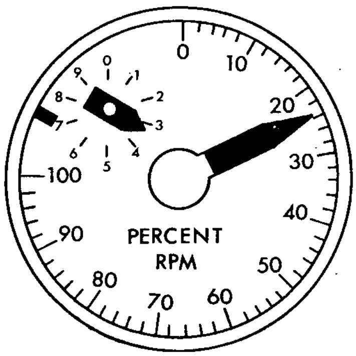
TABLE FOR CONVERTING ACTUAL RUN TIME BETWEEN 117° AND 194°C C. I. T. TO EQUIVALENT RUN TIME.
COUNT EACH MINUTE AT OBSERVED C. I. T. AS GIVEN NUMBER OF EQUIVALENT MINUTES.
DO NOT EXCEED 100 TOTAL EQUIVALENT HOURS AT MAXIMUM THRUST.

C. I. T.	EQUIVALENT MINUTES	C. I. T.	EQUIVALENT MINUTES	C. I. T.	EQUIVALENT MINUTES
117	1	171	25	184	60
143	5	173	30	187	70
158	10	177	40	189	80
163	15	181	50	194	100
167	20				

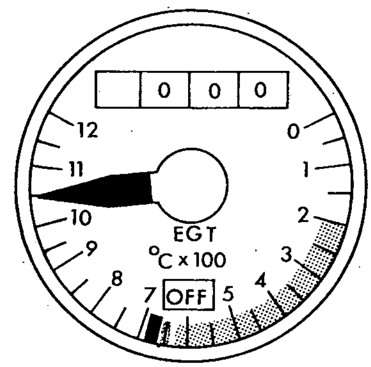
F201-58(a)

Figure 5-1

INSTRUMENT MARKINGS



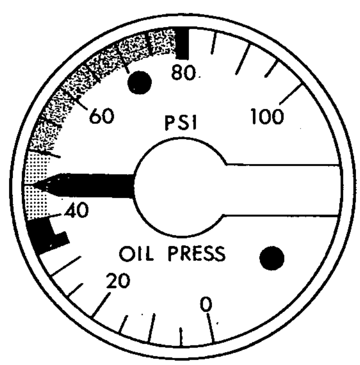
TACHOMETER



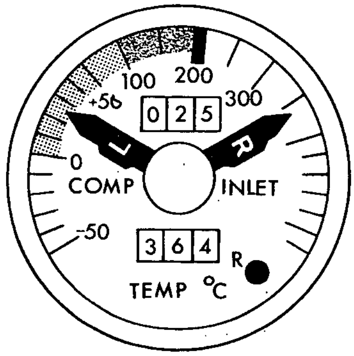
EXHAUST GAS TEMPERATURE INDICATOR

COLOR CODE

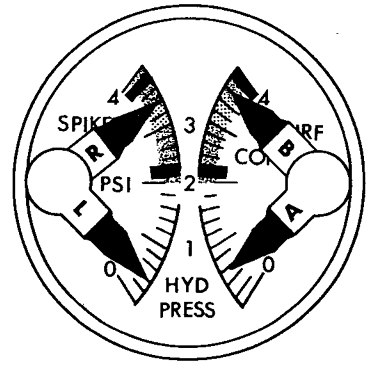
- RED
- GREEN
- YELLOW



ENGINE OIL PRESSURE GAGE



COMPRESSOR INLET TEMPERATURE INDICATOR

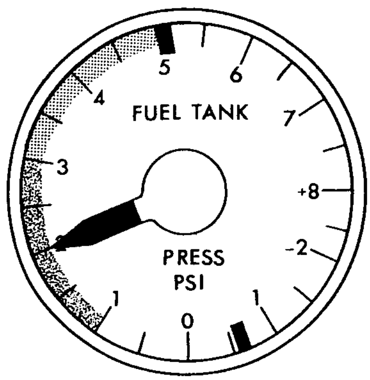


HYDRAULIC SYSTEM PRESSURE GAGE

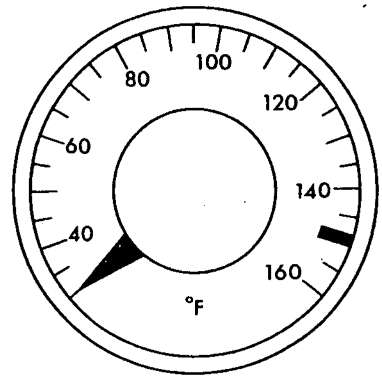
F201-54(1)(b)

Figure 5-2 (Sheet 1 of 2)

INSTRUMENT MARKINGS



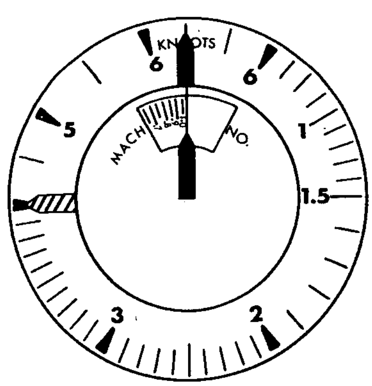
FUEL TANK PRESSURE GAGE



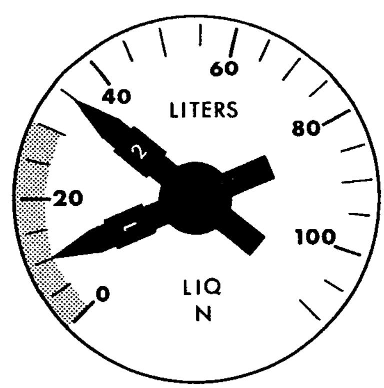
COCKPIT TEMPERATURE INDICATOR

COLOR CODE

- RED
- GREEN
- YELLOW



AIRSPEED-MACH METER



LIQUID NITROGEN QUANTITY INDICATOR

F201-54(2)(b)

Figure 5-2 (Sheet 2 of 2)

TEMPORARY AIRSPEED AND ALTITUDE RESTRICTIONS

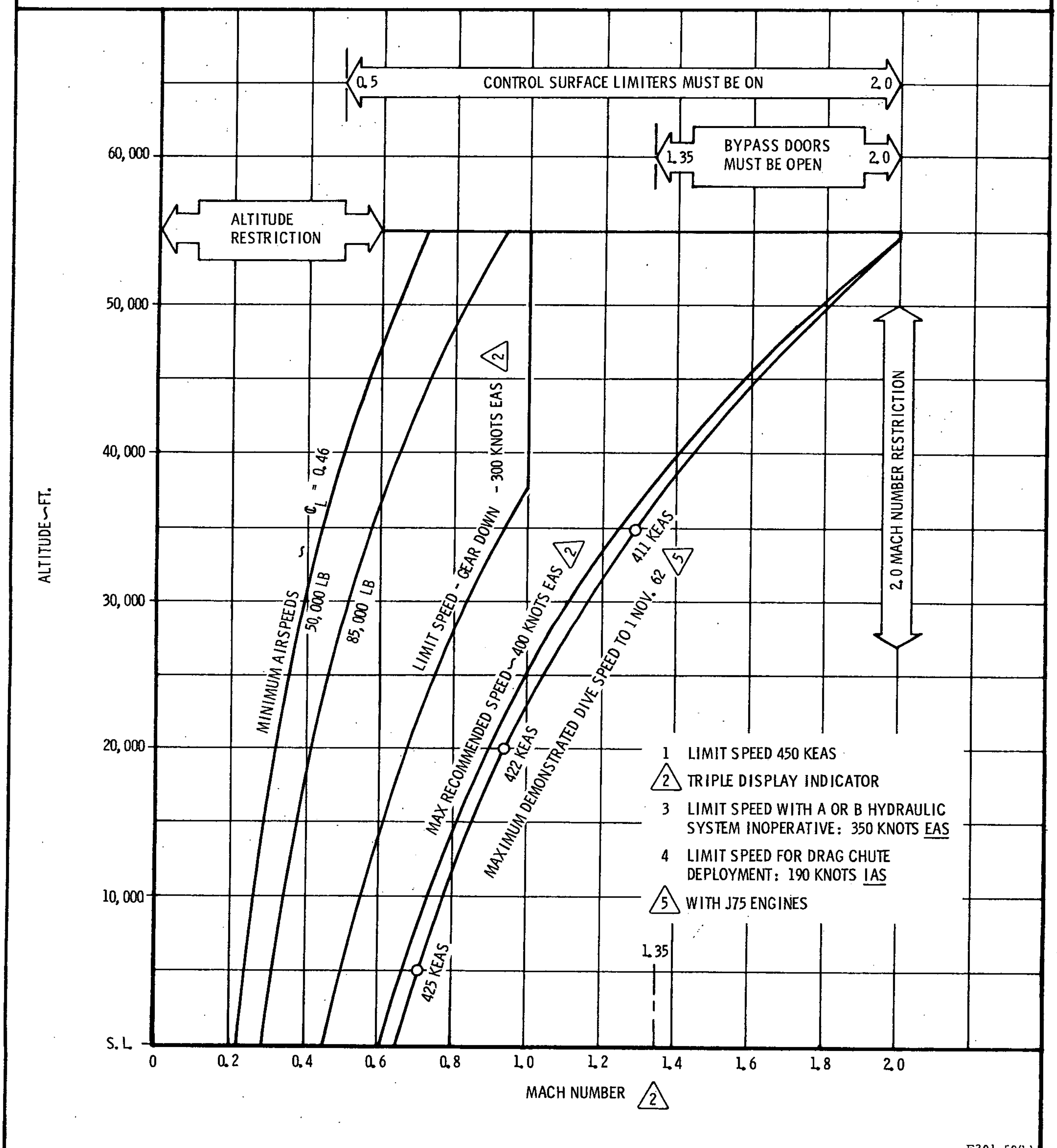


Figure 5-3

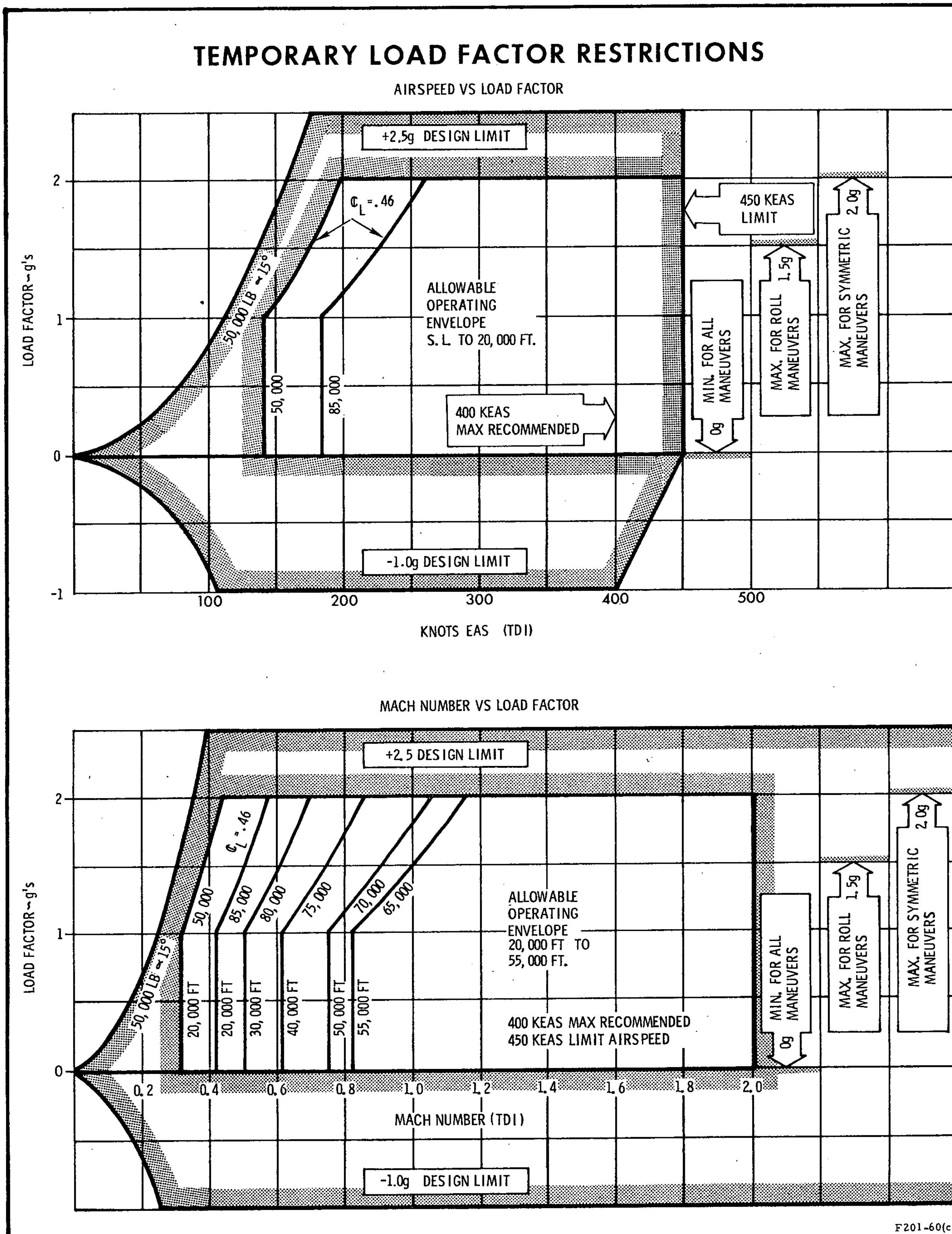

TEMPORARY LOAD FACTOR RESTRICTIONS
AIRSPEED VS LOAD FACTOR
+2.5g DESIGN LIMIT
C_L = .46
450 KEAS LIMIT
50,000 LB ~ 15°
ALLOWABLE OPERATING ENVELOPE S.L. TO 20,000 FT.
50,000
85,000
400 KEAS MAX RECOMMENDED
MIN. FOR ALL MANEUVERS
0g
MAX. FOR ROLL MANEUVERS
1.5g
MAX. FOR SYMMETRIC MANEUVERS
2.0g
-1.0g DESIGN LIMIT
LOAD FACTOR~g's
2
1
0
-1
100
200
300
400
500
KNOTS EAS (TDI)
MACH NUMBER VS LOAD FACTOR
+2.5 DESIGN LIMIT
C_L = .46
50,000
85,000
80,000
75,000
70,000
65,000
50,000 LB ~ 15°
ALLOWABLE OPERATING ENVELOPE 20,000 FT TO 55,000 FT.
20,000 FT
20,000 FT
30,000 FT
40,000 FT
50,000 FT
55,000 FT
400 KEAS MAX RECOMMENDED
450 KEAS LIMIT AIRSPEED
MIN. FOR ALL MANEUVERS
0g
MAX. FOR ROLL MANEUVERS
1.5g
MAX. FOR SYMMETRIC MANEUVERS
2.0g
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
MACH NUMBER (TDI)
-1.0g DESIGN LIMIT
F201-60(c)

Figure 5-4

PROHIBITED MANEUVERS

Inverted flight, full stalls, and spins are prohibited.

MAXIMUM WEIGHT AND LOAD FACTOR RESTRICTIONS

The allowable flight load factor envelope, based on present load factor, EAS, and Mach number restrictions, is shown in Figure 5-4.

MAXIMUM TAKEOFF GROSS WEIGHTS

The maximum takeoff weight is 85,000 pounds. This weight must be reduced 397 pounds for each degree over 79° F ambient temperature in order to maintain single-engine takeoff climb capability at 4500-foot field elevation.

Refer to the Appendix to determine if maximum gross weight is further restricted by the takeoff field length available.

MAXIMUM IN-FLIGHT WEIGHT

Do not exceed 85,000 pounds maximum in-flight weight.

MAXIMUM LANDING WEIGHT

There is no restriction on landing weight.

CENTER-OF-GRAVITY LIMITS

To insure that c.g. is in the recommended range no more than 2° nosedown pitch trim is permissible during stabilized supersonic flight. When nosedown pitch trim exceeds 2 degrees fuel should be transferred forward as required.

The aircraft shall be fueled so as to operate within the center of gravity range from 19 to 28 percent MAC. The recommended center of gravity range for subsonic flight and landing is from 19 to 25 percent MAC. Abnormal fuel usage sequences are not recommended except for forward fuel transfer prior to landing or inflight refueling and to maintain operation within the required center of gravity range.

FUEL LOADING LIMITATIONS

The maximum fuel quantity permitted in tank 1 is 3000 pounds.

AIRCRAFT SYSTEMS LIMITATIONS

STABILITY AUGMENTATION SYSTEM

The SAS shall be on for all takeoffs.

AUTOPILOT SYSTEM

Below 37,000 feet the pitch autopilot shall be used only at speed lower than 300 KEAS or 0.75 Mach number except that, when using the recommended subsonic cruise fuel management procedures, the Mach number limit may be increased to Mach 0.75 at 10,000 feet increasing linearly to Mach 0.8 above 20,000 feet and remaining at Mach 0.8 until above 37,000 feet. At higher speeds a hardover pitch autopilot failure may have sufficient power to over stress the aircraft. The roll autopilot is not restricted.

LANDING GEAR SYSTEM

Landing Gear Extension Airspeed Limitation

In flight, operation at supersonic speeds with gear extended is forbidden. When subsonic, do not exceed 300 KEAS and Mach 0.7 with gear extended as the limits of the gear door strength may be exceeded.

Landing Gear

The landing gear is designed for landing sink speeds at touchdown ranging from 9 FPS at 52,000 pounds to 7 FPS at 85,000 pounds. Side loads during takeoff, landing, and taxiing must be kept to a minimum as landing gear side-load strength is critical during ground maneuvering. Rapid turns while taxiing can overstress the airframe at relatively low speeds. Figure 5-6 illustrates the relationship of forward speed and turning angle. Note that the turn speeds indicated are limits at which design load factor is developed; operationally, turns should be made at speeds less than these to permit a structural safety factor.

Tires

The rated groundspeed limit is 239 knots for Goodrich 27.5 x 7.5 x 16 "silver" tires. This corresponds to 210 KIAS with 40°C (104°F) ambient temperature on a calm day at 4500 feet elevation. 225 KIAS is allowable at 0°C (32°F) ambient temperature. Limit indicated airspeed on the ground decreases by the amount of tailwind component along the runway and increases by the headwind component.

Brakes

The one-stop energy rating for the brakes is 118,800,000 foot pounds. Figure 5-6 presents the indicated airspeeds corresponding to this limit as a function of weight, ambient temperature, wind and drag chute deployment.

There is no limitation on airspeed for brake application when the drag chute is used.

Brakes in a new condition have a capacity for one hard stop from rated speed. If applied sooner, they will burn out prior to stop. In normal operations, delaying brake application until below 75% of limit speeds reduces wear and conserves brake capacity for high energy stops.

If brakes chatter at slow speeds during taxi, turns, and at the end of the landing roll, light braking only must be used to avoid "walking the gear" and cyclic loads on the airframe structure.

CANOPIES

The canopies should be opened or closed only when the aircraft is completely stopped. Maximum taxi speed with the canopies open is 40 knots. Gusts or strong winds should be considered as a portion of the 40-knot limit speed.

DRAG CHUTE LIMITATIONS

The maximum speed for drag chute deployment is 190 KIAS. The maximum crosswind component for jettisoning the drag chute is 12 knots. The minimum airspeed for jettisoning the drag chute is 55 KIAS. Taxiing with the chute attached is permitted if the elevons are not moved.

OXYGEN SYSTEM

Flights are restricted to altitudes below FL 500 and speeds below 420 KEAS when using an oxygen mask and regulator instead of a pressure suit.

RATED TIRE SPEED

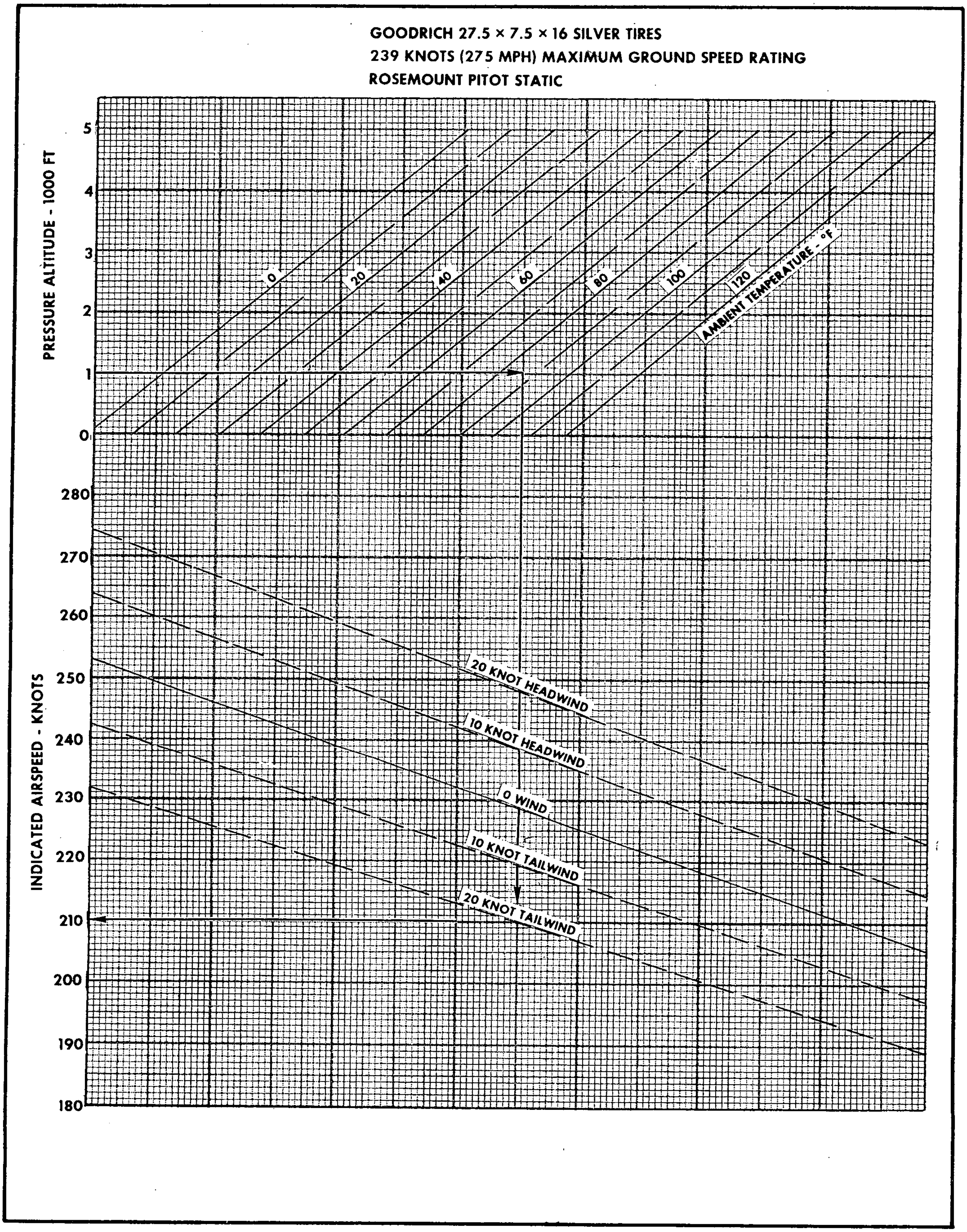


Figure 5-5

INITIAL BRAKING SPEED FOR STOP USING RATED BRAKE CAPACITY

ONE STOP CAPABILITY
6 × 4 ROTOR BRAKES 118,800,000 FOOT - POUND CAPACITY
NOSE DOWN DRY AND HARD RUNWAY
ZERO WIND, ZERO SLOPE
ROSEMOUNT PITOT STATIC

WITH DRAG CHUTE: NO INITIAL BRAKING SPEED LIMIT

WITHOUT DRAG CHUTE

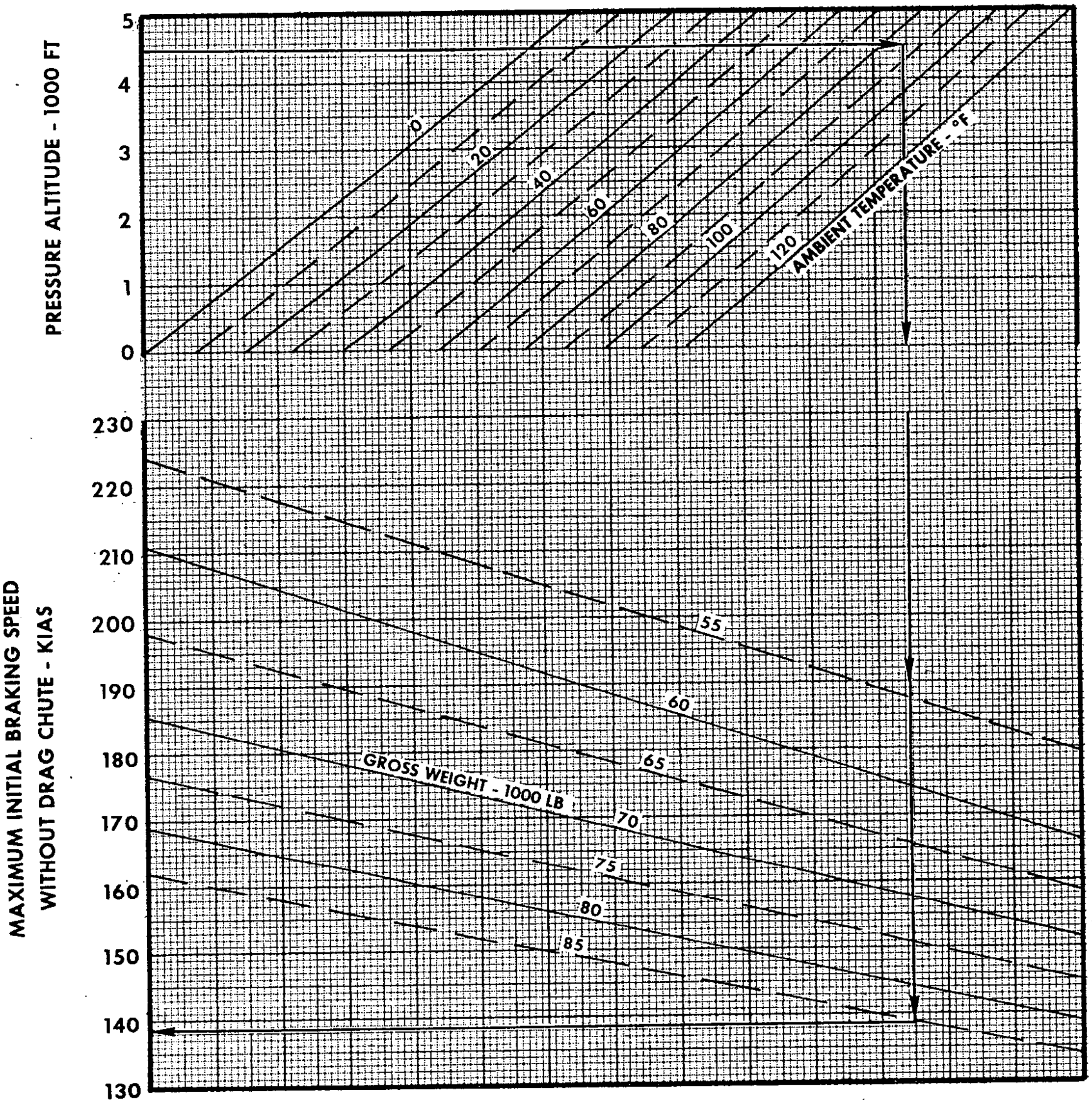


Figure 5-6

Approved for Release: 2017/07/25 C06230172

LIMIT TAXI TURN SPEEDS

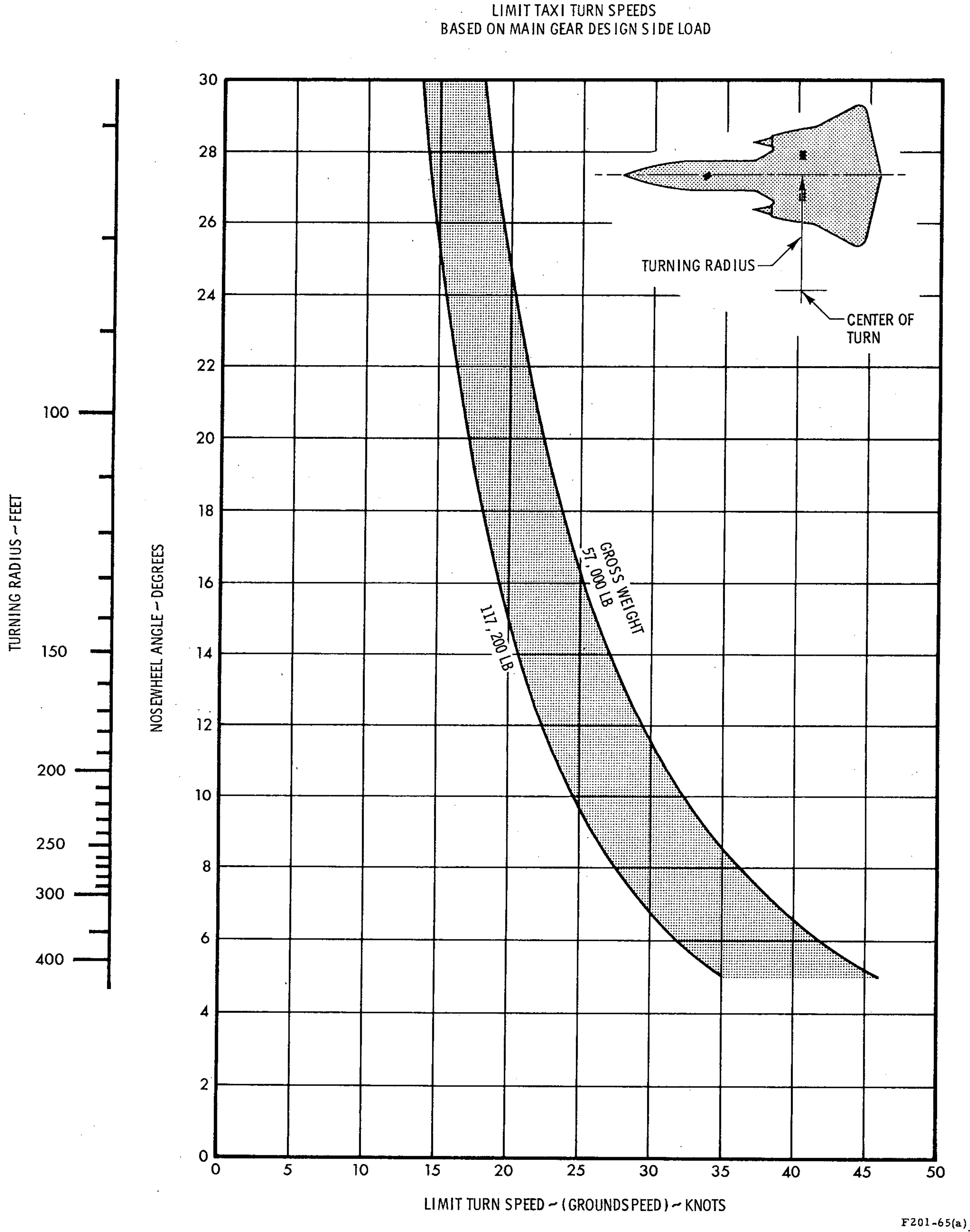


Figure 5-7

SECTION VI

FLIGHT CHARACTERISTICS

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GENERAL

The trainer is equipped with J-75 engines and does not have the performance capability of tactical aircraft powered by higher-thrust J-58 engines. Other characteristics are similar to the tactical aircraft in those respects necessary for initial training and familiarization. These aircraft are designed to operate efficiently over a large altitude, Mach-number, and gross-weight range. Small natural stability margins are necessary to obtain optimum mission cruise performance and this requires the use of a stability augmentation system to provide artifically improved handling qualities. The trainer operates in a restricted flight envelope where, with the exception of landing, the stability margins are generally greater than those of the tactical aircraft. Within the limits specified in Section V, flight tests as of 1 November 1962 and subsequent operating experience has disclosed no undesirable or unsafe characteristics with all systems operating properly. Precautionary and emergency procedures in the event of system failures are in Section III.

PERFORMANCE CHARACTERISTICS

Refer to the Appendix for specific performance information.

GROUND HANDLING

The tricycle gear with nosewheel steering provides conventional ground handling characteristics although, initially it may be necessary to get used to maneuvering from a cockpit station approximately 50 feet ahead of the pivot point. Steering by use of the rudder pedals is good. All taxiing and turns should be at slow speeds to minimize landing gear side loads. High thrust on one engine and low thrust on the opposite engine should also be avoided for the same reason. Idle rpm is generally sufficient for taxi. Brake chatter may occur at slow speeds during taxi, turns, and the end of landing roll. To minimize chatter, light brake applications which are smooth and positive are preferable to intermittent brake application and release. The brakes will not hold the aircraft above MILITARY thrust, and TAKEOFF thrust should not be applied until the aircraft is rolling.

TAKEOFF

Airspeed increases rapidly during the takeoff and the nosewheel can be lifted about 70 knots below normal takeoff speeds; however, premature rotation should be avoided because it increases drag and extends the run. An extended run can also cause excessive main gear tire heating. A technique of lifting the nosewheel approximately 3 seconds before reaching takeoff speed minimizes drag and provides a smooth rotation to lift-off attitude at the scheduled takeoff speed.

Takeoff speed is scheduled as a function of either gross weight or ambient air temperature as shown in the Appendix. The speeds which are based on weight are the minimum recommended takeoff speeds; refer to Minimum Airspeed, this section. These airspeeds are superseded when ambient air temperature conditions are such that minimum single engine control speed requirements govern the takeoff.

Single-Engine Takeoff

The takeoff gross weight is restricted to a maximum of 85,000 pounds to provide adequate single-engine takeoff climb capability. This weight must be reduced as shown in the Appendix when taking off without water injection at temperatures warmer than 26°C, or when using water injection at temperatures warmer than 38°C. At low ambient temperatures, or light gross weight, the scheduled takeoff airspeeds are the minimum speeds required to maintain a wings-level, zero-sideslip flight path with a dead engine. (See figure 3-1, Section III.) Single-engine operation is critical immediately after takeoff. Increasing the airspeed is more advantageous than attempting to gain altitude at maximum rate.

CLIMB

After takeoff, a small but positive rate of climb can be established to accelerate to climb speed. The acceleration is rapid and a definite rotation is required to establish the climb attitude. The attitude is moderately high and there may be a tendency to overshoot the climb speed, particularly when piloting from the aft cockpit. If a 400 KEAS climb is planned, rotation should be started at about 370 KEAS. An increase in the level of wind noise may be noticed in the forward cockpit at 380 KEAS. Some light transonic roughness can be expected at about 25,000 feet if the climb is made at 400 KEAS. Similarly, a supersonic hum may be noticed between 35,000 and 40,000 feet as Mach 1.3 to 1.4 is reached. These characteristics are normal for this aircraft. Rough air during the climb is amplified considerably at the pilot's station due to the natural response of the flexible fuselage.

SUPERSONIC ACCELERATION

The lowest altitude at which Mach 1.0 can be attained without exceeding 400 KEAS is 25,000 feet. See figure 5-3, Section V. Under standard temperature conditions this would be the best region to accelerate supersonically because the excess thrust is greatest. However, ambient temperatures here are frequently hotter than standard by 10° or more and this decreases the acceleration capability. Under these conditions it is necessary to make the acceleration at higher altitude where the temperature is lower. The excess thrust decreases with increasing altitude; however, this is offset by the colder temperature. The following general guides are useful when planning a supersonic acceleration:

1. Do not make a 400 KEAS climbing acceleration when the temperature is warmer than 5°C above standard at altitudes above 20,000 feet.

2. When temperatures are high, select the lowest altitude at which the temperature is standard or slightly colder than standard to make the acceleration.

3. Use the procedures given in Section II; however, if a diving acceleration is made, do not dive into a warmer than standard temperature condition at lower altitude.

4. Do not attempt level accelerations at 45,000 feet or higher because there is not sufficient excess thrust.

The excess thrust relationship is such that supersonic acceleration is always slow until the Mach number exceeds approximately 1.2. Light transonic roughness may be expected between 0.9 and Mach 1.0. The supersonic hum at Mach 1.3 to 1.4 should not be confused with duct buzz. The bypass doors must be opened manually at about 1.35 Mach to avoid inlet duct buzz and roughness will start at about Mach 1.4. Afterburner flameout and engine stall may follow if the acceleration is continued with the doors closed. Maximum afterburning is required for supersonic acceleration. The engine thrust should be regulated by EGT, observing 635°C maximum. The throttles should not be retarded to hold 100 percent rpm. Maintain 635° EGT and allow rpm to increase with Mach number as long as 106.5 percent rpm is not exceeded. Normally, the rpm is approximately 103 percent at Mach 2. The throttles should be retarded very slowly at the end of acceleration to avoid afterburner flameout and engine stall. Yaw maneuvers should not be made at maximum speed unless the yaw damper is on. Return to neutral after rudder kick is slow with the yaw damper off.

CRUISE

Cruise techniques are conventional. The best subsonic range at Military thrust is obtained by making a 300 KEAS Military-thrust climb and then cruise-climbing at this thrust setting and an indicated 0.85 Mach number from the triple display indicator. Essentially, this is also a true Mach number of 0.85. This Mach number may be used for either constant Military thrust cruise climb, or constant altitude cruise. The latter requires thrust reduction as weight decreases to hold the Mach number and altitude constant. During subsonic cruise, the Mach number should not be allowed to exceed 0.90 if range is important. The miles per pound will begin to diminish rapidly above this Mach number. A 400-KEAS cruise mission is supersonic above 25,000 feet. The mission is flown at maximum afterburning thrust, climbing at constant speed as weight reduces.

MAXIMUM ENDURANCE

If maximum endurance is desired, retard the throttles and fly at minimum fuel flow. At altitudes of 20,000 to 35,000 feet this would be approximately 0.75 Mach.

DESCENT

Descents are made at 300 to 350 KEAS with the gear up. A minimum fuel flow of 1500 pph per engine must be maintained to protect the fuel control from high fuel temperatures. The minimum descent rpm is approximately 80 percent. It is not advisable to throttle below 80 percent rpm at higher altitudes because of the possibility of engine compressor stall.

APPROACH AND LANDING

Landings are normally made at a center-of-gravity position no further aft than 25 percent MAC. The maximum 3000 pounds of fuel should be transferred forward into tank 1 prior to landing. The transfer rate is substantially higher during descent than during level flight. It may be necessary to repeat the forward transfer since the tank 1 fuel will start to feed as soon as forward transfer is terminated. The normal attitude at touchdown is approximately 10 degrees, or nose on the horizon. If the attitude exceeds 14 degrees, there is danger of scraping the tail. Landing speeds for weights greater than 54,000 pounds are scheduled to maintain a constant lift coefficient of 0.46 and vary with gross weight as shown in the Appendix. The SAS is normally on for landing. Approaches and landings have been made with the SAS off, but approach control is more difficult. Unless an emergency exists, SAS-off landings are not recommended under the following conditions:

1. At center-of-gravity positions aft of 25 percent.

2. At gross weights exceeding 55,000 pounds.

3. In rough air.

Simulated and actual single engine landings can be made using the procedures outlined in Section III. During a single-engine landing with the operative engine at low rpm, or a normal landing with both engines at idle rpm, the hydraulic flow rate is reduced. This decreases the available rate of control surface movement. Normally, adequate control is available, but caution should be observed and higher than normal approach speeds used when landing in extremely turbulent air where maximum control rates may be required.

GO-AROUND

Maximum thrust can be applied for go-around without retrimming immediately. Retrimming may be desirable as the gear is retracted and airspeed increases. Rotating to about 10 degrees attitude is helpful for checking descent and allows the aircraft to accelerate as thrust is increased. Over-rotation should be avoided because it increases drag and decreases the thrust available for acceleration.

MINIMUM AIRSPEEDS

The minimum speeds were established to provide adequate ground clearance consistent with satisfactory takeoff and landing performance. The speeds correspond to a lift coefficient of 0.46 and approximately a 10-degree attitude. This provides approximately 34 inches minimum tail clearance. Minimum speeds away from the ground are based on the same lift coefficient. See figure 5-3, Section V. The flight characteristics at low airspeeds are typical of delta-wing aircraft. There is no sharply defined wing stall. It is possible to maintain lift with angles of attack greater than 10 to 12 degrees, but such angles of attack or high nose up cruise attitudes should be avoided. Observe the minimum speed restrictions of Section V.

MANEUVERING CHARACTERISTICS

Load factor restrictions as a function of EAS and Mach number are shown in figure 5-4, Section V. These load factor restrictions must be observed. The maneuvering characteristics have been satisfactory at bank angles in excess of 50 degrees. The maximum roll rate is approximately 80 degrees per second at refueling and subsonic cruise Mach numbers, and 50 degrees per second at 0.5 Mach number. At Mach numbers greater than 1.5, maneuvering at load factors close to 0G may cause engine compressor stall.

SPINS

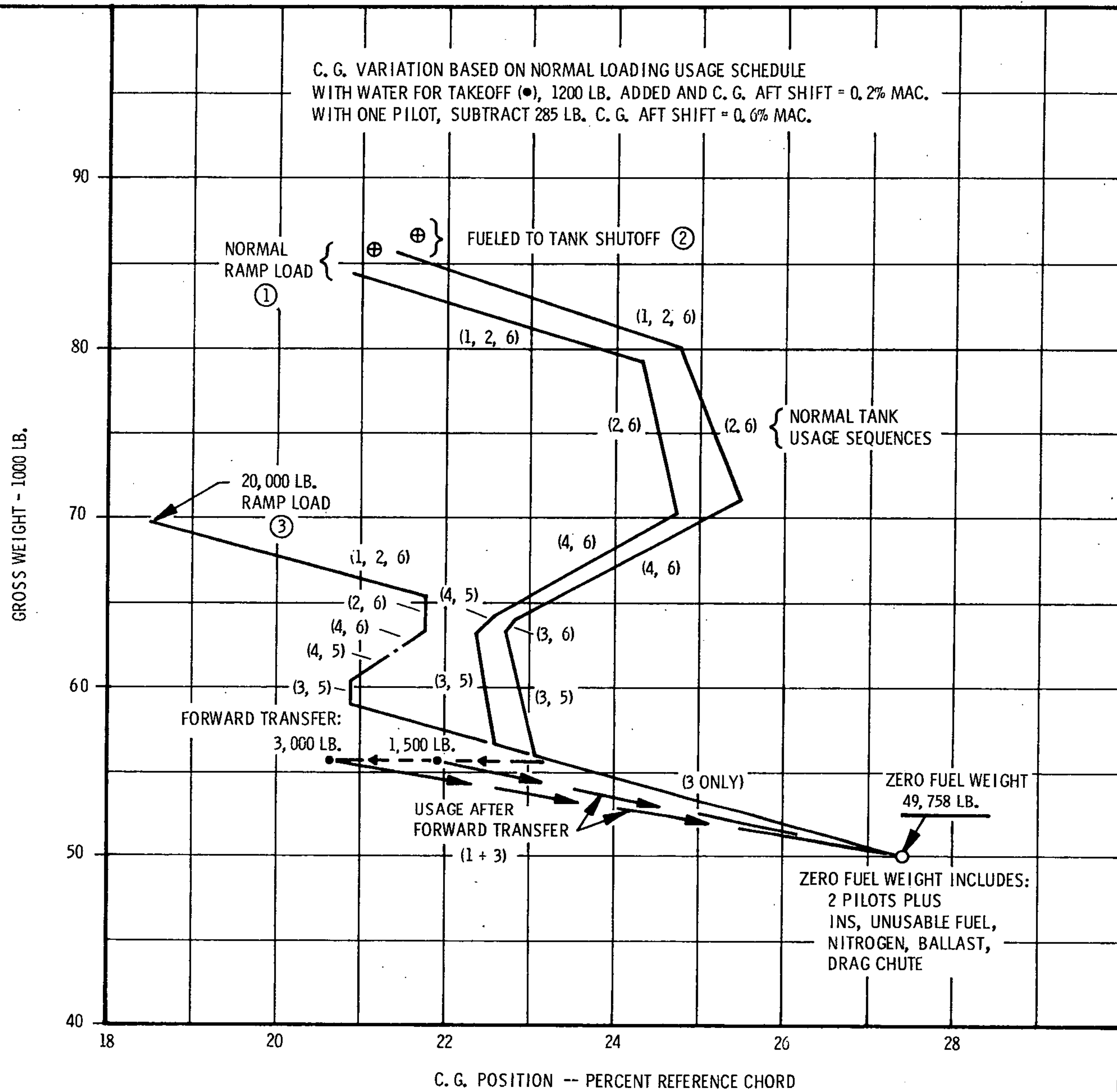
Intentional spins are prohibited. The load factors developed during spin recovery are likely to exceed structural capabilities. In case of inadvertent spin, however, the following recovery techniques are recommended:

1. Center the controls, disengage surface limiters, and determine the direction of rotation from the turn indicator.
2. Apply forward stick and full aileron control into the direction of spin as the nose drops.
3. Apply opposite rudder to stop rotation.
4. Center rudder and roll control as rotation stops.
5. Start pull-out at 300 to 350 knots.
6. If possible, avoid exceeding 450 knots and 2.5G during recovery.

STABILITY AND CONTROL CHARACTERISTICS

The SAS provides good stability, control, and handling characteristics, and has demonstrated excellent system reliability. The directional control during engine stall and afterburner flameout at Mach 2.0 has been very good.

GROSS WEIGHT-CENTER OF GRAVITY VARIATION



TANK NO.	FUEL LOAD—LB. ① NORMAL	② FULL (REFUELED)	③ 20,000
1	3,000	3,000	2,500
2	6,000	6,000	2,000
3	10,200	10,200	10,200
4	3,300	3,500	1,500
5	3,700	3,800	1,500
6	8,600	9,300	2,300
GROSS WEIGHT	84,558	85,558	69,758

F201-57(a)

Figure 6-1

PITCH STABILITY

Normally, the center of gravity is positioned forward for takeoff at approximately 20 percent MAC. This can be controlled through combinations of ballast and/or takeoff fuel load distribution. The center-of-gravity variation with normal fuel usage can also be varied with different fuel load distribution. The variation for a typical loading is shown in figure 6-1. The smallest pitch stability margin is during landing when the remaining fuel is in tank 3. The largest margin is at transonic and supersonic Mach numbers. It is always desirable to move the center of gravity position forward for landing by transferring fuel forward into tank 1 prior to approach. The SAS gives the aircraft a solid feel in all flight conditions and the Mach trim system effectively eliminates unstable pitch trim changes in the transonic region. The stick forces are supplied by feel springs and are a function of stick displacement. The forces are moderately light but positive. The breakout forces are considered to be exceptionally good although they are somewhat greater for single-place aircraft. Control is adequate with the SAS pitch damper off. An upset results in an aircraft pitch motion with a relatively long period. At aft center-of-gravity positions the aircraft may not return to the trim condition; but, due to the long period, the divergence can be controlled. The aircraft has not been tested above Mach 1.8 with the pitch damper off.

LATERAL-DIRECTIONAL STABILITY

The SAS provides good lateral-directional stability and aircraft roll or yaw motions are damped immediately. All dampers should be on for supersonic flight in case of an engine failure at high Mach number; experience has shown that it is sometimes difficult for the pilot to determine which engine has stalled and the SAS is required to help the pilot maintain directional control. The SAS response is more rapid than pilot recognition and reaction, and the dampers act immediately to minimize yaw and roll. Even so, rapid pilot followup with rudder and aileron control is desirable. Shutting off the afterburner and reducing thrust on the operative engine should be done as soon as possible.

Experience has also shown that the SAS should be on for satisfactory lateral-directional control during takeoff. This provides good control during normal takeoff and also serves as a precautionary measure in case of a takeoff engine failure. With the SAS roll and yaw dampers off, the lateral-directional characteristics are typical of delta-wing aircraft. Roll and yaw for motions are easily induced by gusts or maneuvering, with a high ratio of roll to yaw. Use of the roll damper will improve the handling characteristics if the yaw dampers are off. The aircraft has not been tested above Mach 1.8 with the roll and yaw dampers off.

AERIAL REFUELING

There are no adverse flight characteristics from the tanker downwash and handling is satisfactory with the SAS operating. Refueling can be made in level flight at 28,000 feet altitude or during descent, using approximately a 300 fpm descent rate. Pitch control is a little more sensitive after hookup and there may be some small roll oscillation as the aircraft moves laterally in the downwash field. The recommended refuelings can be made at either Mach 0.7 or 0.8, but pitch control is not quite as effective at Mach 0.7. During approach and hookup, approximately 94 to 96 percent rpm is required at 28,000 feet, Mach 0.8, and 60,000 pounds gross weight. Approximately 98 percent rpm is required to maintain refueling Mach number and altitude after receiving 10,000 pounds of fuel. If the SAS pitch damper is inoperative, the backup pitch damper is available for pitch stability augmentation during refueling. The BUPD is optimized for use at light weight, aft center-of-gravity position, and subsonic speeds from Mach 0.3 to 0.8. It is not intended for use in conditions other than refueling and landing approach. With no pitch stability augmentation available, hookup and fuel transfer would be extremely difficult.

SECTION IX

ALL WEATHER OPERATION

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Introduction

Except for repetition necessary for emphasis or continuity of thought, this section contains only those procedures which differ from or are in addition to the normal procedures supplied in Section II.

INSTRUMENT FLIGHT PROCEDURES

The aircraft handles well during all phases of instrument flight when operated in accordance with procedures specified in the following paragraphs. As with all high performance jet aircraft, constant attention to flight instruments is required. Normal jet instrument techniques are satisfactory for operation during instrument conditions. Turn off rotating beacon lights when flying in weather. Navigational aids include an inertial navigation system, FRS, TACAN and ADF. IFF/SIF is also installed.

The ships pitot static system is the primary speed and altitude reference during takeoff, penetration, approach and landing. Speeds given here are knots indicated airspeed (KIAS). Equivalent airspeeds (KEAS) and altitude information from the air data computer system (TDI instrument) can be used; however, TDI response may not be as rapid as the ship system indications during transient airspeed situations.

The stall warning indication is referenced to the attitude probe in the Rosemount pitot-static boom. It is independent of pitot-static pressures sensed by the ship and air data computer systems to that extent. Pitot heat should be sufficient to keep both the pitot static head and the attitude probe operating during icing conditions. However, in the event that complete pitot blockage is suspected, use the stall warning indication and visual attitude reference as a minimum airspeed boundary.

Note

Keep pitot heat on during all subsonic instrument flight operations.

BEFORE INSTRUMENT TAKEOFF

After aligning the aircraft with the centerline of the runway, check synchronization of the FRS, check the display MODE SELECT switch in the MAG position and the ATT/AP SELECT switch in FRS position, and set the attitude indicator so that the miniature airplane is level with the horizon line. Place the BEARING SELECT switch in the TACAN position to display TACAN bearing information on the HSI.

Note

Use the FRS for heading reference during all takeoffs and instrument departures.

INSTRUMENT TAKEOFF

Use Maximum thrust for instrument takeoffs, and use takeoff procedures identical to those contained in Section II until after rotation is started. The following procedures supplement those given in Section II:

a. Rotation - Begin at computed rotation speed. Apply smooth, constant back pressure to establish an indication of +10 to +12 degrees on the attitude indicator in about three seconds. The aircraft will fly off the runway at normal airspeeds.

b. Maintain 10 to 12 degrees pitch attitude indication while accelerating to desired climb speed. The altimeter and vertical-velocity indicator should show a definite climb indication before retracting the landing gear. Exercise care to ensure that a positive rate of climb is maintained during acceleration to climb speed in order to prevent the aircraft from settling back to the runway.

Note

Initial indications of the altimeter and vertical speed indicator may be that of a slight descent.

c. Landing gear lever - UP when definitely airborne.

d. Afterburners - OFF as 300 KEAS is approached when a Military power climb is used for instrument departure.

Note

Use indicated airspeed during takeoff and climb until proper climb schedule speed is reached on the triple display indicator.

INSTRUMENT CLIMB

The optimum VFR Military Thrust schedule is suitable for instrument climbs to intermediate altitudes. As soon as the climb schedule is intercepted, the TDI becomes the primary pitch control instrument for the remainder of the climb.

Note

The TDI and normal pitot-static flight instruments should be cross checked periodically during instrument flight to confirm proper operation.

As soon as VFR on TOP conditions are reached, the optimum VFR Maximum Thrust climb schedule should be established. Restrict all turning maneuvers to 30 degrees maximum bank angle during low altitude instrument flight.

MAXIMUM THRUST CLIMBS

Instrument climbs using afterburner can be made safely as long as the pilot allows for more rapid acceleration and steeper climb attitudes than are available with Military Thrust. Maximum Thrust climbs are desirable at heavy gross weights or when climbs above Flight Level 300 are scheduled. Maximum Thrust may be resumed after stabilizing at the desired climb speed.

INSTRUMENT CRUISING FLIGHT

Establish cruising airspeed at the desired altitude and retrim the aircraft. After instrument departure instructions have been accomplished, the HSI may be switched to display INS navigation information as required to complete the mission. Readjust the horizon bar on the attitude indicator to indicate level flight attitude when the aircraft is in level flight at cruising airspeed. This aircraft has excellent handling characteristics throughout its normal flight speed range if properly trimmed and flown by reference to the flight instruments.

Note

Below flight level 180, the altimeter must be set to station pressure and used to maintain assigned altitude. The normal pitot-static flight instruments become primary flight instruments at FL 180 when descending.

TURNS

A constant 30 degrees angle of bank may be used for all turns except rate turns when required or desired.

STEEP TURNS

Any angle of bank exceeding 30 degrees is considered a steep turn; however, the aircraft is easily controlled on instruments in banks up to 60 degrees. Because of structural load restrictions bank angles in excess of 45 degrees should be avoided.

HOLDING

Holding patterns should be flown at 275 KIAS. Five knots may be added to appropriate holding airspeed for each 5000 lb of fuel remaining above 15,000 pounds. Single-needle-width turns (1-1/2 degrees per second) are recommended while in the holding pattern. Approximately 91 percent engine rpm and 4600 pounds per hour per engine fuel flow can be expected during level flight in the holding pattern at 20,000 feet MSL. During turns in the holding pattern, fuel flow requirements will increase to approximately 5300 pounds per hour per engine at 93%. To descend in the holding pattern, lower the nose of the aircraft and reduce power to maintain proper holding airspeed. Lead the desired level-off altitude by 500 to 1000 feet. Prior to initial station passage and entry into the holding pattern, the ATT/AP SELECT switch must be moved to the FRS position. Check the FRS for synchronization and that the BEARING SELECT switch is in the desired TACAN or ADF position.

JET PENETRATION

Fly penetrations at 275 KIAS, with 82% rpm which gives 1500 pounds per hour per engine fuel flow at normal penetration gross weights. This power setting should be made at 20,000 feet and the fuel flow should be allowed to increase in the descent. Power may be varied as required by gross weight, with the minimum recommended at 1500 pounds per hour fuel flow per engine and/or 82 percent engine RPM. Landing gear may be used for additional drag during the penetration if desired, but should be extended no earlier than middle station passage and no later than the turn onto final approach when making a figure-eight type penetration. In a normal teardrop penetration the landing gear should be extended after completion of the penetration turn. After landing gear extension through turn to final approach, airspeed will be maintained at 230 to 250 KIAS at normal approach gross weights. Final approach speeds are identical to those for normal traffic patterns and landings and will be adjusted for existing gross weight. For a single-engine approach, the gear should not be extended until final approach is initiated. Minimum approach speed is 200 KIAS for single-engine situation.

INSTRUMENT APPROACHES

The aircraft is equipped to make either TACAN or ADF approaches. Precision approach radar (PAR) approaches may also be made. When flown as recommended, aircraft control response is good at all times. The downwind or outbound portions are flown at 250 KIAS with the landing gear up. The base leg or procedure turn portions are flown at 230 KIAS and the gear extended during the turn to final approach. The landing gear may be extended earlier for additional drag if required. With normal landing gross weights the final approach speed is 165 KIAS. Adjust final approach speed for existing gross weight. With one engine inoperative, delay gear extension until the final turn is completed, and maintain a minimum final approach speed of 200 KIAS.

Note

- If the left engine has failed, the landing gear must be extended using the Emergency Landing Gear Extension procedure in Section III. The pilot should be aware of the time required and of the other aircraft systems which are affected by the loss of the left engine.

JET PENETRATION

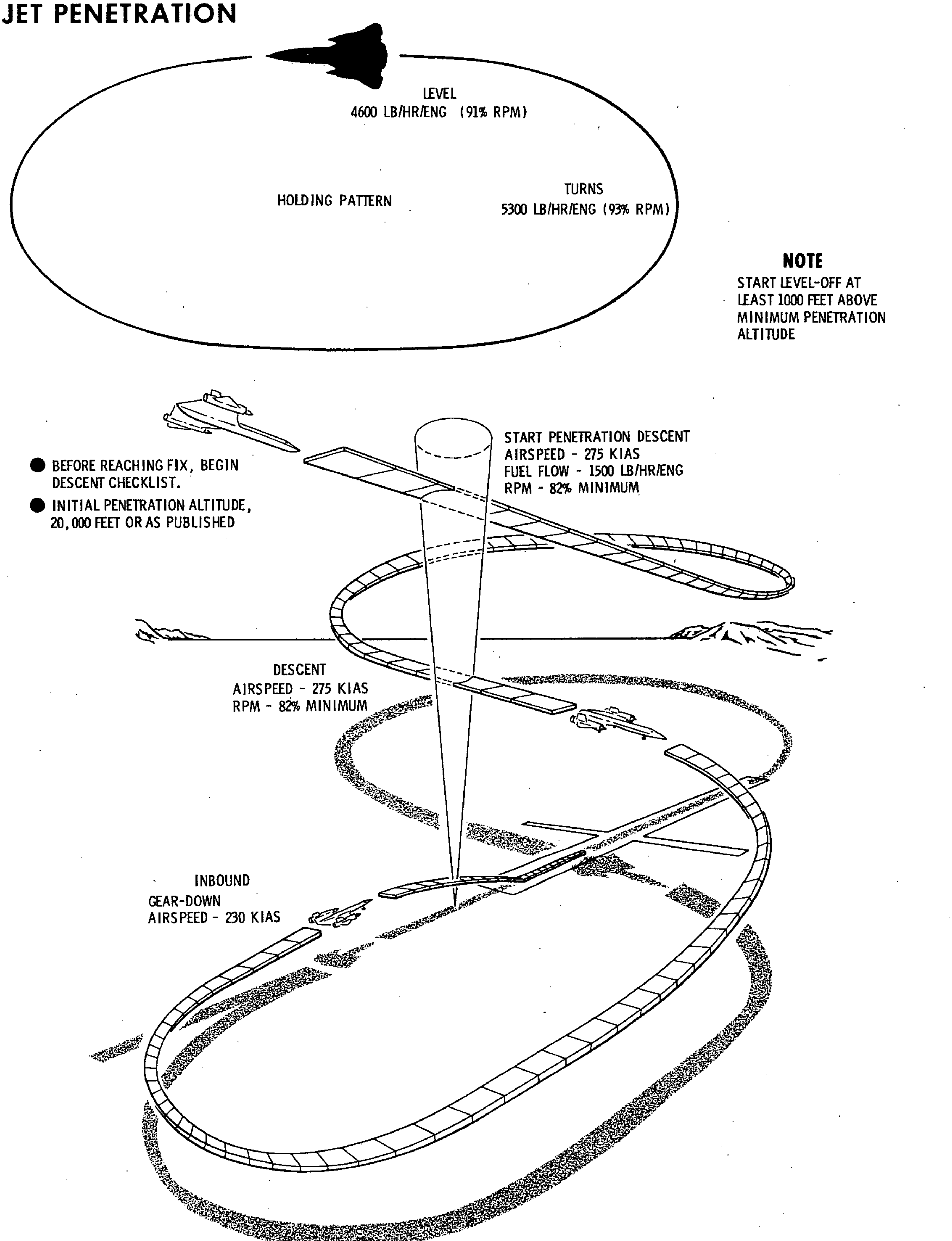
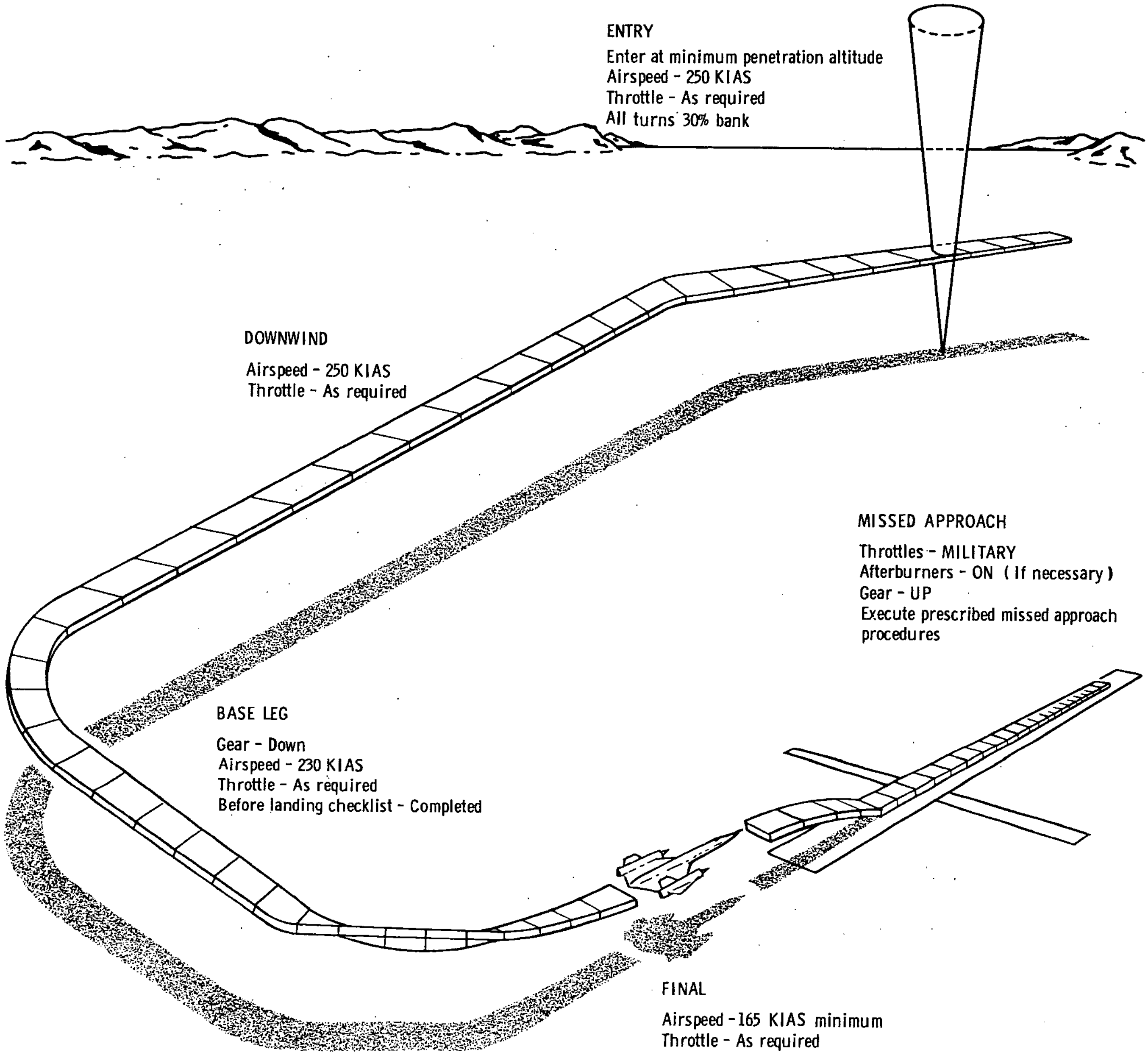


Figure 9-1

PRECISION APPROACH RADAR



NOTE

Increase final approach speed 1 knot for each additional 1000 lbs. of fuel above 5000 lbs. remaining

F201-51(b)

Figure 9-2

- When using the alternate pitot-static system, airspeeds recommended for final approach and landing are 10 KIAS less than for normal operation. Refer to Appendix I for normal and alternate system corrections.

MISSED APPROACH OR GO-AROUND

Apply Military thrust as soon as it is determined that a go-around is necessary. Use afterburning (Maximum thrust) if necessary. Raise the landing gear only after a climb has been established, and climb to the missed approach altitude at 250 KIAS. Begin power reduction approximately 1000 feet below missed approach level-off altitude to avoid overshoot. In the event a single engine missed approach is necessary, follow the single engine go-around procedures in Section III and observe the single engine minimum control speed.

ICE AND RAIN

Detailed information on flight through icing conditions is not conclusive at this time. Flights in areas where heavy icing conditions and/or heavy rain are present or forecast is prohibited. Extended flight in any known icing conditions is also prohibited. If icing conditions or heavy rain at near freezing conditions is encountered in flight, the engines must be examined for damage during post flight inspection.

FLIGHT IN RAIN

In rain, forward visibility is obscured by a water film which extends over almost all of the windshield area. Use of the rain remover liquid during light and moderate rain conditions improves visibility to a usable condition at approach speeds. Visibility is momentarily obscured as the liquid is applied, then the windshield clears and beads of water form which stream across the glass. Rain remover application is needed at ten to fifteen second intervals for the best results. The rain remover system is not effective in very heavy rain conditions.

Note

Reduce speed below 250 KIAS before applying rain remover fluid.

CAUTION

Do not apply rain repellent on a dry windshield. Prolonged obscuration may result.

1. Rain removal button - PUSH.

Note

Momentary cloudiness will occur.

CAUTION

Do not apply removal liquid after passing approach minimums.

2. Repeat as required when visibility deteriorates.

HIGH HUMIDITY CONDITIONS

If fog emanates from cockpit distribution ducts:

1. Temp control knob - INCREASE as required.

If condensation forms on inner or outer glass:

2. Cockpit defog switch - INCREASE as required.

TURBULENCE AND THUNDERSTORMS

Flight should not be scheduled through areas where severe or extreme turbulence is forecast. In the event that such conditions are encountered however, airspeed should be maintained between 250 and 350 KEAS.

Normal penetration and approach speeds are compatible with rough air penetration schedules. However, the normal turn to final approach speed may be increased from 230 KIAS to 250 KIAS in order to avoid the possibility of upset during this phase. Standard rough air penetration techniques apply to this aircraft.

COLD AND HOT WEATHER PROCEDURES

Detailed cold and hot weather procedures are not available. The pilot should always be aware of the effects of non-standard temperatures on takeoff and landing distances and minimum single engine control speeds. The pilot should also be aware of the effects of wet, icy, and slush covered runways on takeoff and landing distances and on ground handling characteristics.

NIGHT FLYING

Detailed specific night flying procedures are not required; however, the normal precaution of memorizing the positions of switches located in dim or unlighted locations should be accomplished.

APPENDIX I

PERFORMANCE DATA

TABLE OF CONTENTS

PART I

INTRODUCTION

DATA BASIS

The performance charts are based on flight test data from J-75 engine equipped aircraft, supplemented by test results from other aircraft and by wind tunnel performance data. Additional data obtained with trainer Serial 124 will be incorporated as the information becomes available.

AIRSPEED SYSTEMS

Airspeed, altitude, and Mach number are available from the ship system instruments and from the triple display indicator (TDI). The ship normal and alternate systems supply conventional altimeter and airspeed Mach number indicators. The TDI provides digital values for equivalent airspeed (KEAS), corrected pressure altitude, and true Mach number. The differences between indicated airspeed (KIAS) and KEAS are a function of speed, altitude, and ship system position error. A comparison of KEAS from the triple display indicator and KIAS from the ship's normal system instruments is shown by Figure A1-3. For example: at 400 KEAS, the normal ship system will indicate 420 KIAS at 20,000 feet indicated pressure altitude, and 475 KIAS at 50,000 feet indicated altitude. Other combinations of indicated altitude and KIAS can be determined from Figure A1-3 for use in the event of TDI failure.

POSITION ERROR CORRECTIONS

Triple Display Indicator

The Triple Display Indicator of the Air Data computer system is the primary instrument for climb and for all operations above FL 240. It is almost completely compensated for position error and compressibility effects; however, the TDI airspeed lags during takeoff. IAS from the normal ship system should be used until climb speed is attained. The ship system should also be used for pattern operation and landing, although the TDI follows these speed and altitude changes without excessive lag.

Normal Ship System

Figures A1-1 and A1-2 show position error corrections for the altimeter and airspeed-Mach number indicators when the normal (Rosemount pitot static) system is selected. Corrections for operation at subsonic speeds were obtained by calibrations in flight and during ground runs. Corrections provided for supersonic speeds were obtained from wind tunnel results. Standard corrections for compressibility effects must be applied (subtracted) after the position error corrections are made in order to obtain equivalent airspeeds.

Alternate Ship System

The alternate system senses pitot static pressure by means of a flush static port and total head tube located under the right-hand chine. When the alternate system is selected, these pressures operate the ship system altimeter and airspeed-Mach number indicator. The position error corrections for subsonic speeds are provided by Figure A1-4. The corrections for supersonic operation have not been established.

COMPRESSIBILITY CORRECTIONS

Standard corrections for compressibility effects on KIAS are provided by Figure A1-5. These corrections should be subtracted from KIAS after the airspeed position error corrections are made in order to obtain KEAS.

TRUE MACH NUMBER VS EQUIVALENT AIRSPEED

Figure A1-6 shows the relationship between true Mach number, pressure altitude, and equivalent airspeed; based on a γ of 1.4.

STANDARD ATMOSPHERE TABLE

The standard atmosphere table, figure A1-7, provides reference temperature pressure, air density, and sonic speed information which may be of assistance in overall flight planning.

STANDARD UNITS CONVERSION

The standard units conversion chart, figure A1-8, provides a means for direct conversion of temperature, distance, and speed between English and metric units.

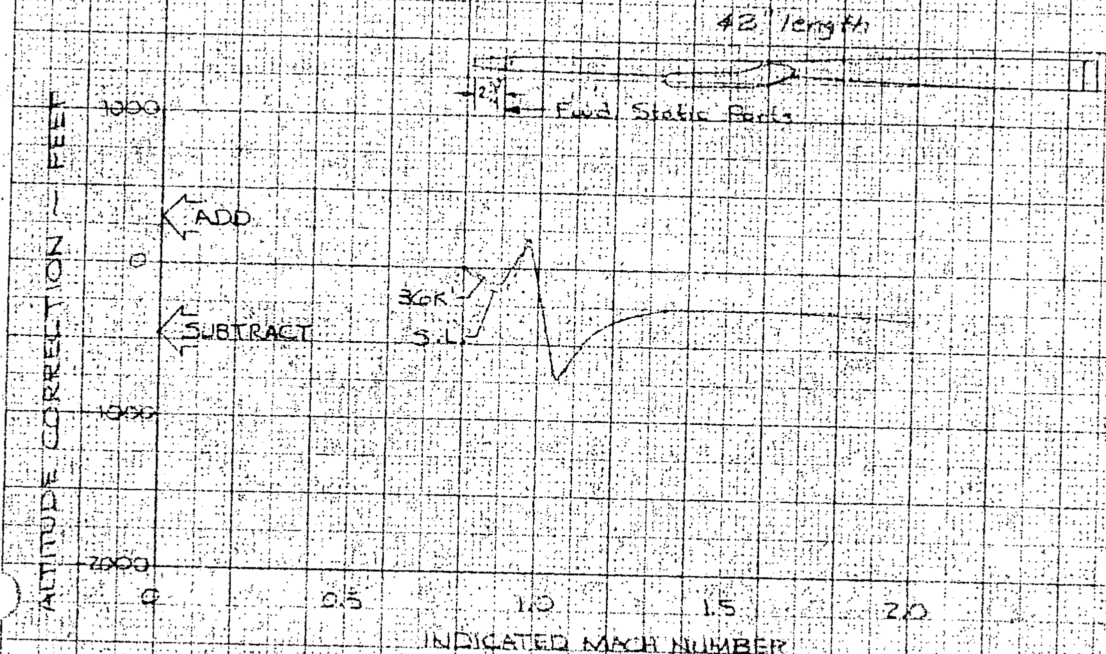
PREPARED BY
DATE
CHECKED BY

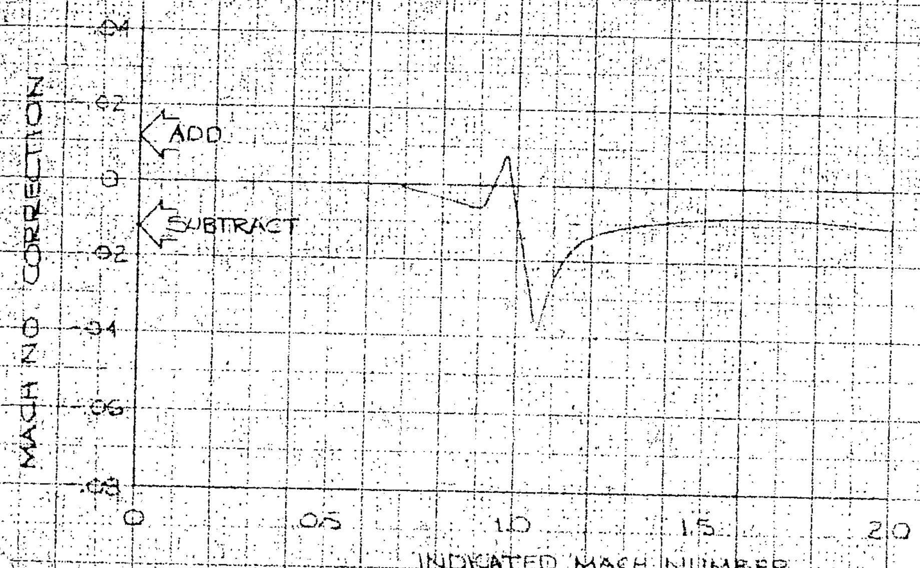
MODEL J11-12

POSITION ERROR CORRECTIONS

SHIP'S SYSTEM ALTITUDE AND MACH NO. INSTRUMENTS

ROSEMOUNT PITOT STATIC TYPE 855W
S. SYSTEM – FWD STATIC PORTS 26° OFF VERTICAL





FORM 5878A

FIGURE A1-1

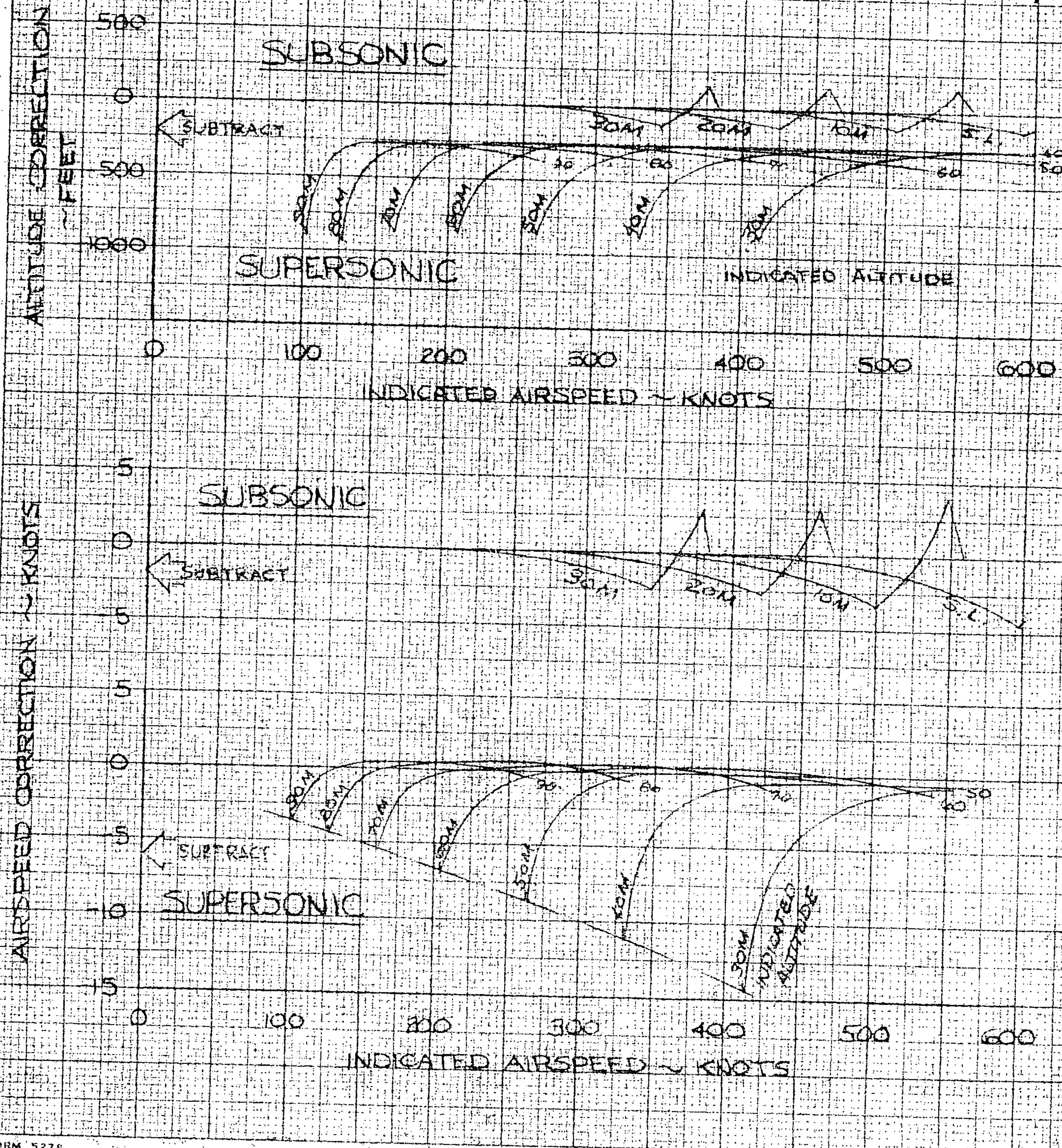
PREPARED BY
DATE
CHECKED BY

MODEL TA-12

POSITION ERROR CORRECTIONS

SHIP SYSTEM ALTITUDE AND AIRSPEED

APPLICABLE WITH ROSEMOUNT PITOT STATIC TYPE NO. 855



FORM 5278

FIGURE A1-2

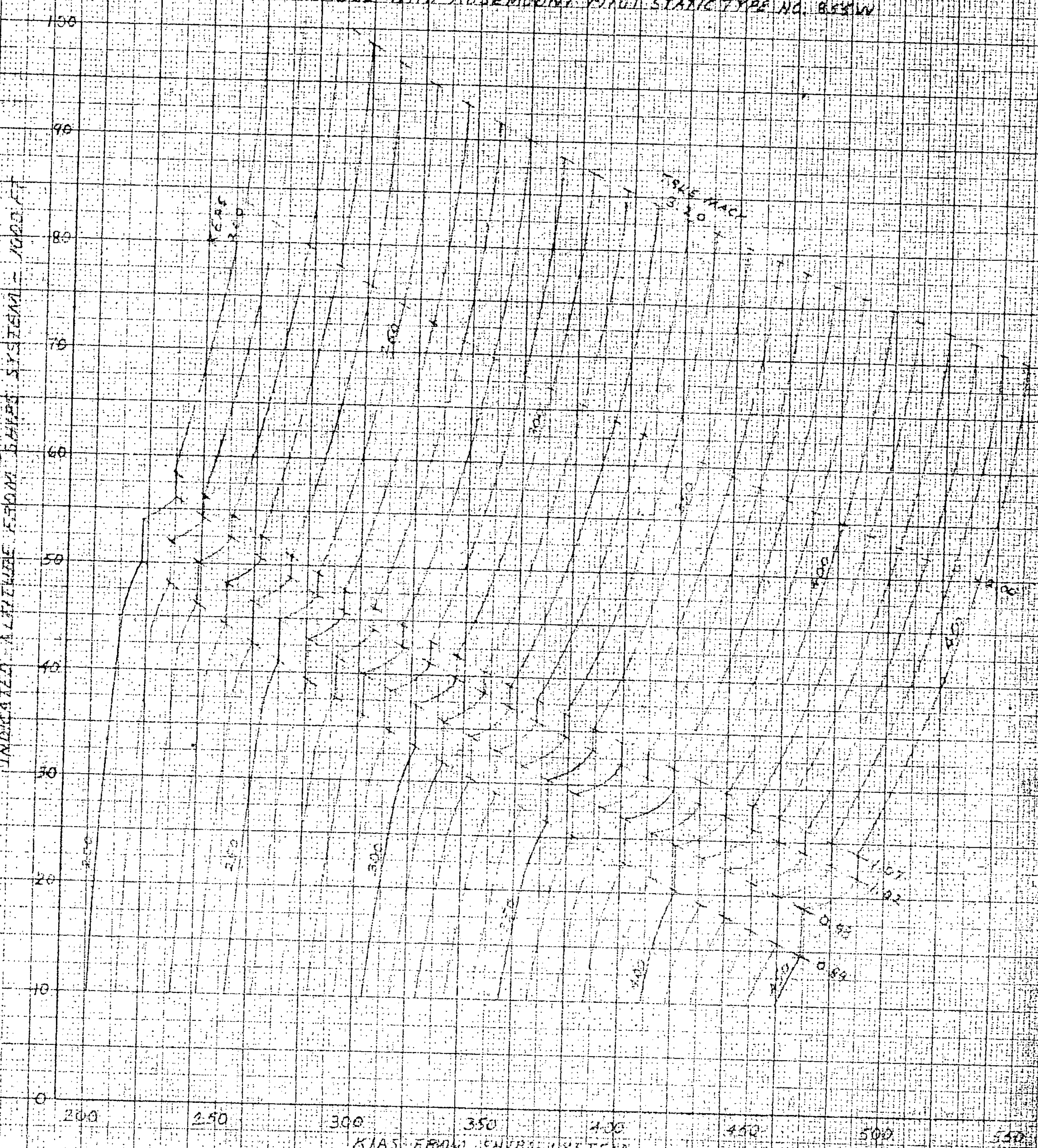
PREPARED BY__________
DATE__________
CHECKED BY__________

MODEL TA-12

APPROXIMATE DIFFERENCES IN IAS AND EAS INDICATIONS

NOTE: EAS, PRESSURE ALTITUDE, AND MACH NUMBER BY TRIPLE DISPLAY INDICATOR ARE COMPENSATED FOR STATIC ERROR AND COMPRESSIBILITY EFFECTS

APPLICABLE WITH ROSEMOUNT PITOT STATIC TYPE NO. 855W



FORM 5278A

PREPARED BY
DATE
CHECKED BY

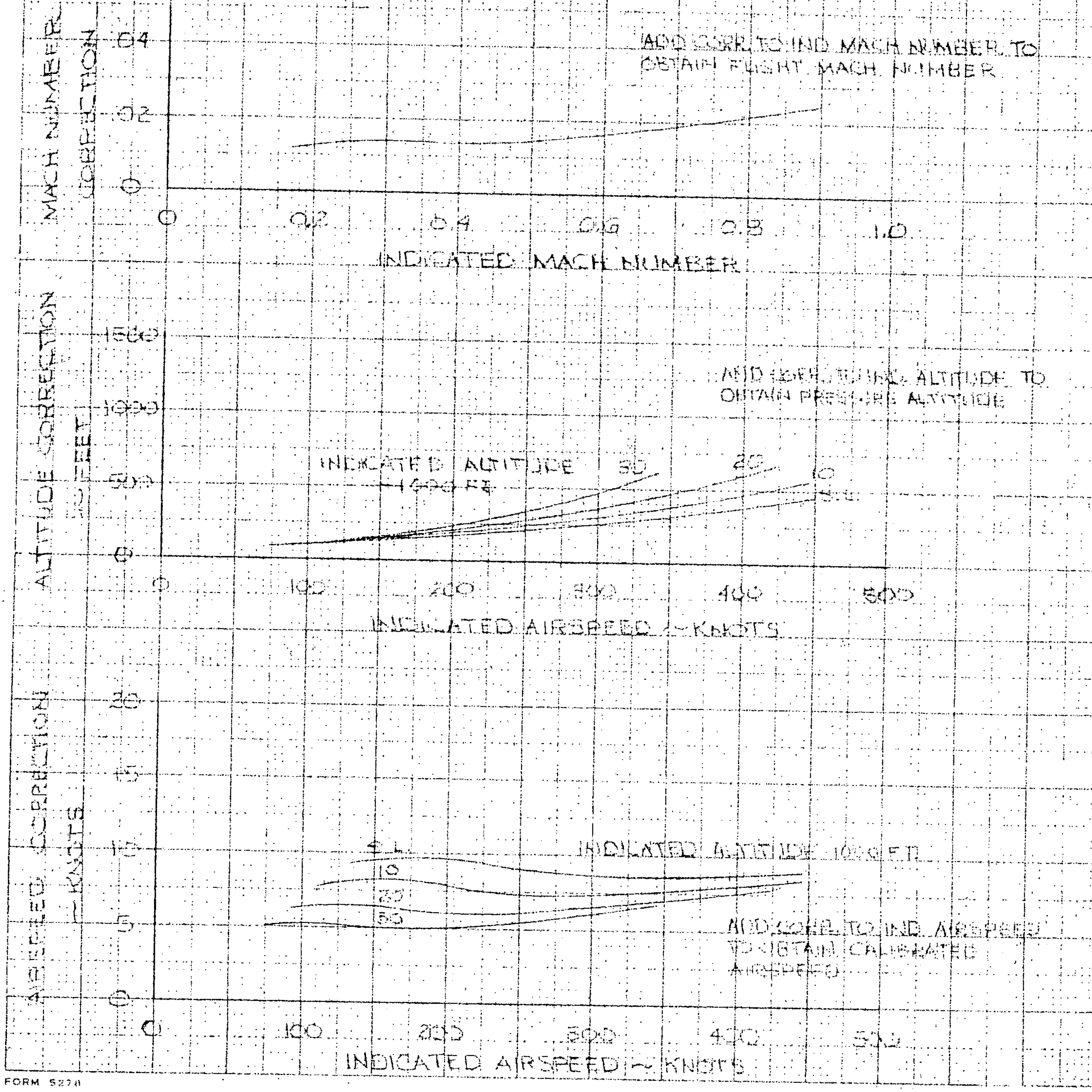
MODEL TA-12

POSITION ERROR CORRECTIONS

ALTERNATE (FLIGHT RECORDER) AIRSPEED SYSTEM

CHINE PITOT AND FLUSH STATIC

SUBSONIC ONLY



FORM 5220

FIGURE A1-4

PREPARED BY ____________
DATE ____________
CHECKED BY ____________

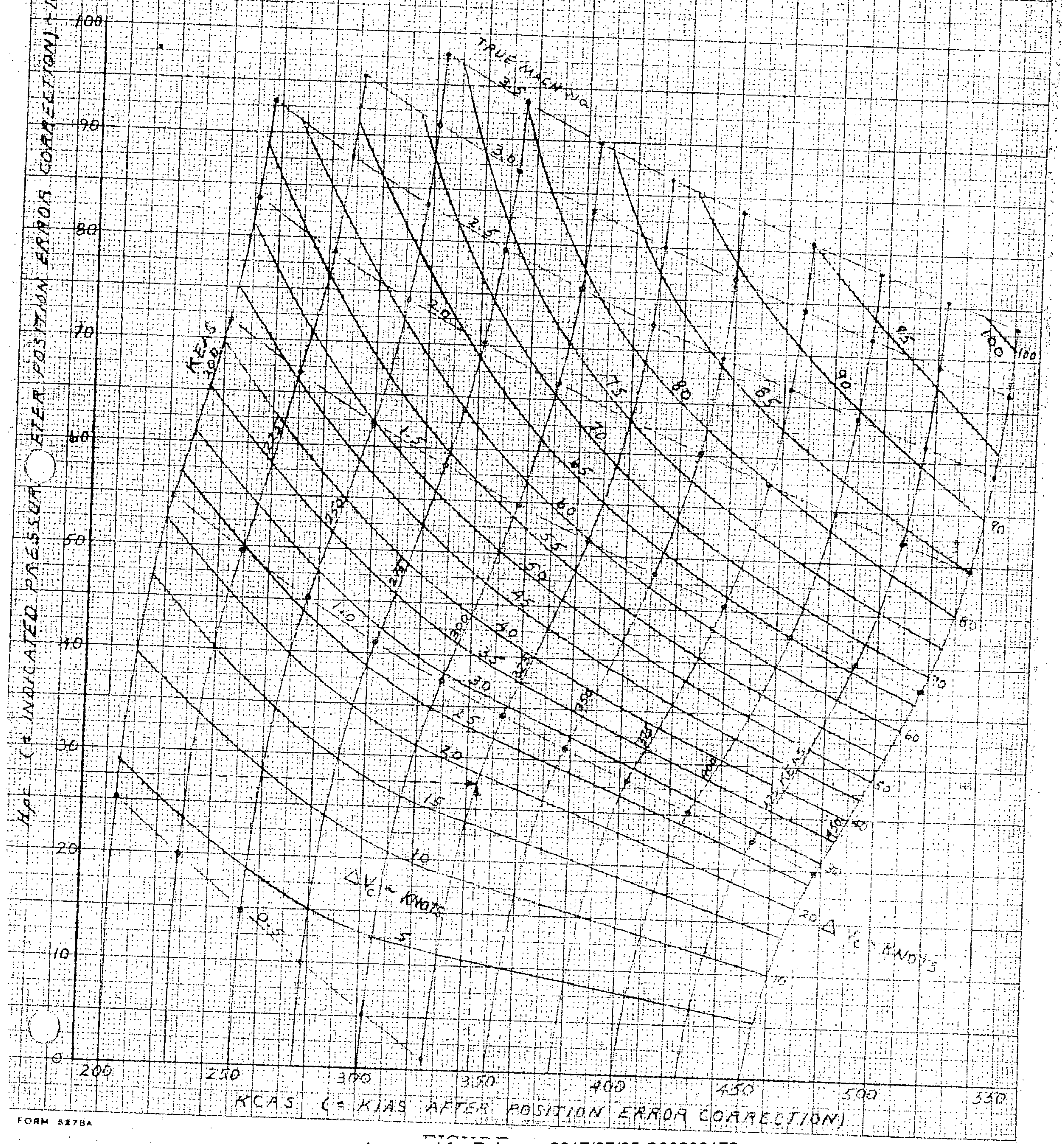
APPENDIX I
PART I

MODEL TA-12

AIRSPEED COMPRESSIBILITY CORRECTION CHART

APPLICABLE TO SHIP NORMAL OR ALTERNATE AIRSPEED SYSTEMS AFTER POSITION ERROR CORRECTION

SUBTRACT ΔV_c FROM KCAS TO OBTAIN KEAS



FORM 527BA

FIGURE

TRUE MACH NUMBER VS EQUIVALENT AIRSPEED

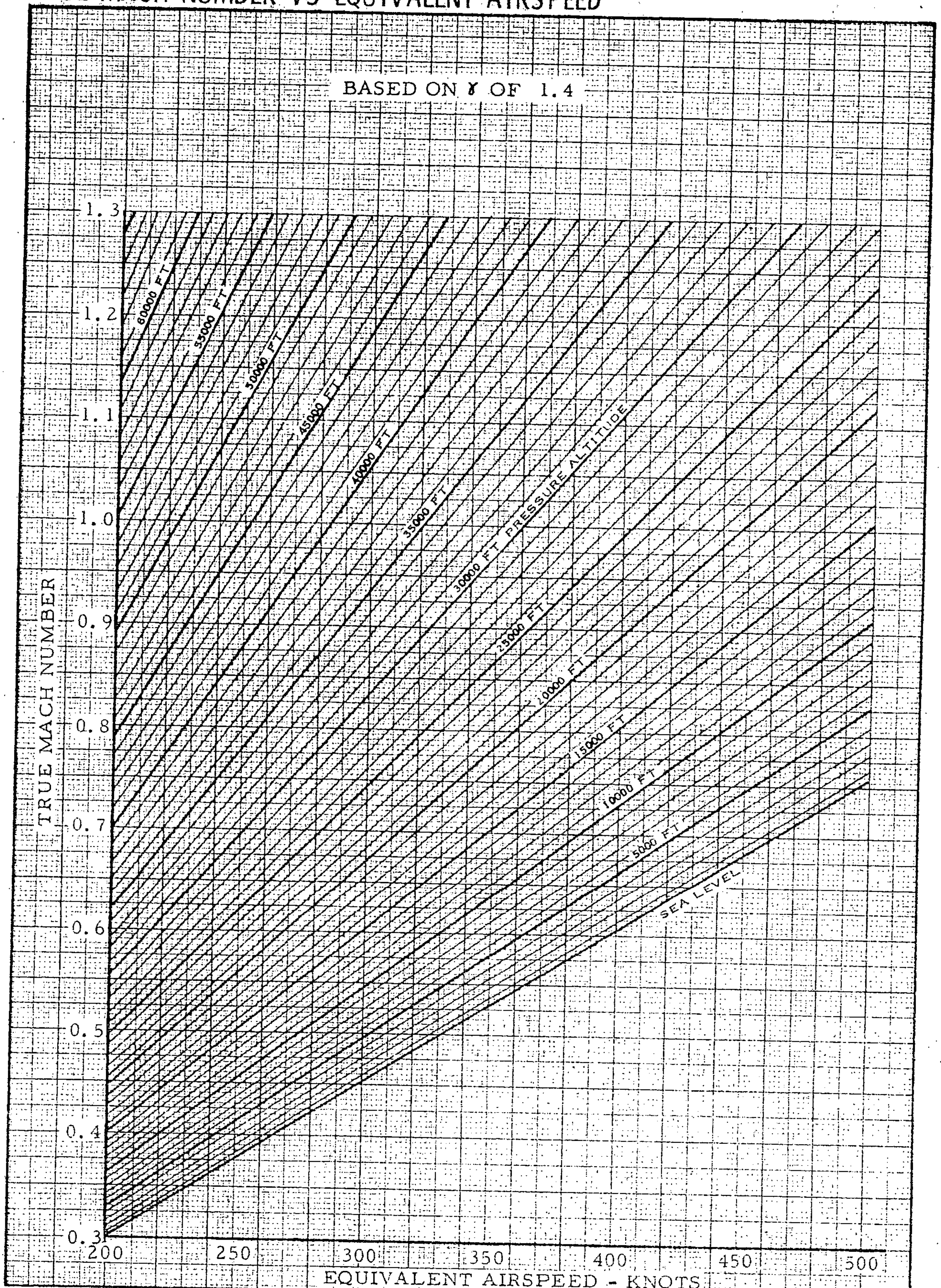


Figure A1-6
(Sheet 1 of 2)

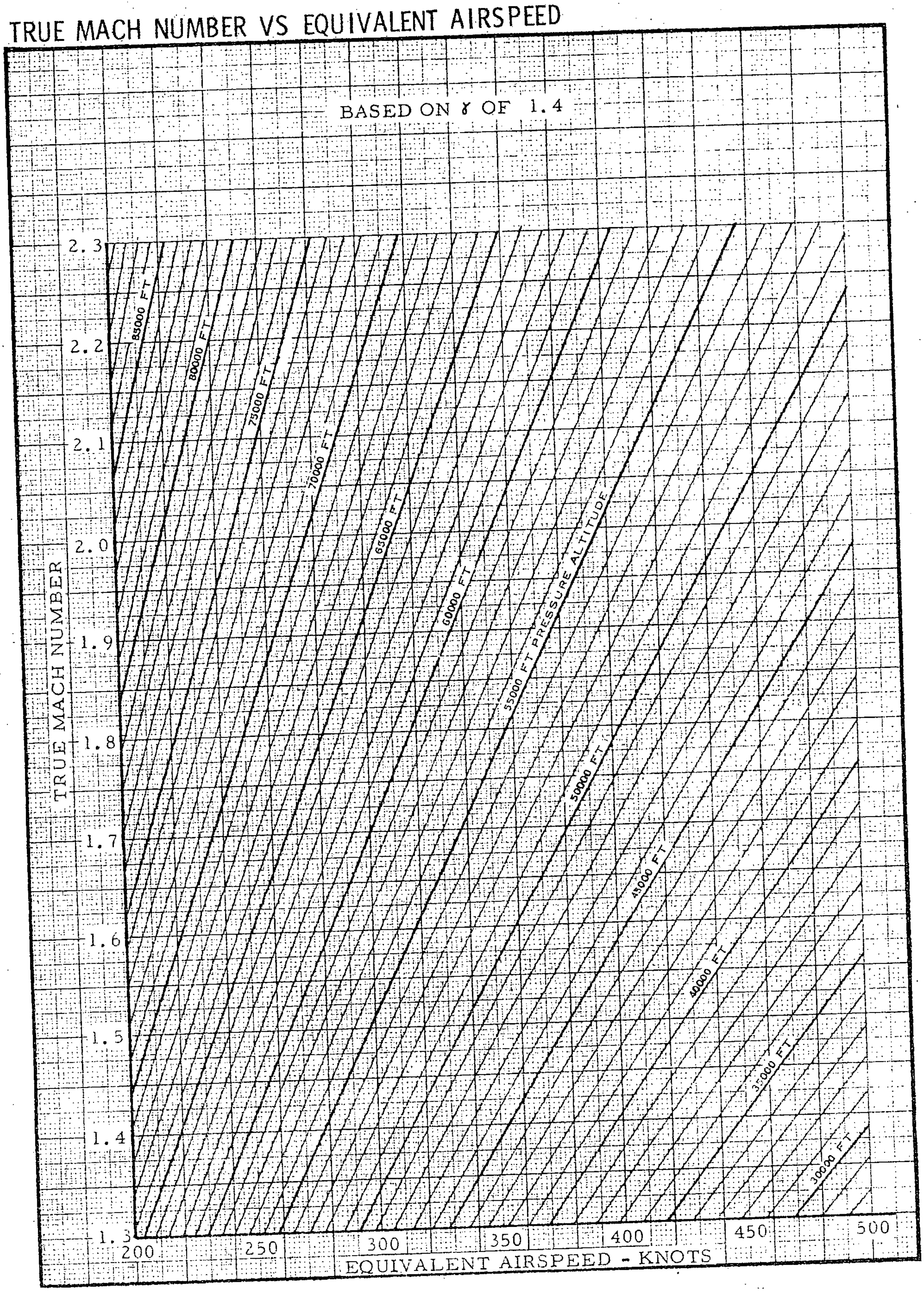


Figure A1- 6
(Sheet 2 of 2)

STANDARD ATMOSPHERE TABLE

ARDC MODEL ATMOSPHERE – 1956

Alt ft	Temp. t °F	Temp. t °C	Press. P in. Hg	Press. P lb/ft²	$\frac{\rho}{\rho_0} = \sigma$	$\sqrt{\frac{\rho}{\rho_0}}$	$\frac{P}{P_0} = \delta$	$\frac{T}{T_0} = \theta$	$\sqrt{\frac{T}{T_0}}$	$\frac{P}{P_0}\sqrt{\frac{T}{T_0}}$	c ft/sec	Alt ft
0	59.0	15.0	29.92	2116	1.000	1.000	1.000	1.000	1.000	1.000	1117	0
1000	55.4	13 0	28 85	2041	.9711	.9854	.9644	.9931	.9965	.9610	1113	1000
2000	51 9	11 0	27.82	1968	.9428	.9710	.9298	.9862	.9931	9234	1109	2000
3000	48.3	9 1	26.82	1897	.9151	.9566	.8962	.9794	.9896	.8869	1105	3000
4000	44.7	7.1	25.84	1828	.8881	.9424	.8637	.9725	.9862	.8518	1101	4000
5000	41 2	5.1	24.90	1761	.8617	.9283	.8320	.9656	.9826	.8175	1098	5000
6000	37.6	3 1	23.98	1696	.8359	.9143	.8014	.9587	.9791	.7847	1094	6000
7000	34.0	+1.1	23.09	1633	.8106	.9003	.7716	.9519	.9757	.7529	1090	7000
8000	30.5	−0 8	22.22	1572	.7860	.8866	.7428	.9450	.9721	.7221	1086	8000
9000	26.9	−2.8	21 39	1513	.7620	.8729	.7148	.9381	.9686	.6924	1082	9000
10000	23.3	−4.8	20 58	1455	.7385	.8594	.6877	.9312	.9650	.6636	1078	10000
11000	19.8	−6 8	19.79	1400	.7156	.8459	.6614	.9244	.9615	.6360	1074	11000
12000	16.2	−8.8	19.03	1346	.6932	.8326	.6360	.9175	.9579	.6092	1070	12000
13000	12.6	−10.8	18.29	1294	.6713	.8193	.6113	.9106	.9543	.5834	1066	13000
14000	9.1	−12.7	17.58	1243	.6500	.8062	.5875	.9037	.9506	.5585	1062	14000
15000	5.5	−14.7	16.89	1194	.6292	.7932	.5643	.8969	.9470	5344	1058	15000
16000	+1.9	−16 7	16.22	1147	.6090	.7804	.5420	.8900	.9434	5113	1054	16000
17000	−1 6	−18 7	15.57	1101	.5892	.7676	.5203	.8831	.9397	.4889	1050	17000
18000	−5.2	−20.7	14.94	1057	.5699	.7549	.4994	.8762	.9361	.4675	1045	18000
19000	−8.8	−22 6	14.34	1014	.5511	.7424	.4791	.8694	.9324	.4467	1041	19000
20000	−12.3	−24.6	13 75	972.5	.5328	.7299	.4595	.8625	.9287	.4267	1037	20000
21000	−15.9	−26 6	13.18	932.4	.5150	.7176	.4406	.8556	.9250	.4076	1033	21000
22000	−19.5	−28.6	12.64	893.7	.4976	.7054	.4223	.8487	.9212	.3890	1029	22000
23000	−23.0	−30.6	12.11	856.3	.4806	.6933	.4046	.8419	.9176	.3713	1025	23000
24000	−26.6	−32.5	11.60	820.2	.4642	.6813	.3876	.8350	.9138	.3542	1021	24000
25000	−30.2	−34.5	11.10	785.3	.4481	.6694	.3711	.8281	.9100	.3377	1016	25000
26000	−33.7	−36.5	10.63	751.6	.4325	.6576	.3552	.8212	.9062	.3219	1012	26000
27000	−37.3	−38 5	10.17	719.1	.4173	.6460	.3398	.8144	.9024	.3066	1008	27000
28000	−40.9	−40.5	9.725	687.8	.4025	.6344	.3250	.8075	.8986	.2920	1004	28000
29000	−44 4	−42.5	9 297	657.6	.3881	.6230	.3107	.8006	.8948	.2780	999.4	29000
30000	−48.0	−44.4	8.885	628.4	.3741	.6116	.2970	7937	8909	.2646	995.1	30000
31000	−51.6	−46.4	8.488	600.3	.3605	.6004	.2837	.7869	.8871	.2517	990.7	31000
32000	−55.1	−48.4	8.106	573.3	.3473	.5893	.2709	.7800	8832	.2393	986.4	32000
33000	−58 7	−50.4	7.737	547.2	.3345	.5784	.2586	.7731	.8793	.2274	982 0	33000
34000	−62.2	−52 4	7.382	522.1	.3220	.5675	.2467	.7662	.8753	.2159	977.7	34000
35000	−65.8	−54.3	7.041	498.0	.3099	.5568	.2353	.7594	.8714	.2050	973.3	35000
36089	−69.7	−56.5	6.683	472.7	.2971	.5450	.2234	.7519	.8671	.1937	968.5	36089
37000	−69.7	−56.5	6.397	452.4	.2844	.5333	.2138	.7519	.8671	.1854	968.5	37000
38000	−69.7	−56 5	6.097	431.2	.2710	.5206	.2038	.7519	.8671	.1767	968.5	38000
39000	−69.7	−56 5	5.811	411.0	.2583	.5082	.1942	.7519	.8671	.1684	968.5	39000
40000	−69.7	−56.5	5.538	391.7	.2462	.4962	.1851	.7519	.8671	.1605	968.5	40000
41000	−69.7	−56.5	5.278	373 3	.2346	.4844	.1764	.7519	.8671	.1530	968 5	41000
42000	−69.7	−56.5	5.030	355.8	.2236	.4729	.1681	.7519	.8671	.1458	968.5	42000
43000	−69.7	−56.5	4.794	339.1	.2131	.4616	.1602	.7519	.8671	.1389	968.5	43000
44000	−69.7	−56 5	4.569	323.2	.2031	.4507	.1527	.7519	.8671	.1324	968.5	44000
45000	−69.7	−56.5	4.355	308.0	.1936	.4400	.1455	.7519	.8671	.1262	968.5	45000
46000	−69.7	−56.5	4.151	293.6	.1845	.4295	.1387	.7519	.8671	.1203	968.5	46000
47000	−69.7	−56.5	3.956	279.8	.1758	.4193	.1322	.7519	.8671	.1146	968.5	47000
48000	−69.7	−56.5	3.770	266.7	.1676	.4094	.1260	.7519	.8671	.1093	968.5	48000
49000	−69.7	−56.5	3.593	254.1	.1597	.3996	.1201	.7519	.8671	.1041	968.5	49000
50000	−69.7	−56.5	3.425	242 2	.1522	.3901	.1145	.7519	.8671	.09928	968.5	50000
51000	−69.7	−56.5	3.264	230.8	.1451	.3809	.1091	.7519	.8671	.09460	968.5	51000
52000	−69.7	−56.5	3.111	220.0	.1383	.3719	.1040	.7519	.8671	.09018	968.5	52000
53000	−69.7	−56.5	2 965	209.7	.1318	.3630	.09909	.7519	.8671	.08592	968.5	53000
54000	−69.7	−56.5	2 826	199.8	.1256	.3544	.09444	.7519	.8671	.08189	968.5	54000
55000	−69.7	−56.5	2.693	190.5	.1197	.3460	.09001	.7519	.8671	.07805	968.5	55000
56000	−69.7	−56.5	2.567	181.5	.1141	.3378	.08578	.7519	.8671	.07438	968.5	56000
57000	−69.7	−56.5	2.446	173.0	.1087	.3297	.08176	.7519	.8671	.07089	968.5	57000
58000	−69.7	−56.5	2.331	164.9	.1036	.3219	.07792	.7519	.8671	.06756	968.5	58000
59000	−69.7	−56.5	2.222	157.2	.09877	.3143	.07426	.7519	.8671	.06439	968.5	59000
60000	−69.7	−56 5	2.118	149.8	.09414	.3068	.07078	.7519	.8671	.06137	968.5	60000
61000	−69.7	−56.5	2.018	142.8	.08972	.2995	.06746	.7519	.8671	.05849	968.5	61000
62000	−69.7	−56.5	1.924	136.1	.08551	.2924	.06429	.7519	.8671	.05575	968 5	62000
63000	−69.7	−56.5	1.833	129.7	.08150	.2855	.06127	.7519	.8671	.05313	968.5	63000
64000	−69 7	−56.5	1.747	123.6	.07767	.2787	.05840	.7519	.8671	.05064	968.5	64000
65000	−69.7	−56.5	1.665	117.8	.07403	.2721	.05566	.7519	.8671	.04826	968.5	65000
66000	−69.7	−56.5	1.587	112.3	.07055	.2656	.05306	.7519	.8671	.04600	968.5	66000
67000	−69.7	−56.5	1.513	107.0	.06724	.2593	.05056	.7519	.8671	.04384	968.5	67000
68000	−69.7	−56.5	1.442	102.0	.06409	.2532	.04819	.7519	.8671	.04179	968.5	68000
69000	−69.7	−56.5	1.374	97.19	.06108	.2471	.04592	.7519	.8671	.03982	968.5	69000
70000	−69.7	−56.5	1.310	92 63	.05821	.2413	.04377	.7519	.8671	.03795	968.5	70000

Figure AI-7
(Sheet 1 of 2)

STANDARD ATMOSPHERE TABLE

ARDC MODEL ATMOSPHERE – 1956

Alt ft	Temp. t °F	Temp. t °C	Press. P in. Hg	Press. P lb/ft²	$\frac{\rho}{\rho_o} = \sigma$	$\sqrt{\frac{\rho}{\rho_o}}$	$\frac{P}{P_o} = \delta$	$\frac{T}{T_o} = \theta$	$\sqrt{\frac{T}{T_o}}$	$\frac{P}{P_o}\sqrt{\frac{T}{T_o}}$	c ft/sec	Alt ft
71000	-69.7	-56.5	1.248	88.28	.05548	.2355	.04172	.7519	.8671	.03618	968.5	71000
72000	-69.7	-56.5	1.190	84.14	.05288	.2300	.03976	.7519	.8671	.03448	968.5	72000
73000	-69.7	-56.5	1.134	80.19	.05040	.2245	.03789	.7519	.8671	.03285	968.5	73000
74000	-69.7	-56.5	1.081	76.43	.04803	.2192	.03611	.7519	.8671	.03131	968.5	74000
75000	-69.7	-56.5	1.030	72.84	.04578	.2140	.03442	.7519	.8671	.02985	968.5	75000
76000	-69.7	-56.5	.9815	69.42	.04363	.2089	.03280	.7519	.8671	.02844	968.5	76000
77000	-69.7	-56.5	.9355	66.16	.04158	.2039	.03127	.7519	.8671	.02711	968.5	77000
78000	-69.7	-56.5	.8916	63.06	.03963	.1991	.02980	.7519	.8671	.02584	968.5	78000
79000	-69.7	-56.5	.8497	60.10	.03777	.1943	.02840	.7519	.8671	.02463	968.5	79000
80000	-69.7	-56.5	.8099	57.28	.03600	.1897	.02707	.7519	.8671	.02347	968.5	80000
81000	-69.7	-56.5	.7718	54.59	.03431	.1852	.02580	.7519	.8671	.02237	968.5	81000
82021	-69.7	-56.5	.7349	51.98	.03267	.1807	.02456	.7519	.8671	.02130	968.5	82021
83000	-68.1	-55.6	.7012	49.59	.03104	.1762	.02343	.7550	.8689	.02036	970.5	83000
84000	-66.4	-54.7	.6685	47.28	.02947	.1717	.02234	.7582	.8607	.01923	972.5	84000
85000	-64.8	-53.8	.6374	45.08	.02798	.1673	.02130	.7613	.8725	.01858	974.5	85000
86000	-63.2	-52.9	.6079	43.00	.02658	.1630	.02032	.7645	.8744	.01777	976.6	86000
87000	-61.5	-51.9	5799	41.02	.02525	.1589	.01938	.7677	.8762	.01698	978.6	87000
88000	-59.9	-51.1	.5533	39.13	.02399	.1549	.01849	.7708	.8780	.01623	980.6	88000
89000	-58.2	-50.1	5280	37.45	.02280	.1510	.01765	.7740	.8798	.01553	982.6	89000
90000	-56.6	-49.2	.5040	35.65	.02167	.1472	.01684	.7772	.8816	.01485	984.6	90000
91000	-54.9	-48.3	.4811	34.03	.02061	.1436	.01608	.7804	.8834	.01421	986.6	91000
92000	-53.3	-47.4	.4594	32.49	.01960	.1400	.01535	.7835	.8852	.01359	988.6	92000
93000	-51.6	-46.4	.4387	31.03	.01864	.1365	.01466	.7867	.8870	.01300	990.6	93000
94000	-50.0	-45.6	.4191	29.64	.01773	.1332	.01401	.7899	.8888	.01245	992.6	94000
95000	-48.3	-44.6	.4004	28.32	.01687	.1299	.01338	.7931	.8906	.01192	994.6	95000
96000	-46.7	-43.7	.3826	27.06	.01606	.1267	.01279	.7962	.8923	.01141	996.6	96000
97000	-45.1	-42.8	.3656	25.86	.01529	.1236	.01222	.7994	.8941	.01093	998.6	97000
98000	-43.4	-41.9	.3495	24.72	.01455	.1206	.01168	.8026	.8959	.01046	1001	98000
99000	-41.8	-41.0	.3341	23.63	.01386	.1177	.01117	.8058	.8977	.01003	1003	99000
100000	-40.1	-40.1	.3195	22.60	.01320	.1149	.01068	.8089	.8994	.009606	1005	100000
110000	-23.7	-30.9	.2062	14.58	.008196	.09053	.006890	8407	.9170	.006318	1024	110000
120000	-7.19	-21.8	.1352	9.561	.005179	.07197	.004518	.8724	9340	.004220	1043	120000
130000	-9.27	-12.6	.09000	6 365	.003327	.05768	.003008	.9041	.9508	.002860	1062	130000
140000	25.7	-3.50	.06076	4.297	.002170	.04658	.002031	.9359	.9674	.001965	1081	140000
150000	42.2	-5.67	.04156	2.940	.001436	.03789	.001389	.9676	.9837	.001366	1099	150000
200000	-6.78	21.5	.00621	0.440	.000238	.01542	.000208	.8732	.9345	.000194	1044	200000

ATMOSPHERIC STANDARDS

	English	Metric
Gravity	32.17405 ft/sec²	9.80665 m/sec²
Absolute zero	-459.688°F	-273.16°C
Standard Values at Sea Level		
Pressure	29.92 in. Hg	760 mm Hg
Pressure	2116 lb/ft²	10332 kg/m²
Temp	59°F	15°C
Abs temp	518.688°R	288.16°K
Specific wt $g\rho_o$	0.076475 lb/ft³	1.2250 kg/m³
Density	0.0023769 lb sec²/ft⁴	0.12492 kg sec²/m⁴
Standard Values at Altitude		
Isothermal alt H_i	36,089.2 ft	11,000 m
Isothermal temp	-69.7°F	-56.5°C

GENERAL PROPERTIES OF GASES

$Pv = RT$ or $P = \rho g RT$ or $PV = mRT$

Constant Volume $P_1/P_2 = T_1/T_2$

Constant Pressure $V_1/V_2 = T_1/T_2$

Constant Temperature $P_1/P_2 = V_2/V_1$

Reversible Adiabatic $\frac{P_1}{P_2} = \left(\frac{V_2}{V_1}\right)^{\gamma}$

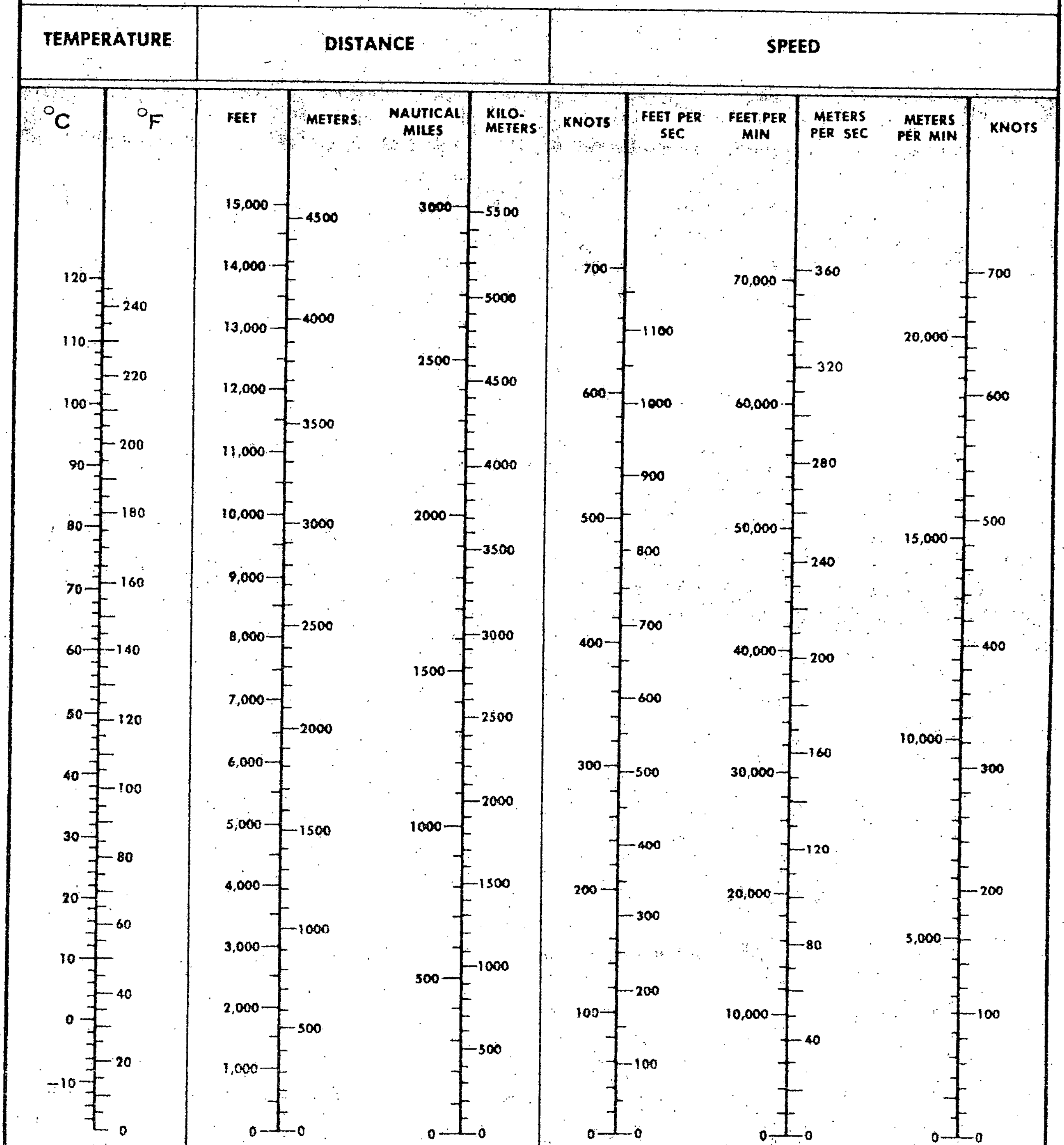
$$\frac{T_1}{T_2} = \left(\frac{V_2}{V_1}\right)^{\gamma-1} = \left(\frac{P_1}{P_2}\right)^{\frac{\gamma-1}{\gamma}}$$

Polytropic $P_1V_1^n = P_2V_2^n$

$$\frac{T_1}{T_2} = \left(\frac{V_1}{V_2}\right)^{1-n} = \left(\frac{P_1}{P_2}\right)^{\frac{n-1}{n}}$$

Figure A1-7
(Sheet 2 of 2)

STANDARD UNITS CONVERSION CHART



NOTE:

TO OBTAIN U S GALLONS MULTIPLY LITERS BY 0.264

TO OBTAIN IMPERIAL GALLONS MULTIPLY LITERS BY 0.220

TO OBTAIN INCHES OF MERCURY MULTIPLY MILLIBARS BY .0295

TO OBTAIN POUNDS MULTIPLY KILOGRAMS BY 2.20

Figure A1-8

PART II

FIELD LENGTH REQUIREMENTS

PLANNING CHARTS

The charts in this part show takeoff and landing field length requirements and single engine climbout capabilities for a fixed base type of operation. They have been prepared for a field elevation of 4500 feet. Availability of the lakebed has not been considered for normal operations except as providing an unobstructed clearway. Values provided by the charts can be applied to lower field elevations with some degree of conservatism if such a requirement should occur.

MAXIMUM GROSS WEIGHT

The first chart, Figure A2-1, shows the relationship between weight, temperature, and single engine climbout capability at takeoff speeds. The curves show how 38°C (100°F) is the critical temperature for operation with Takeoff Thrust at the 85,000 pound weight condition. Takeoff weight should be reduced at higher temperatures if climbout capability is to be maintained. The critical temperature is 26°C (79°F) without water injection at the Maximum Thrust rating. At these conditions, the aircraft is assumed to be at takeoff speed and attitude on one engine, just off the ground, with full rudder and zero bank angle. Gear retraction and a slight bank toward the operating engine reduce drag sufficiently for acceleration and climbout. A good single engine climb speed is approximately 300 KEAS. Acceleration to this speed at a shallow climb angle will place the aircraft in an advantageous condition for single engine climb at Maximum Thrust. Weight reduction by dumping fuel may be desirable.

TAKEOFF PERFORMANCE

Ground run data are supplied for operation with either Takeoff Thrust (water injection on) or Maximum Thrust (no water injection). Rotation and takeoff speeds and refusal speeds are provided for each of these power settings.

Takeoff Speed Schedules

Normal rotation and takeoff speed schedules are determined from the top parts of Figures A2-2 and A2-3. Takeoff speed for a given weight-temperature condition and thrust setting is the greater of the airspeeds for either minimum control (V_{mc}) with one engine inoperative, or for "maximum performance at a (C_L) of 0.46. The lift coefficient value of 0.46 is arbitrary and has been established to maintain adequate tail clearance during rotation and lift-off. The minimum control speed assures a capability to maintain directional control in the event of engine failure at takeoff speed. Rotation speeds have been established to allow three seconds for smooth transition to the takeoff attitude.

The method for finding takeoff speed is illustrated on the chart for a takeoff condition of 80,000 pounds with 86°F air temperature at the runway. At 80,000 pounds, the speed for a C_L of 0.46 is 179 KIAS. V_{mc} is greater by a margin of approximately 6 knots with water injection, and takeoff speed should be 185 KIAS for start of rotation at 167 KIAS. Without water injection, V_{mc} at the example condition is less than the speed for a C_L of 0.46 by a one knot margin and the takeoff speed is 179 KIAS.

The heavy weight landing speed schedule is the same as the maximum performance takeoff speed schedule. For example, the touchdown speed for landing immediately after takeoff at a weight of 75,000 pounds is 173 KIAS as shown by Figures A2-2 and A2-3.

Takeoff Ground Run Distance

Figures A2-2 and A2-3 also show normal takeoff distances consistent with Takeoff and Maximum Thrust (wet and dry) power settings. The performance is based on acceleration in a level attitude until a smooth rotation is started about three seconds before takeoff speed is reached, and assumes that rotation is completed just as takeoff speed is attained.

There is little difference between the Takeoff and Maximum Thrust distances at moderate air temperatures. This is a result of the faster V_{mc} takeoff speeds with water injection; however, accelerations is greater with water injection and this compensates for the higher speed schedule. Climbout capability is better with water injection, as shown by the location of the weight and temperature lines for zero single engine rate of climb at takeoff speeds.

Use of the charts is illustrated by the example for 80,000 pounds takeoff weight at an air temperature of 86°F. A 4900 foot run is required for a takeoff with water injection at an airspeed of 185 KIAS. With a 10 knot headwind component, the distance is reduced 10% to 4410 feet.

Acceleration Check Speed

Figure A2-4 provides a means for making a speed check at any required distance during the takeoff run. Use the takeoff speed and distance values found from Figures A2-2 or A2-3 to locate the position of a guide line on the acceleration check speed chart. Read acceleration check speed below the intersection of this guide line and the check distance value selected.

For example, for the 80,000 pound takeoff weight problem where the zero wind distance was 4900 feet at 185 KIAS, the guide line illustrated shows that an acceleration check speed of 119 KIAS would be reached at a 2000 foot check distance. For the case where the takeoff run was 4410 feet with a ten knot headwind, a guide line drawn from a point at 4410 feet and 185 KIAS intersects the 2000 foot check distance at 125 KIAS. The 2000 foot check distance point is recommended for normal operation since airspeeds reached at this distance allow reasonable accuracy in making the speed check.

Refusal Speeds

The refusal speed chart, Figure A2-5, provides the maximum airspeeds corresponding to various accelerate-stop distances. For takeoffs with water injection, enter the chart at the left side as illustrated and use the top set of curves. Refusal speed for 80,000 pounds gross weight, 86°F air temperature at the runway, and an accelerate-stop distance of 8300 feet is 167 KIAS with normal drag chute operation and maximum braking. This is also the rotation speed for the example conditions. The Refusal Distance can be determined for this speed from Figure A2-4. The guide line shows a run of 3925 feet at the 167 KIAS speed point for the zero wind example. If operating without water injection, enter the right half of the refusal speed chart and use the same distance grid at the top center of the page. For the 80,000 pound case, 86°F air temperature, 162 KIAS rotation speed, a minimum of 8350 feet accelerate-stop distance is required with normal drag chute operation.

Use the lower set of curves in a similar manner for refusal speeds without drag chute operation. For example, with Takeoff Thrust, 80,000 pounds, and 86°F temperature conditions, the refusal speed for 8300 feet accelerate stop distance is 120 KIAS, and 129 KIAS for a 10,000 foot distance. Very nearly the same speed applies (119 KIAS) if water injection is not used for acceleration. Since brake capacity is limited, a check of the curve in the lower left portion of the chart is necessary. It shows that 154 KIAS is the maximum speed for brake application after chute deployment with these conditions if there is no wind. The maximum braking speed without the chute is 112 KIAS at 80,000 pounds and 86°F for zero wind.

Certain assumptions were made in the refusal speed calculations. First, a three second recognition and action period was assumed to follow complete and instantaneous loss of one engine at refusal speed. During this period, the aircraft is assumed to accelerate at half normal rate, while the remaining engine is put in idle and the drag chute switch placed in the deploy position. Second, a 1.5 second free roll is assumed during chute deployment. Maximum wheel braking technique is assumed after deceleration to the maximum speed for braking. Any further delays in use of the chute or brakes will result in a longer stopping distance.

The overshoot speed reached at the end of the three second delay period is greater than the energy limit speed for braking if the drag chute is not effective or not used. For minimum stopping distance, this requires aerodynamic braking until the wheel brakes can be applied. Aerodynamic braking is a technique of free roll in the takeoff attitude, using rudders for directional control until the nose can be lowered and wheel brakes applied at the energy limit speed. Aerodynamic braking at the takeoff attitude results in initial decelerations of 1/4 to 1/3 of the values for hard braking.

Tire Limit Speeds

The tire limit speed line shown at the top part of Figures A2-2 and A2-3 indicate the overspeed margin available with zero wind conditions. It is a conversion from 239 KTAS to the indicated speed corresponding to 4500 feet elevation and the air temperatures listed. For example at 86°F the allowable speed is 215 KIAS with zero wind component. The speed should be reduced by the amount of tailwind component and increased by headwind component.

LANDING FIELD LENGTH REQUIREMENTS

Landing speed schedules and landing rollout distance information are provided for dry and wet runways, with and without drag chute, and for normal and maximum performance techniques.

NORMAL AND MAXIMUM PERFORMANCE LANDING SPEED SCHEDULES

Figure A2-6 shows the normal and maximum performance landing speed schedules as a function of gross weight down to 60,000 pounds. At gross weights less than 60,000 pounds the landing speed is a constant 145 KIAS for normal performance and 135 KIAS for maximum performance operation. The maximum performance landing speeds are 10 knots less than normal landing speeds for all weight conditions.

Example:

1. For a normal landing at 55,000 pounds gross weight, determine final approach and landing speeds.

   Enter the chart at 55,000 pounds, proceed up to intercept the normal approach speed line at 165 KIAS and the normal landing speed schedule at 145 KIAS.

2. Determine final approach and landing speeds for touchdown at 85,000 pounds. Enter the chart at 85,000 pounds gross weight, proceed up to intercept the final approach speed schedule at 190 KIAS and the maximum performance landing schedule line at 160 KIAS.

LANDING GROUND ROLL DISTANCE

Normal Performance Landing Ground Roll Distance With Drag Chute

The normal performance landing ground roll distance with drag chute for dry and wet runways is shown in figure A2-7 and A2-8, respectively. Performance is given as a function of ambient temperature, pressure altitude and gross weight. Wind and slope effects are included. Standard landing technique assumes chute deploy switch actuation approximately 1 second after touchdown, chute fully deployed approximately 6 seconds after touchdown, and the nose down at 120 KIAS. Full braking pressure requires about 1 second after initial pedal depression. The chute is assumed to be jettisoned at 60 knots for the dry runway case and is retained to full stop for wet runway conditions.

Example:

For conditions of 86°F air temperature, 4500 feet pressure altitude and 55,000 pounds gross weight, find the normal performance landing ground roll distance with drag chute.

1. Enter figure A2-7 for the dry runway at the temperature and altitude condition, proceed horizontally to the gross weight and read downward to determine zero wind, zero slope ground roll distance of 3600 feet. For a headwind of 10 knots and a downhill slope of 1% the ground roll distance would be 3200 feet, as shown in the chart.

2. Applying the same procedure in the wet runway chart, figure A2-8, shows a zero wind, zero slope distance of 5200 feet. For the wind and slope case the distance would be 4600 feet.

Normal Performance Landing Ground Roll Distance Without Drag Chute

Normal performance landing ground roll distance for landing without chute is shown in figures A2-9 and A2-10 for dry and wet runways. Normal performance without chute assumes the same sequence of events as for landing with chute. The nose of the airplane is lowered at or before reaching 120 KIAS and brakes applied. In the no chute wet runway case it is assumed that one engine is shut down and anti-skid is turned off at start of braking.

Example:

Using the same conditions as in the landing with chute example, find the normal performance landing distance without drag chute.

1. For the dry runway case, enter figure A2-9 at the ambient temperature and pressure altitude conditions, proceed horizontally to the gross weight, then read downward to determine zero wind, zero slope ground roll distance of 6950 feet. With wind and slope, the distance is 6300 feet as shown in the chart.

2. For a wet runway condition, the zero wind and slope distance is 12,150 feet, as shown in figure A2-10. The wind and slope distance is 11,400 feet.

Maximum Performance Landing Ground Roll Distance With Drag Chute

When using the minimum roll landing technique, distances with drag chute may be obtained in figure A2-11 and A2-12 for dry and wet runways, respectively. Performance is given as a function of temperature, pressure altitude, and gross weight. Wind and slope effects are included. Minimum roll technique assumes touchdown at 10 knots slower speed than normal. Brakes are applied as soon as the nose gear is on the ground. The chute is assumed jettisoned at 60 knots for the dry runway and is retained to full stop for the wet runway.

Example:

Using the same conditions as in the normal landing examples for 85,000 lb find the maximum performance landing distane with chute.

1. For the dry runway case, enter figure A2-11 at the ambient temperature and pressure altitude, proceed horizontally to the gross weight. Read downward to determine a zero wind, zero slope ground roll distance of 4250 feet. With wind and slope the distance is 3900 feet.

2. In the case of a wet runway, the zero wind, zero slope distance is 6350 feet as shown in figure A2-12. The wind and slope effect gives a distance of 5700 feet.

Maximum Performance Landing Ground Roll Distance Without Drag Chute

Maximum performance landing distances without drag chute are presented in figures A2-13 and A2-14 for dry and wet runways, respectively. The same sequence of events is assumed as for landings with the drag chute. A three second recognition time of chute failure is incorporated before shutdown of the right engine and turning anti-skid off for the wet runway landing.

Example:

Using the same conditions as used previously, find the maximum performance landing distance without chute.

1. For the dry runway case enter figure A2-13 at the ambient temperature and pressure altitude, proceed horizontally to the gross weight. Read downward to determine a zero wind, zero slope distance of 7550 feet. Continuing through the wind and slope corrections gives a distance of 6900 feet.

2. In the wet runway case, the zero wind and zero slope distance is 15,600 feet as shown in figure A2-14. With wind and slope, the distance is 15,000 feet, as shown in the chart.

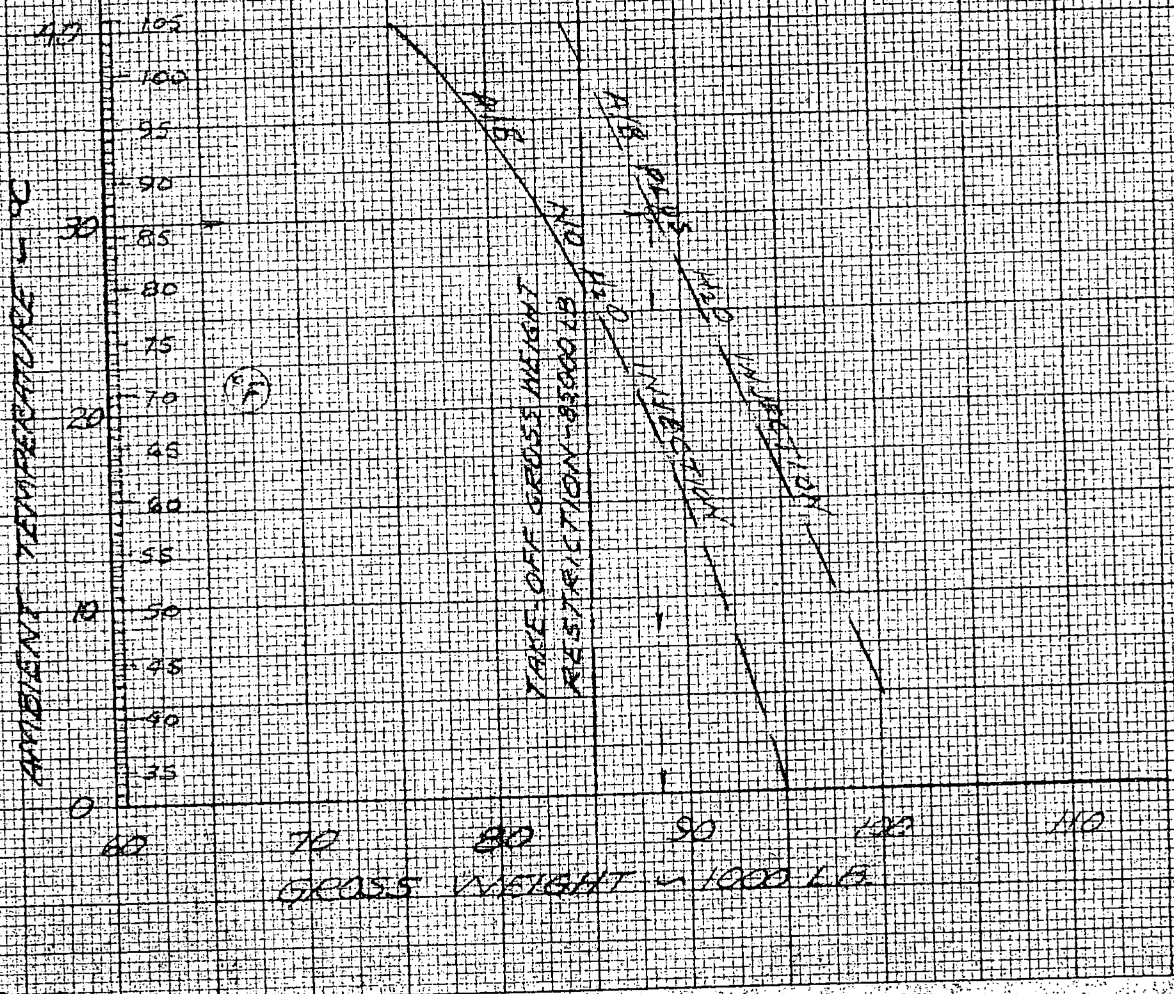
DATE
CHECKED BY

MODEL TH-12

MAXIMUM GROSS WEIGHT
FOR
SINGLE ENGINE LEVEL FLIGHT @ T.O. SPEED
NO CLIMB OR ACCELERATION CAPABILITY

4500 FT ELEVATION

FULL RUDDER DEFLECTION
GEAR DOWN AT THE GROUND



REV 3-7-64
FORM 5278

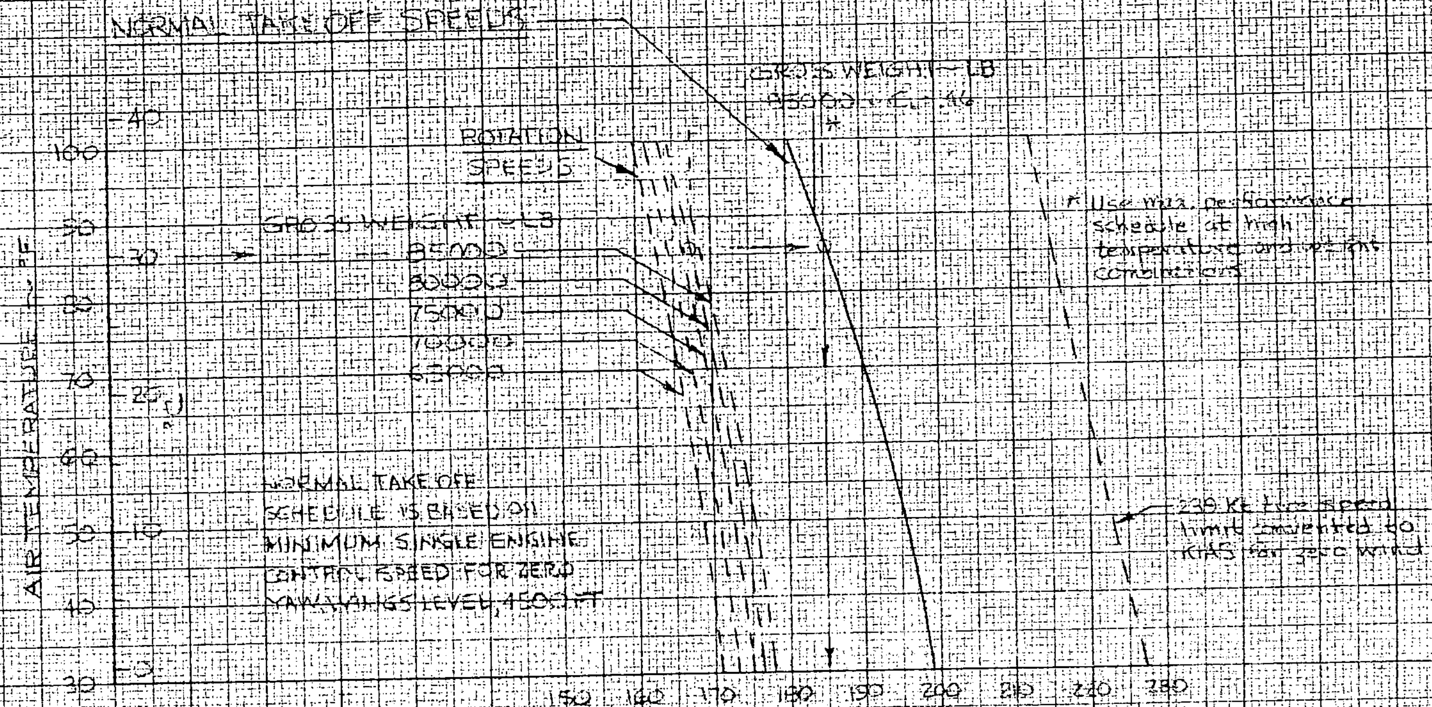
PREPARED BY________
DATE________
CHECKED BY________

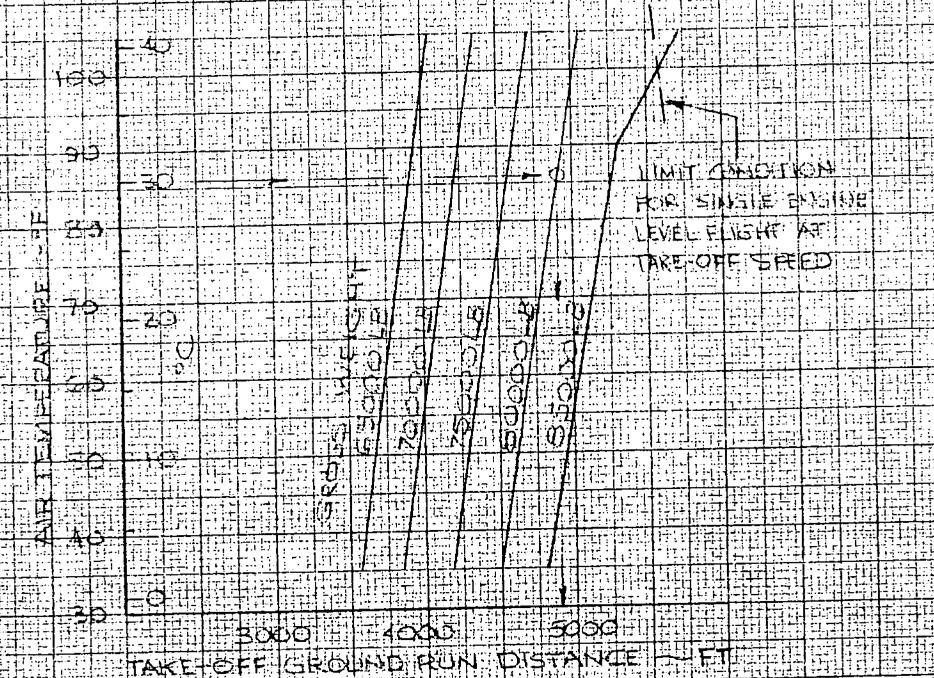
MODEL TR-12

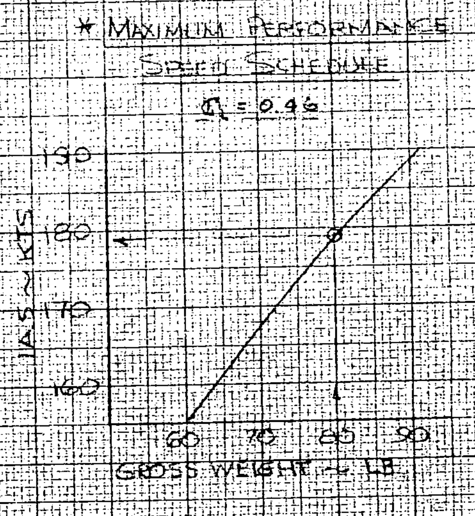
TAKE-OFF GROUND RUN DISTANCE AND SPEED SCHEDULES

0 WIND — "WET" — 4500 FT ELEV

NOTES:
1. TAKE-OFF THRUST
2. WATER INJECTION ON
3. APPLICABLE WITH NOSE MOUNT PITOT STATIC TYPE NO 365







FORM 5278A

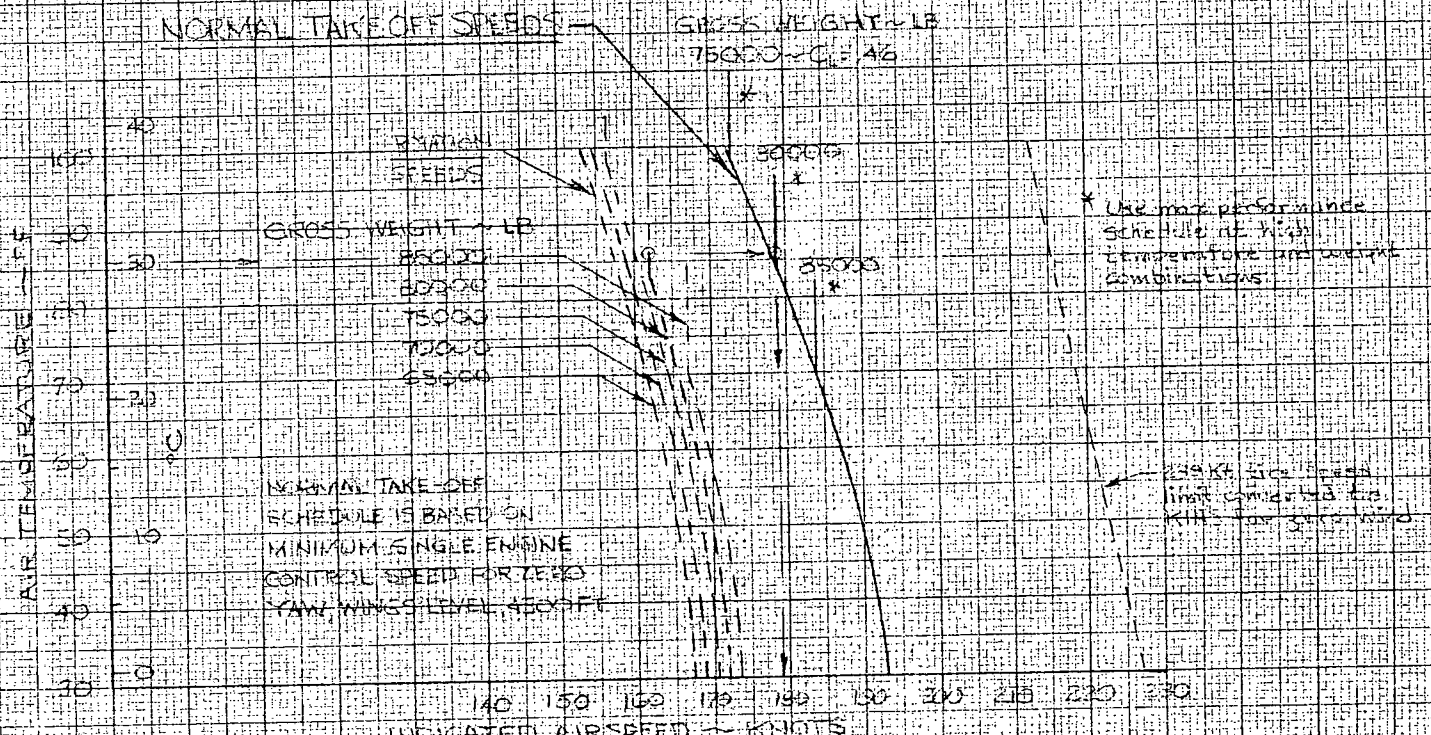
PREPARED BY
DATE
CHECKED BY

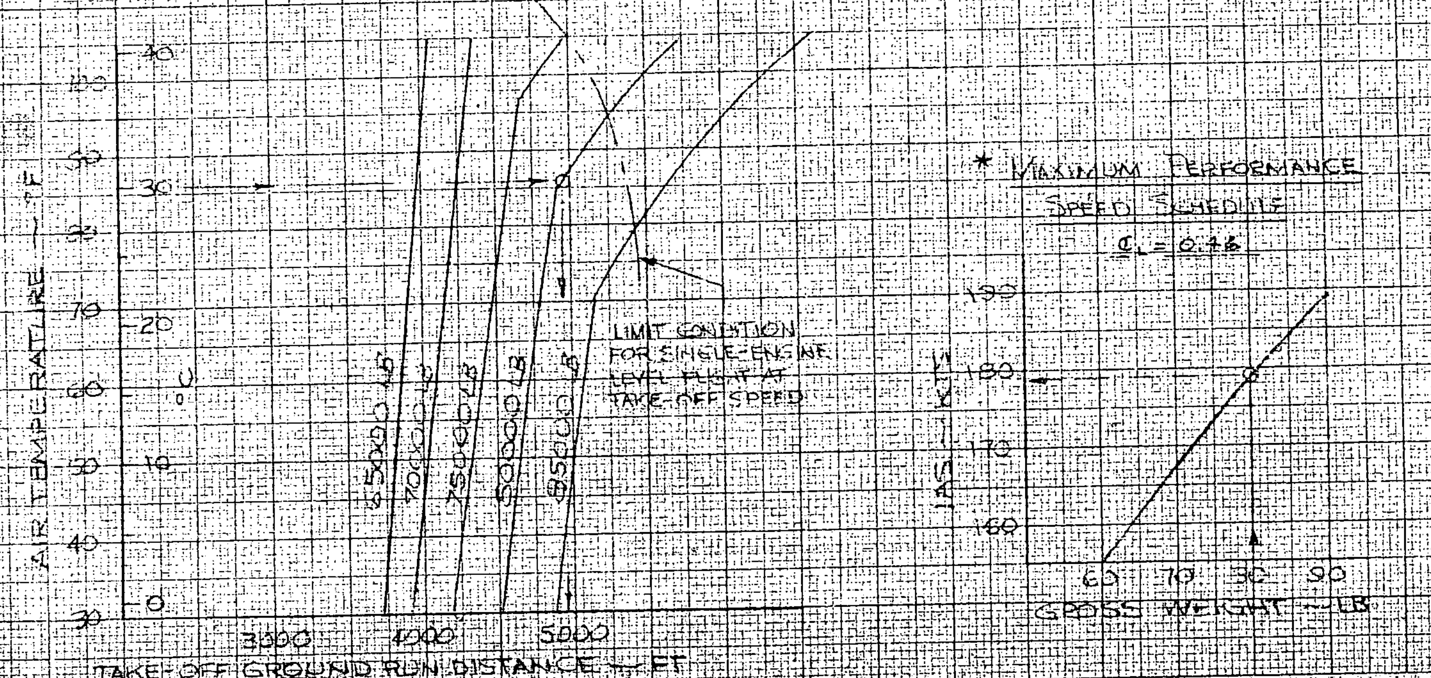
MODEL YA-12

TAKE-OFF GROUND RUN DISTANCE AND SPEED SCHEDULES

0 WIND "DRY" 4500 FT ELEV

NOTES:
1. TAKE-OFF THRUST
2. NO WATER INJECTION
3. APPLICABLE WITH ROSEMOUNT PITOT-STATIC TYPE NO. 855



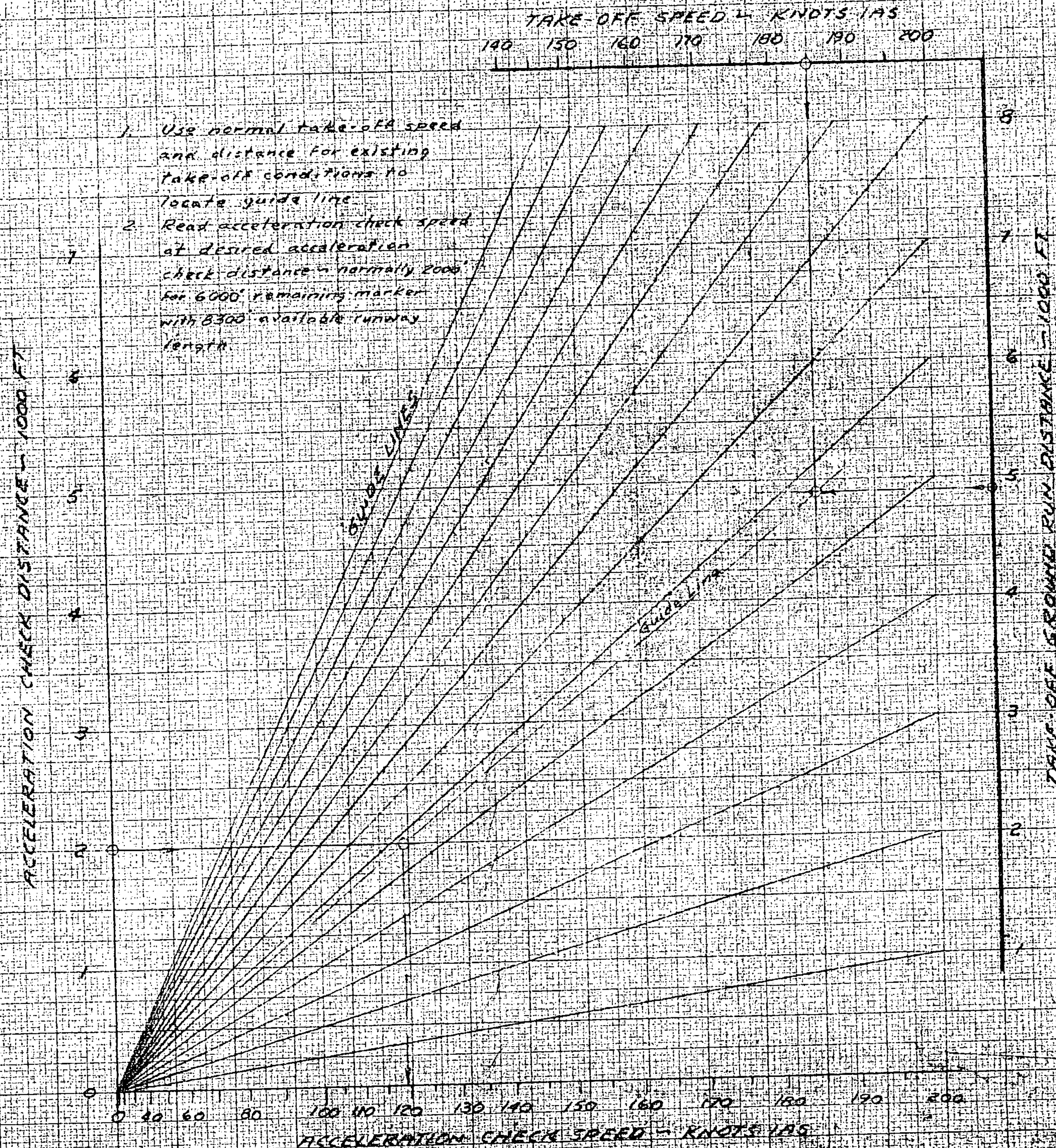


FORM 5278A

PREPARED BY
DATE
CHECKED BY

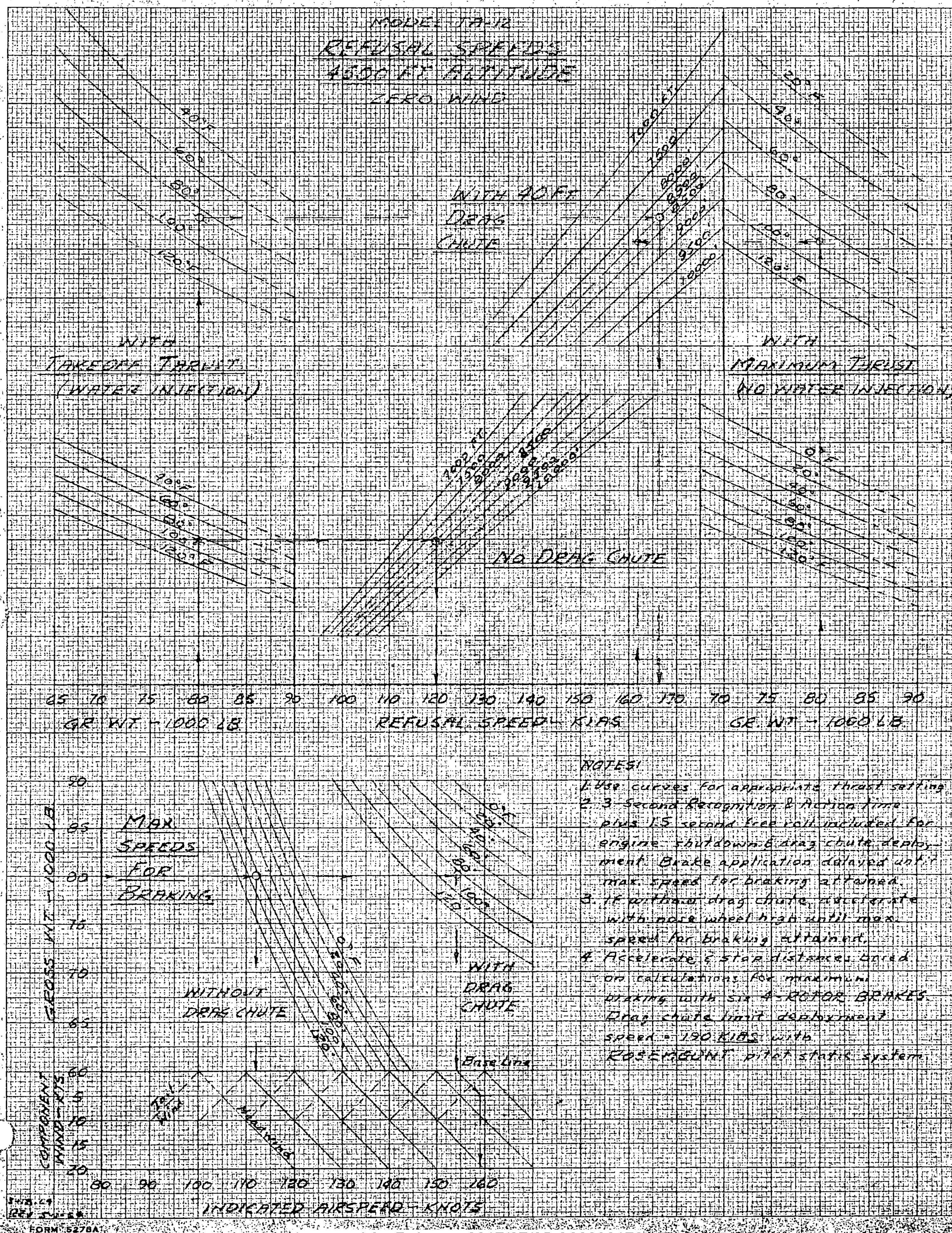
MODEL TA-13

TWO-ENGINE ACCELERATION CHECK SPEED TAKE-OFF AND MAXIMUM THRUST



REV 5-11-53
FORM 5278A

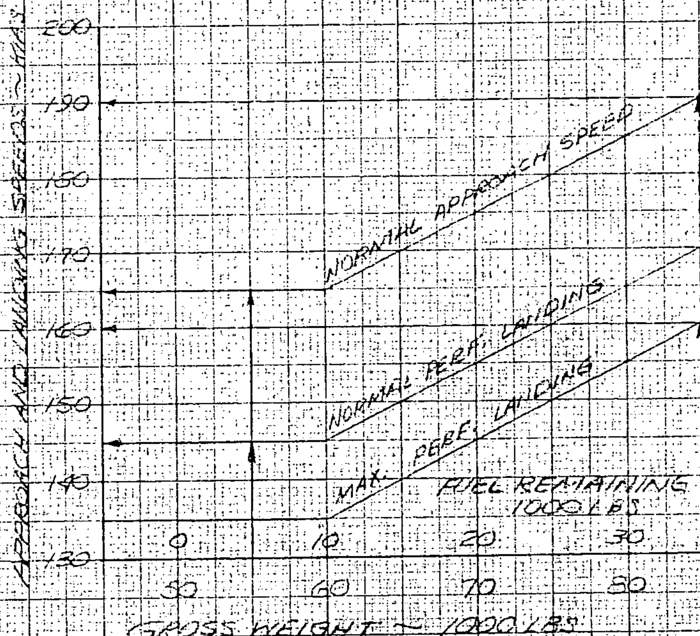
PREPARED BY
DATE
CHECKED BY



FORM 5278A

J-75
ENGINES

APPROACH AND LANDING SPEED SCHEDULES



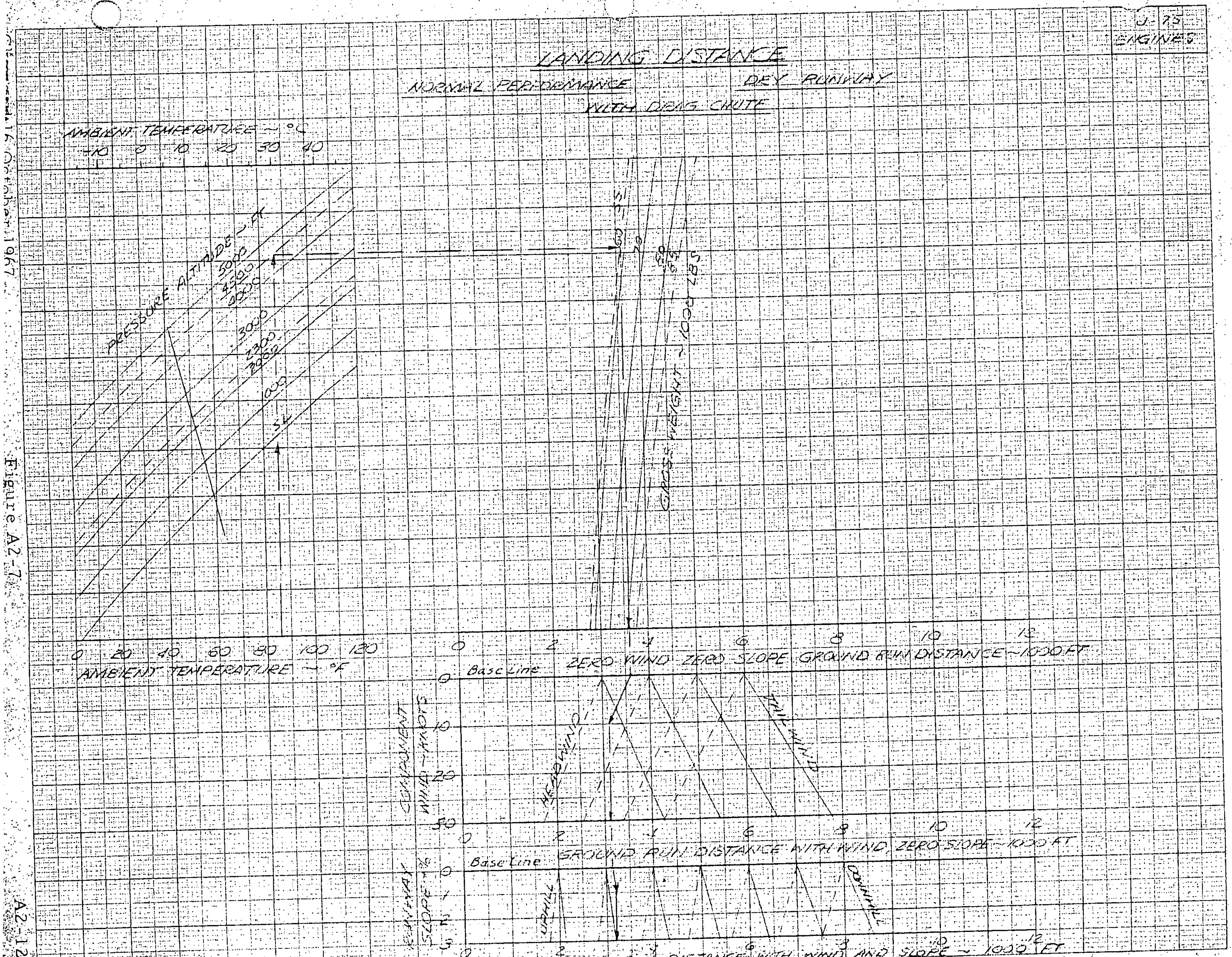


Figure A2-7

16 October 1967

TA-12

APPENDIX I
PART II

Approved for Release: 2017/07/25 C06230172

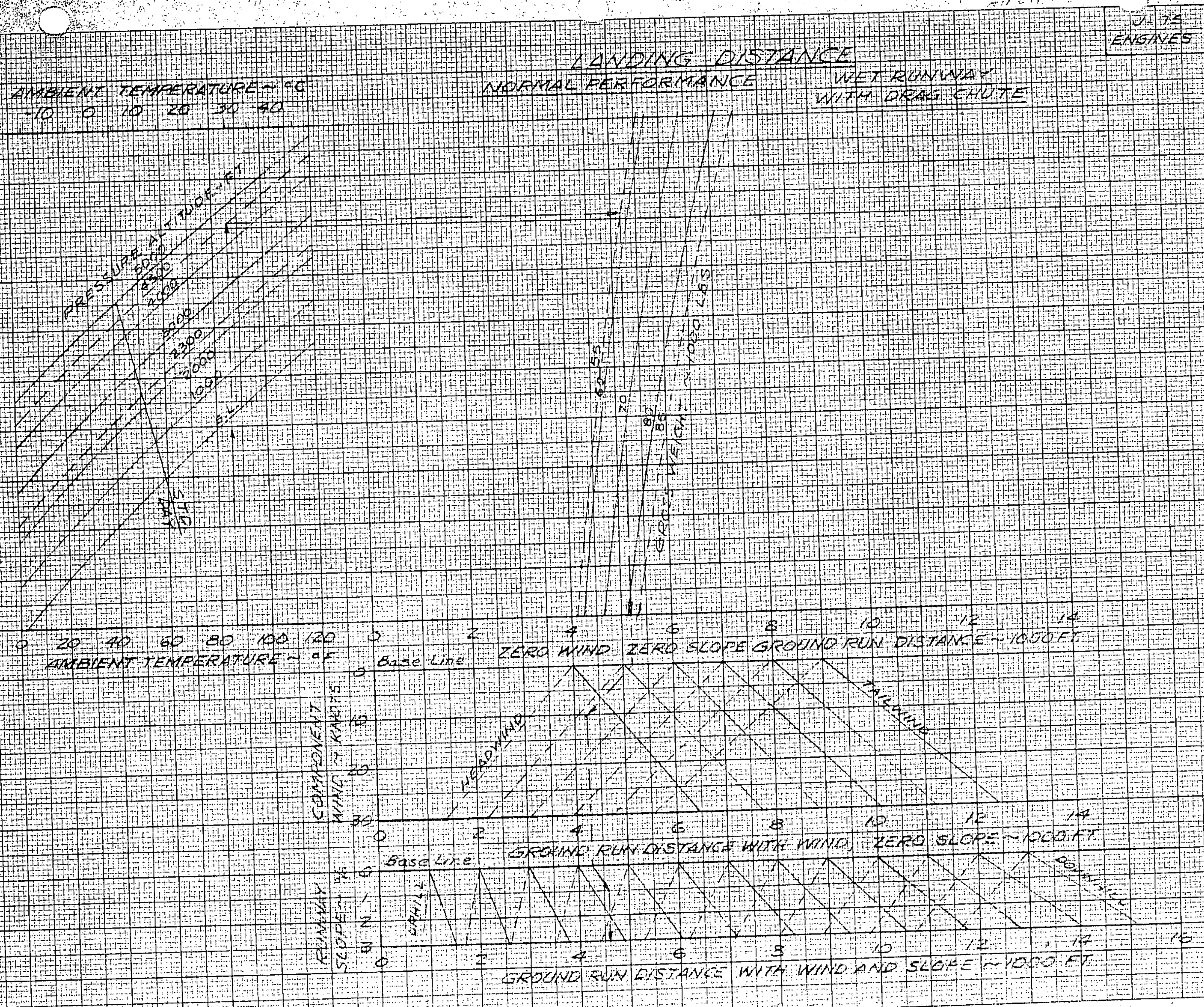
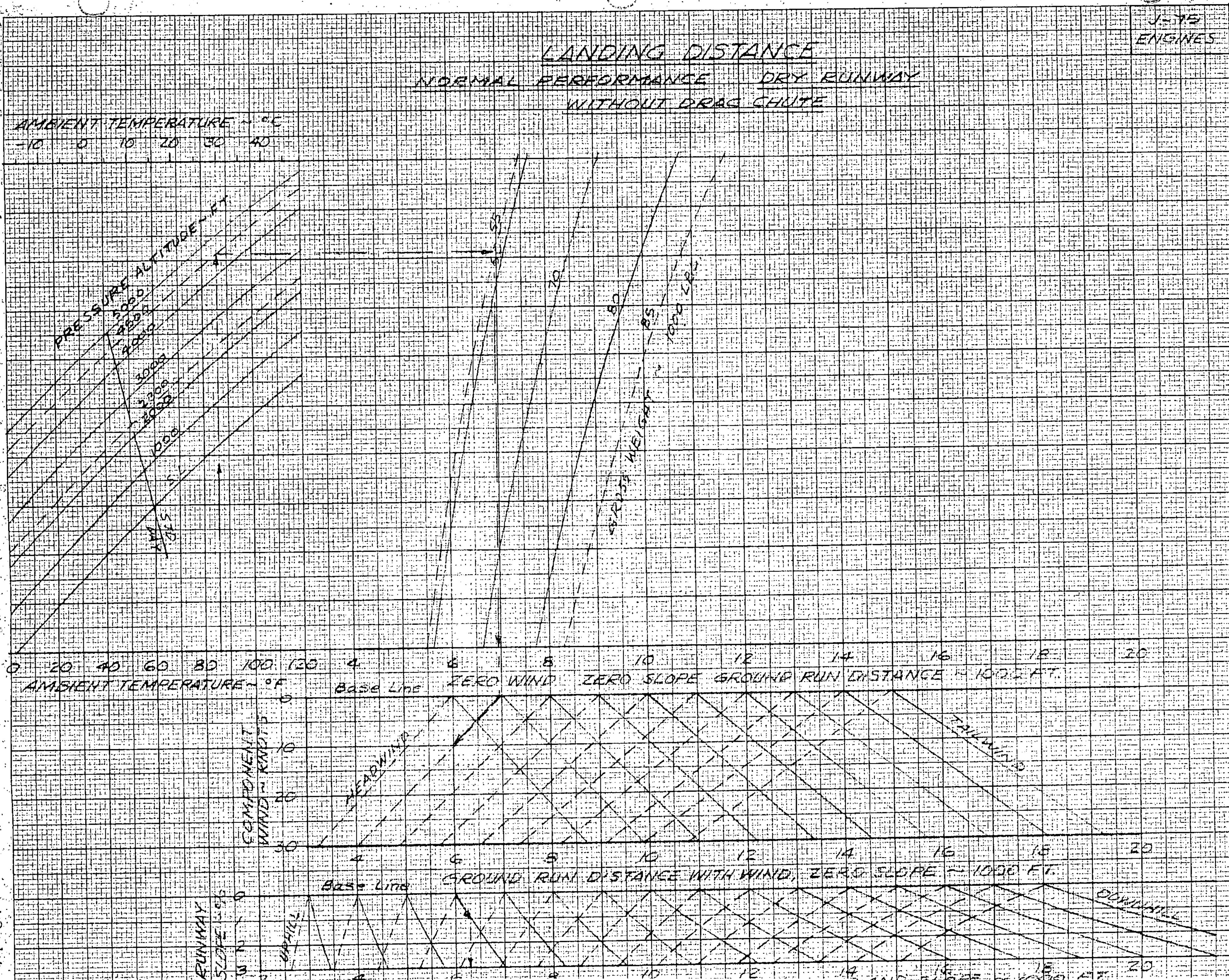

J-75
ENGINES
LANDING DISTANCE
NORMAL PERFORMANCE
WET RUNWAY
WITH DRAG CHUTE
AMBIENT TEMPERATURE ~ °C
-10 0 10 20 30 40
PRESSURE ALTITUDE ~ FT
S.L.
STD DAY
GROSS WEIGHT ~ 1000 LBS
0 20 40 60 80 100 120
AMBIENT TEMPERATURE ~ °F
Base Line
ZERO WIND ZERO SLOPE GROUND RUN DISTANCE ~ 1000 FT
0 2 4 6 8 10 12 14
WIND COMPONENT ~ KNOTS
0 10 20 30
HEADWIND
TAILWIND
GROUND RUN DISTANCE WITH WIND, ZERO SLOPE ~ 1000 FT
RUNWAY SLOPE ~ %
UPHILL
DOWNHILL
0 1 2 3
GROUND RUN DISTANCE WITH WIND AND SLOPE ~ 1000 FT
16

Figure A2-8



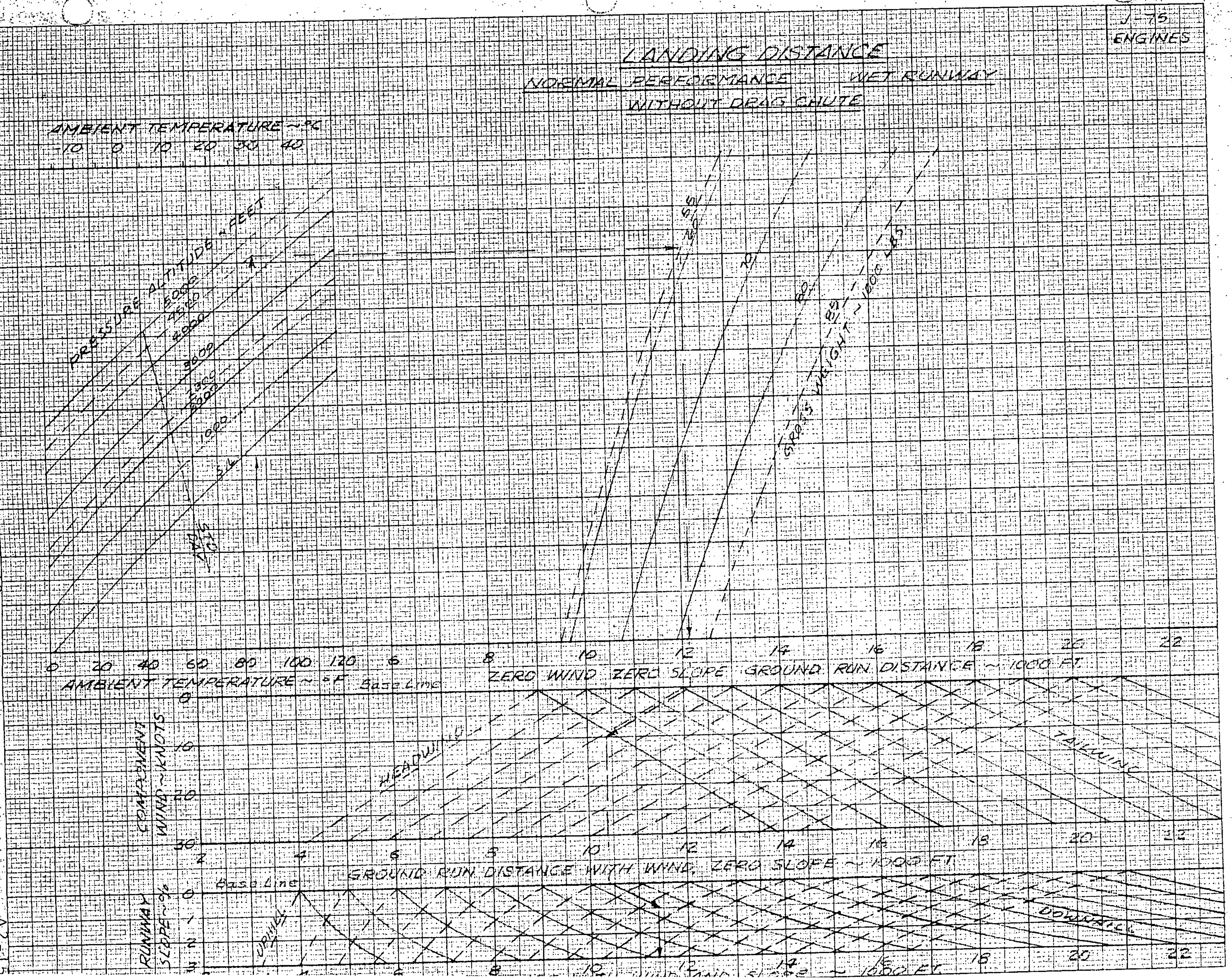
FORM 5278A

Figure A2-6

A2-14

TA-12

APPENDIX I
PART II



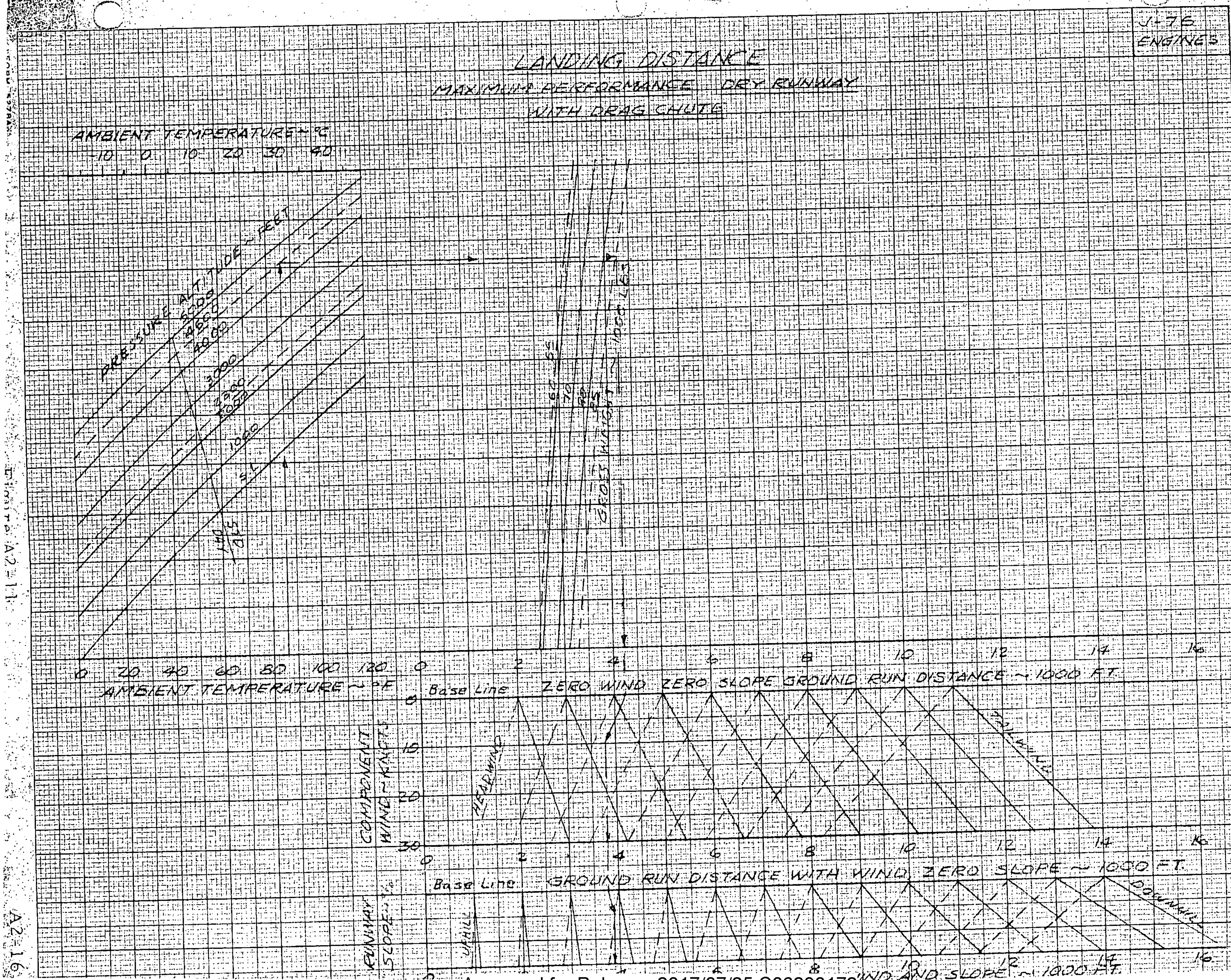
16 October 1967

Figure A2-10

A2-15

TA-12

APPENDIX I
PART II



TA-12

APPENDIX I
PART II

Figure A2-11

A2-16

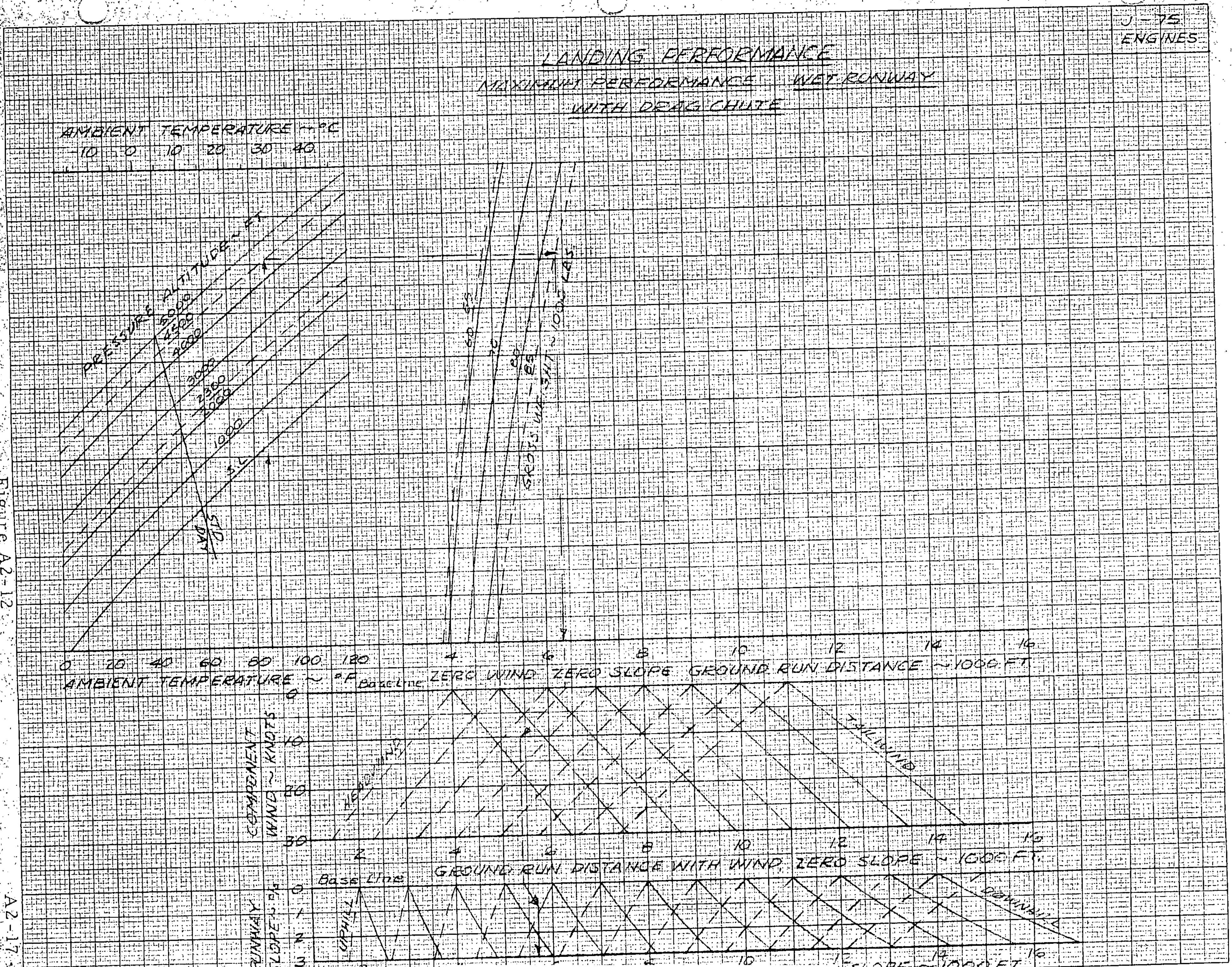
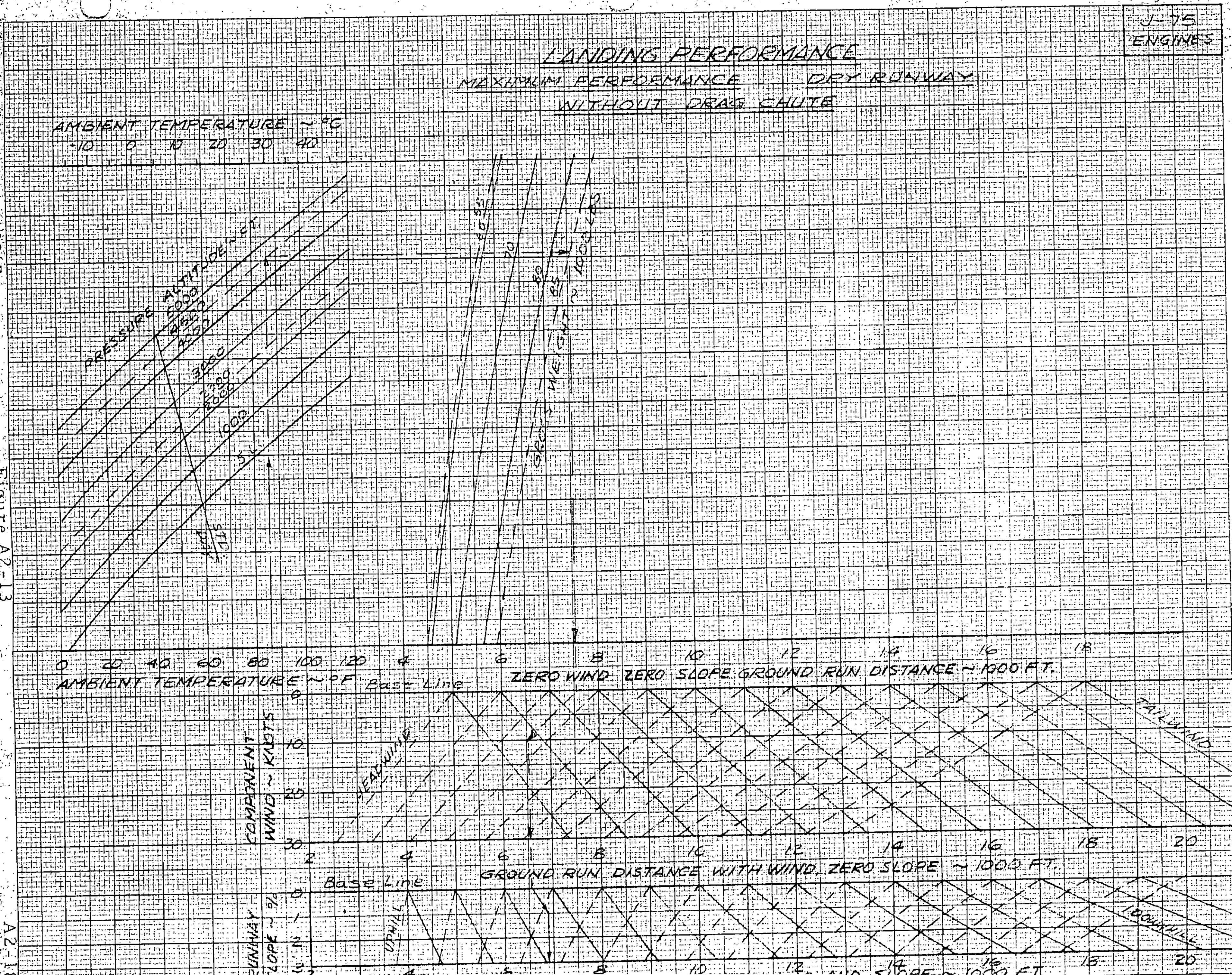


Figure A2-12

TA-12

APPENDIX I
PART II



16 October 1967

Figure A2-13

TA-12

APPENDIX I
PART II

Approved for Release: 2017/07/25 C06230172

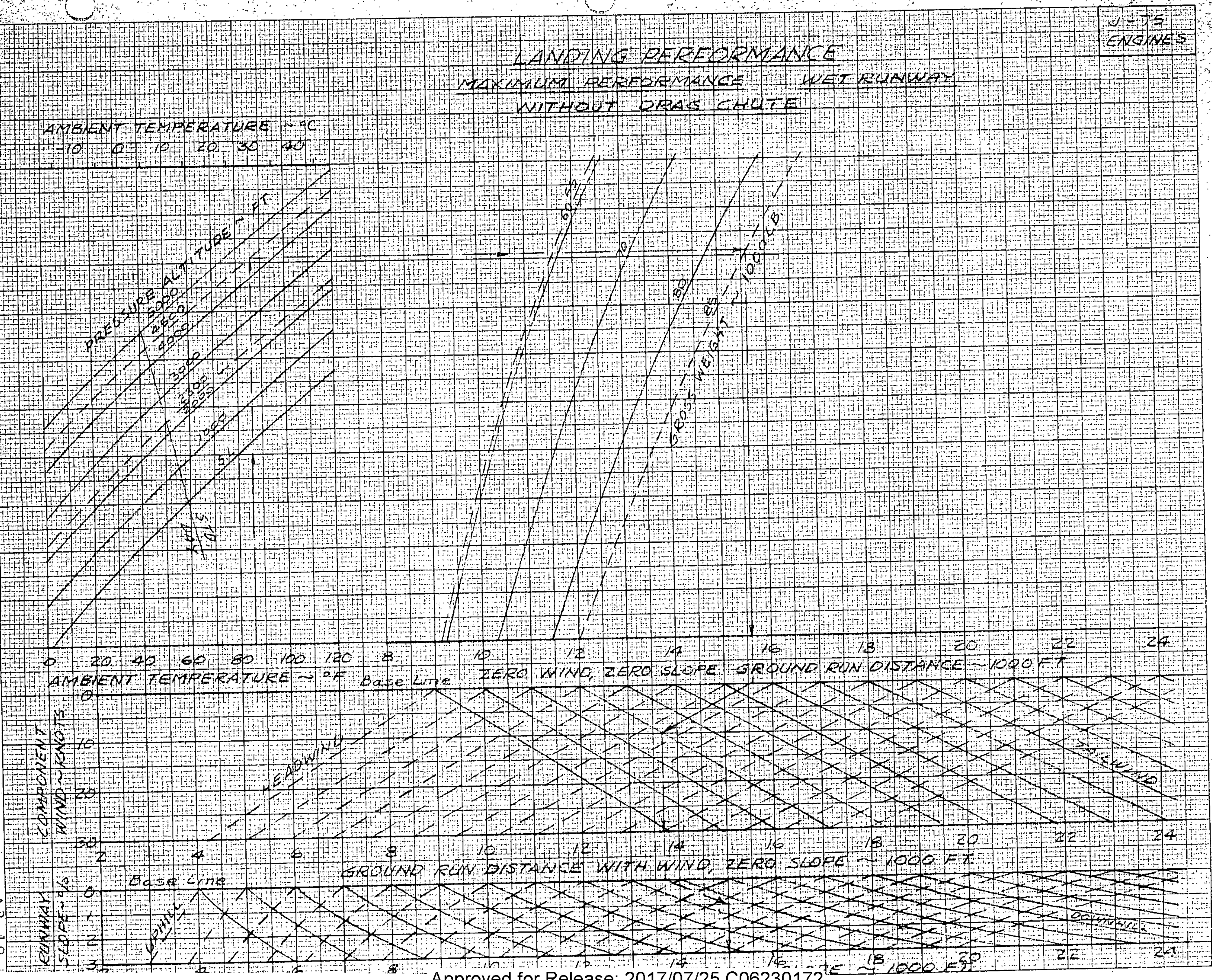


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Figure A2-14

A2-19

TA-12

APPENDIX I
PART II

PART III

CLIMB AND DESCENT PERFORMANCE

CLIMB PERFORMANCE

Maximum Thrust climb performance for two different speed schedules is shown in Figure A3-1. The 350 KEAS - 0.9 Mach number schedule results in the least time and fuel to reach altitudes above 30,000 feet. The 400 KEAS schedule is recommended only when the ambient temperature conditions are favorable; refer to Supersonic Acceleration, Section VI. Military Thrust climb performance at 300 KEAS is shown in Figure A3-2. This climb provides the most distance for the fuel consumed, and should be used when maximum subsonic range is desired.

Flight Planning Allowances

All of the climb data are based on establishing climb power and airspeed at 10,000 feet altitude. Additional allowances must be made for engine start, taxi, takeoff and initial climb. An afterburning takeoff with or without water injection requires approximately 2,000 pounds of fuel from the start of run to 10,000 feet elevation. Ground idle operation burns approximately 50 pounds per minute of fuel.

Data Basis

All except the 300 KEAS standard day climb performance data are based on flight tests of aircraft S/N 121 and S/N 124. The 300 KEAS standard day performance is based on calculations.

DESCENT PERFORMANCE

Descent performance from 55,000 feet is shown in Figure A3-3 for descent speeds of 300 and 400 KEAS with the gear up. Descent time is from 4 to 10 minutes, and descent fuel is only 200 to 500 pounds. Experience has shown that when landing pattern and approach are included, a total of approximately 1500 pounds of fuel are required from 55,000 feet to touchdown.

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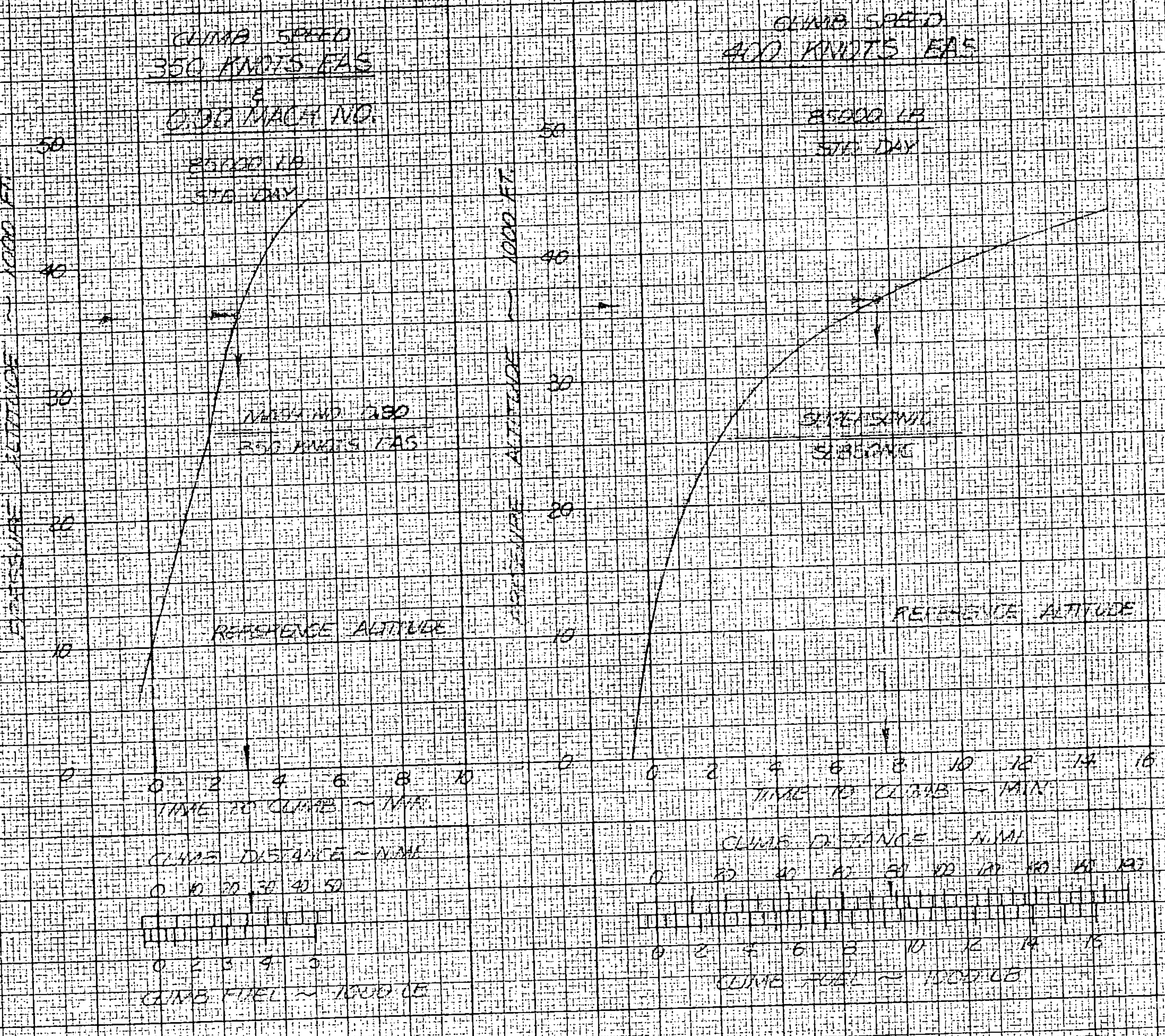
MODEL TR-12

MAXIMUM THRUST CLIMB PERFORMANCE



NOTES: NO SERVICE ALLOWANCES INCLUDED

1. TAKE-OFF ALLOWANCES WITH TAKE-OFF THRUST TO REFERENCE ALTITUDE
   FUEL — ADD 2000 LB, PLUS 50 LB PER MINUTE FROM ENGINE START TO BEGINNING OF TAKE-OFF.
   TIME — ALLOW 1 MIN FOR TIME TO REACH [illegible] FT FROM START OF RUN AT 4500 FT FIELD ELEVATION [illegible]
2. DATA BASED ON FLIGHT TEST.

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FIGURE A3-2

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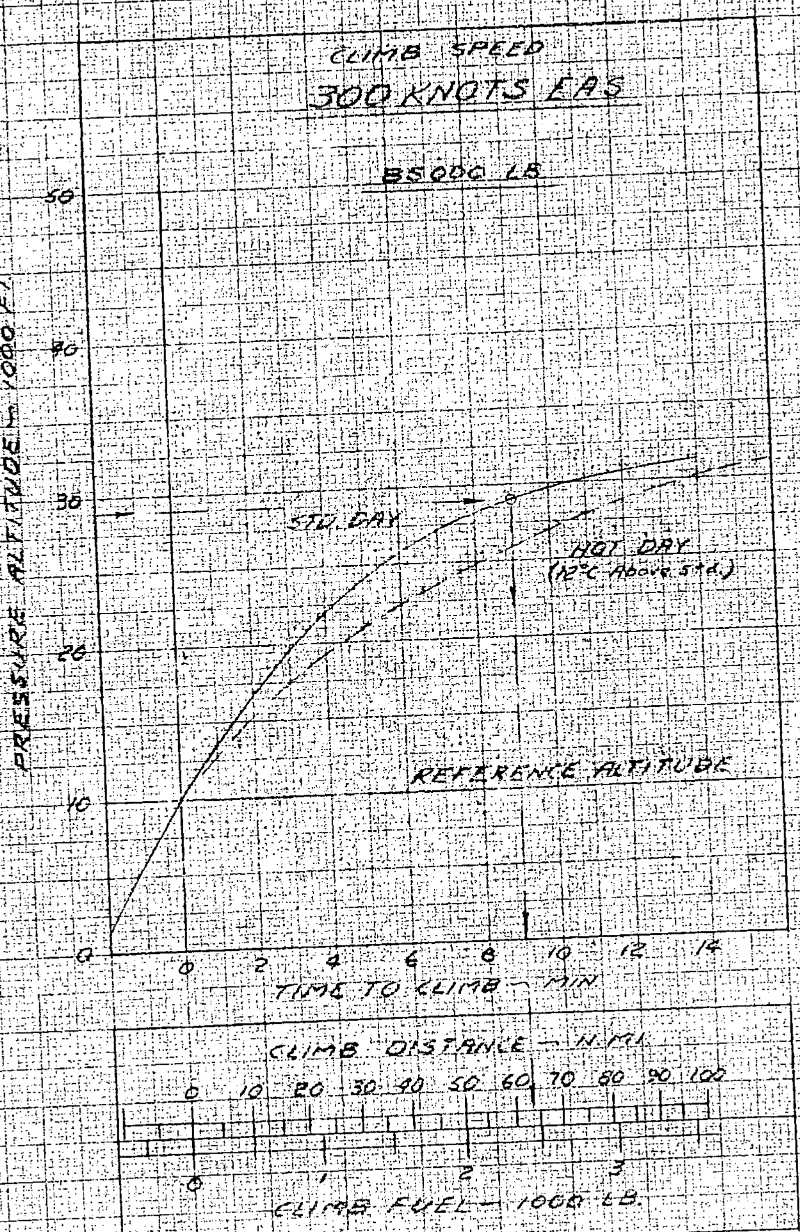
MILITARY THRUST CLIMB PERFORMANCE
300 KNOTS EAS



NOTES: NO SERVICE ALLOWANCES INCLUDED.
TAKE-OFF ALLOWANCE WITH TAKE-OFF THRUST TO REFERENCE ALTITUDE
1. TAKE-OFF ALLOWANCE WITH TAKE-OFF THRUST TO REFERENCE ALTITUDE
FUEL — ADD 2000 LB, PLUS 50 LB PER MINUTE FROM ENGINE START
TO BEGINNING OF TAKE-OFF.
TIME — ALLOW 1 MIN FOR TIME TO REACH REFERENCE ALTITUDE FROM
START OF RUN AT 4500 FT. FIELD ELEVATION.
2. DATA BASED ON CALCULATIONS FOR STD. DAY. HOT DAY DATA BASED ON FLT. TEST.
3. TIME INCREASES APPROX. 35% PER 10°C OVER STD. TEMP. READ DISTANCE AND FUEL
AT CORRECTED TIME FOR DESIRED ALTITUDE.

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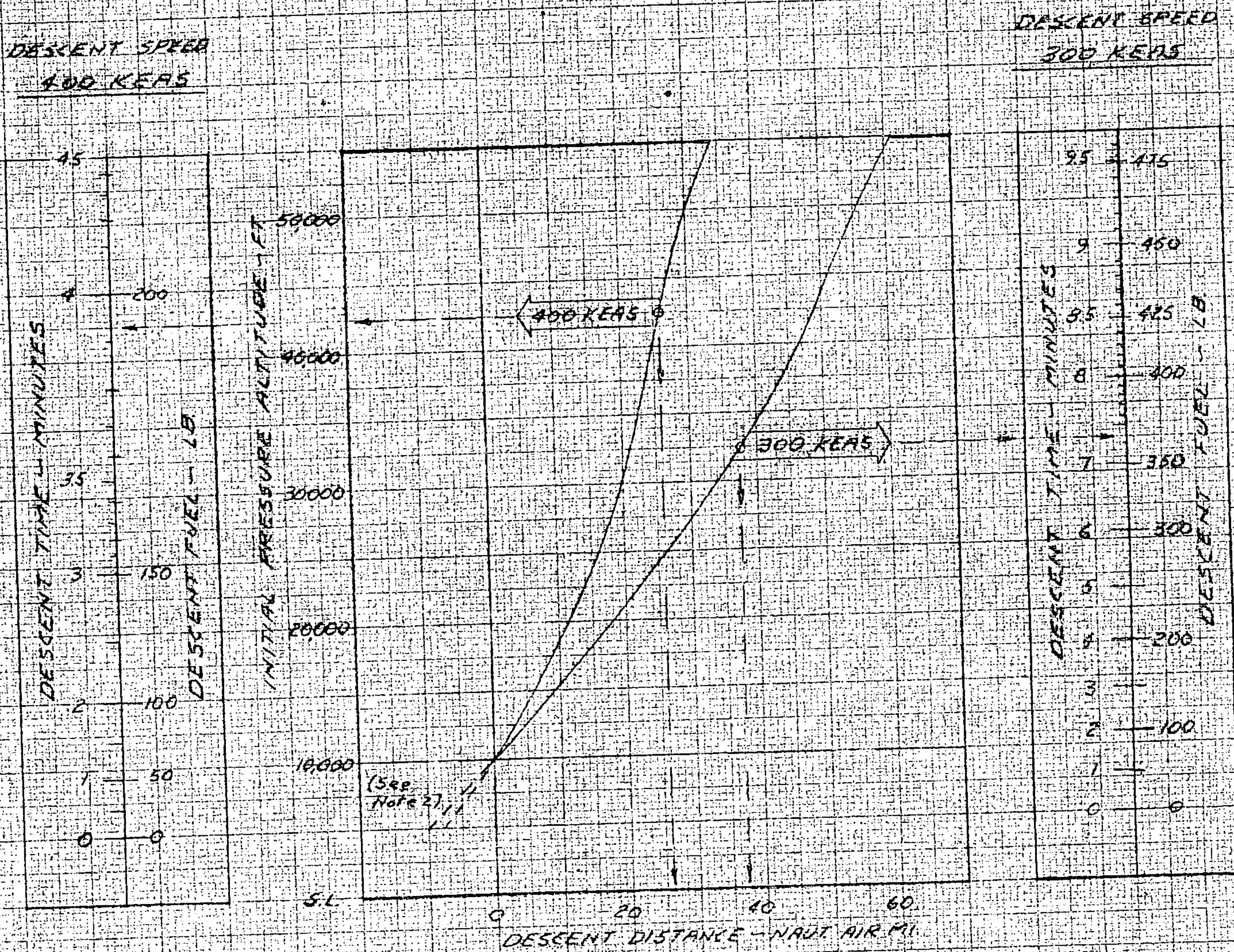
DESCENT PERFORMANCE

IDLE THRUST & 1500 LB/HR/ENGINE FUEL FLOW
GEAR UP
"1-g" LOAD FACTOR LANDING WEIGHT



NOTES:
1. NO ALLOWANCES INCLUDED FOR MANEUVERS BEFORE OR FOLLOWING DESCENT
2. ADD DISTANCE BETWEEN 10,000 FT & PATTERN ALTITUDE IF STRAIGHT-IN APPROACH PROCEDURE IS USED.
3. ALLOW APPROX 200 LB/MIN FOR NORMAL LOW ALTITUDE MANEUVERING
4. ALLOW 1000 LB FOR GO AROUND RESERVE.
5. USE CHART ON AN INCREMENTAL BASIS FOR TERMINAL DESCENT ALTITUDES ABOVE 10,000 FT.

PART IV

CRUISE PERFORMANCE

PROFILE CHARTS

Profile planning charts for long range cruise and high speed flight summarize performance at true Mach 0.85 and 400 KEAS respectively. Figures A4-1 and A4-2 are based on 87,000 lb. loaded gross weight with 1250 pounds of water and 36,000 pounds of fuel. However, a fuel allowance of 2750 lb. for ground maneuver and takeoff reduces the mission fuel available to 33,250 lb. Initial climb weight is approximately 83,000 pounds after expending takeoff fuel and water. Flight distances shown are for on-course climbs and descents. The effects of operating with reserve and landing fuel allowances of up to 6000 lb. are also indicated on the charts. The flight profiles give cross sections of the flight paths so that time and altitude can be related to navigation check points if desired. The fuel remaining vs. flight time and the fuel and time vs. distance curves supply a means for checking progress in flight, either through communications with a ground station or by simple how-goes-it logs maintained in the cockpit.

Temperature Affect On Range

The Mach number 0.85 cruise chart is directly applicable to standard day operations. That is, the time, distance, and fuel remaining relationships given will be met on days when air temperatures are nearly standard. On non-standard days, time, speed and fuel consumption will compensate each other so that standard day range will be obtained, but on a different time schedule. On cold days, true airspeed and fuel flow will be less than with standard temperatures at the same Mach number and altitude schedules. Fuel flow and true speed will be greater on hot days, and higher EGT settings will be required. The altitude schedule selected allows Mach 0.85 to be maintained on hot days at EGT settings within the military thrust limit value. Standard day cruise EGT should range from 560°C to 540°C as the flight progresses. The standard day fuel flow variation with altitude is shown at the right side of the Flight Profile.

High Speed Cruise

The 400 KEAS flight profile is a continuous acceleration at increasing altitude. A top speed reached in tests of aircraft S/N 124 was Mach 1.69 at 48,000 feet. Upper air temperatures were only slightly colder than for a standard day. Acceleration will vary considerably as ambient temperatures change. Top speed will be attained more quickly and at higher altitudes when temperatures above 25,000 feet are less than standard. Conversely, performance will not be as good on hot days and fuel and distance to go must be checked carefully. CIT values for standard day conditions are listed for reference at the left side of the Flight Profile. Deviations noted in flight indicate the degree to which hot or cold day conditions exist.

Turning Allowances

Time, distance, and fuel required to turn must also be considered if an out and back mission is planned. A typical 1.5 Mach number turn of 180° has required slightly over 4 minutes and 4000 lb. of fuel at the 430 level. The distance flown during the turn was approximately 60 miles.

MILES PER POUND CHARTS

Fuel economy charts for two engine operation at normal cruise altitudes are shown in Figures A4-3 to A4-5. Level flight cruise performance is given for speeds from Mach 0.80 to 0.90. Standard day fuel flow and EGT settings are also provided on the curves for reference. The recommended cruise speed is 0.85 Mach number as read on the Triple Display Indicator. However, at light weights, speeds down to Mach 0.80 and up to Mach 0.90 can be used efficiently at Flight Levels 300 and 400 respectively.

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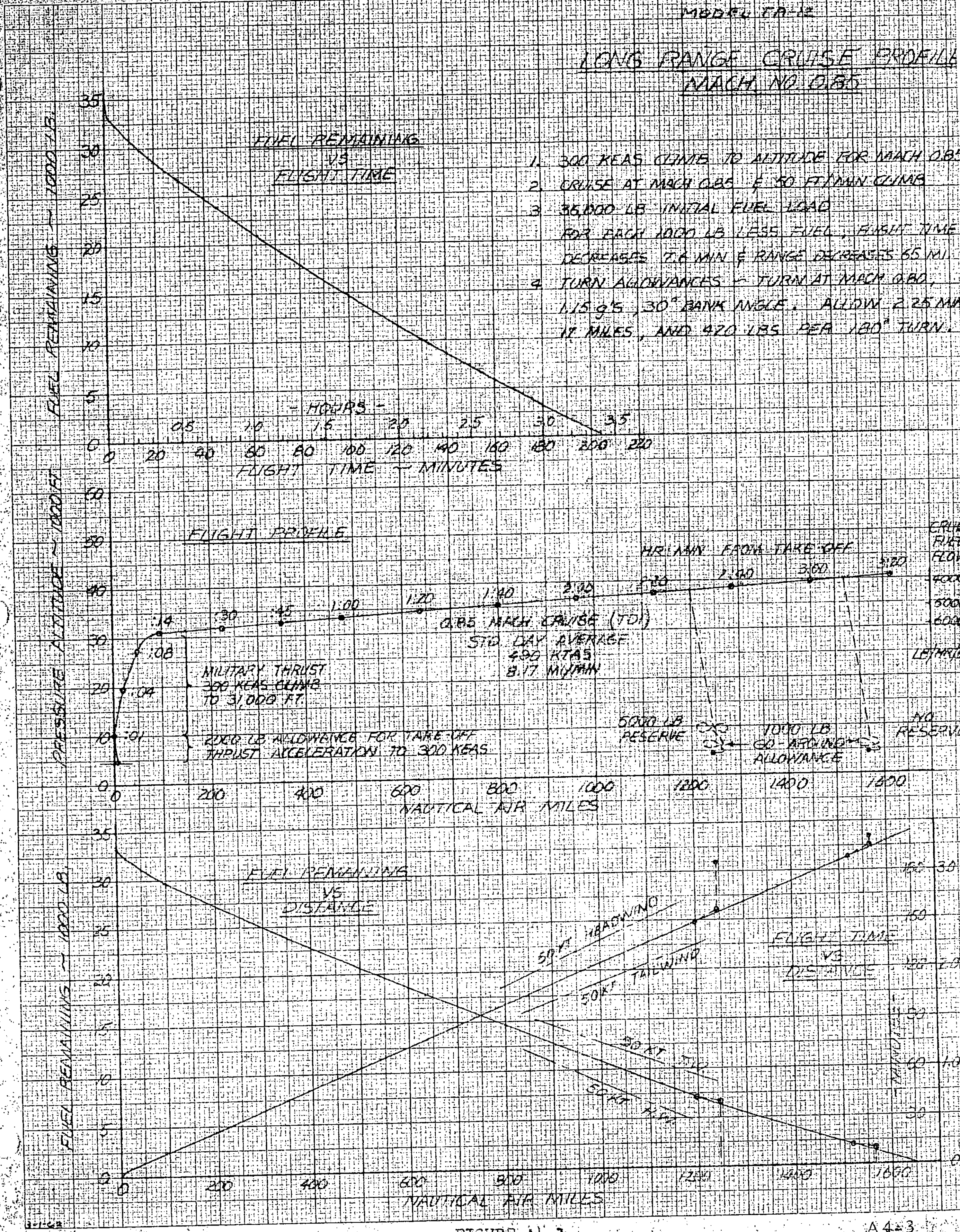

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FIGURE A1-1

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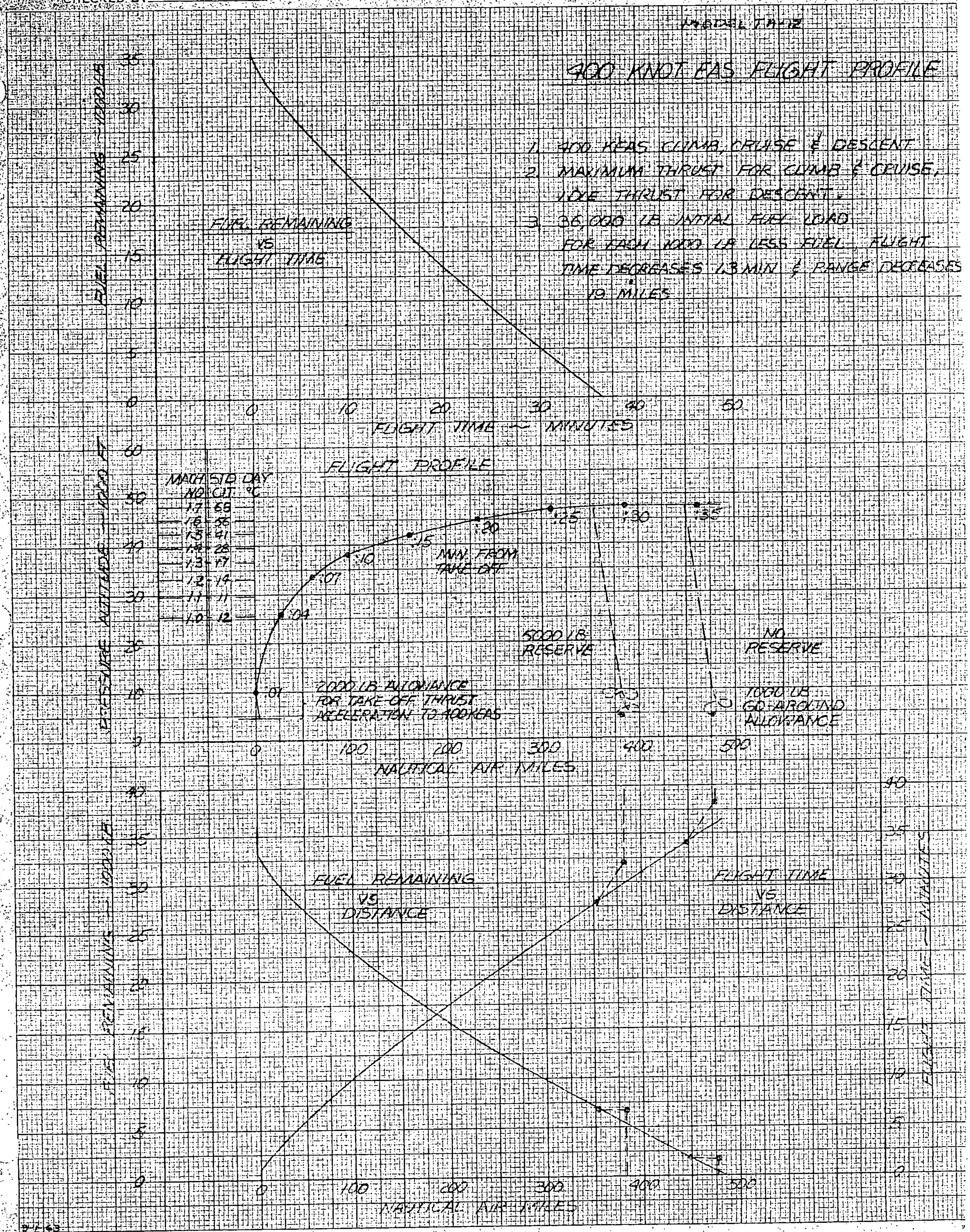

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FIGURE A4-2

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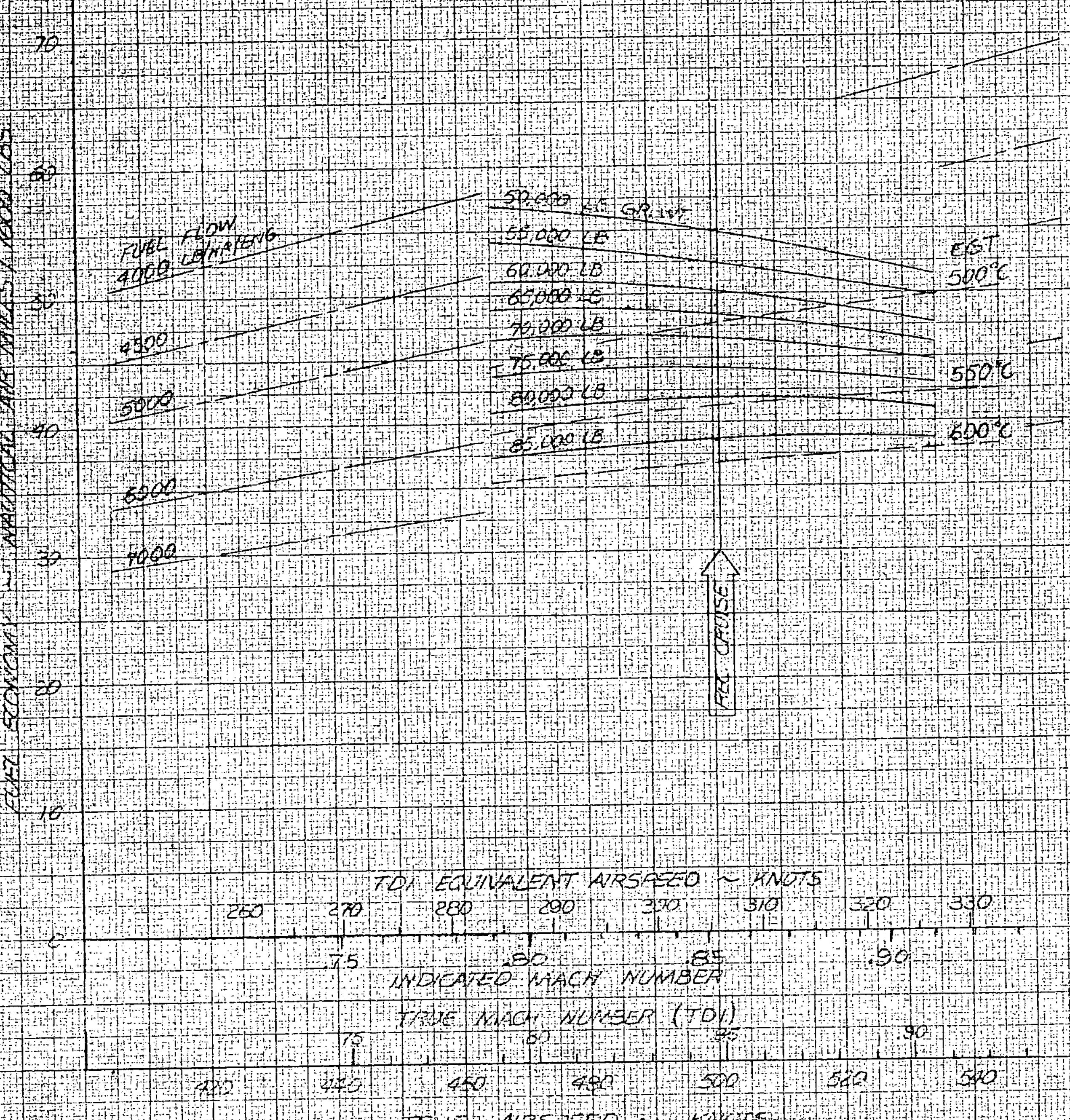
MODEL TAG

TWO ENGINE SUBSONIC CRUISE
NAUTICAL MILES PER 1000 LBS OF FUEL

30,000 FEET

STANDARD DAY
DATA BASIS: FLIGHT TEST
ROSEMOUNT PITOT STATIC TYPE 555 W



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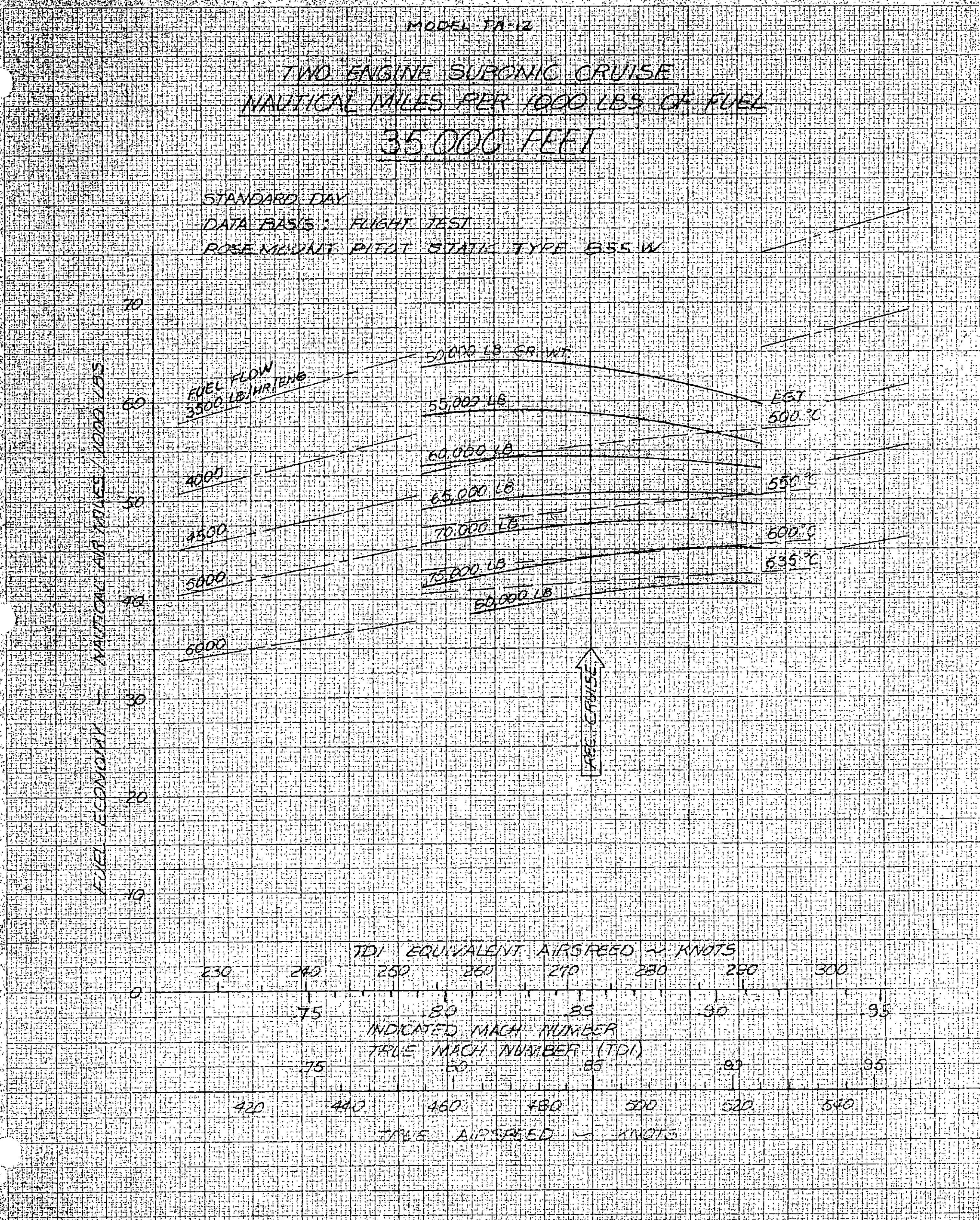

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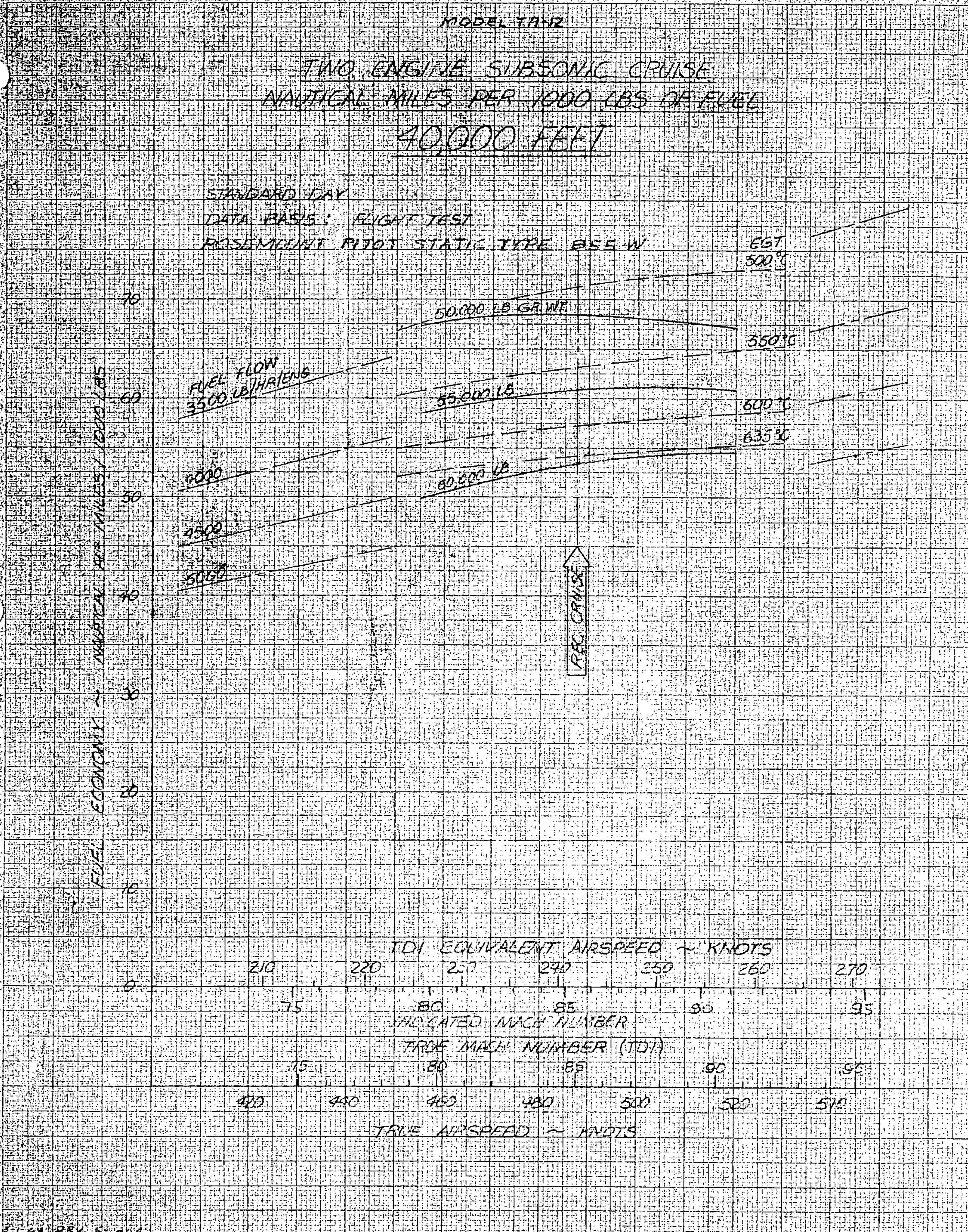

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