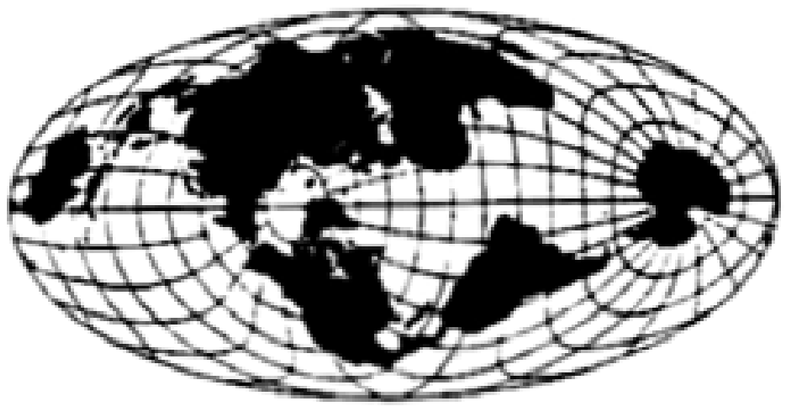

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G01-01-F01.003

F-20A

Tigershark is ready... are you?

20-1-1-3-2)

SCOPE

This manual contains the necessary information for safe and efficient operation of flight test aircraft, N3986B (GI1001) and N44671 (GI1002). Description and procedures for fire control radar applies only to N3986 (GI1001). These instructions provide you with a general knowledge of the aircraft and specific normal and emergency operating procedures. Your experience is recognized; therefore, basic flight principles and detailed description and operation of systems common to all other aircraft are avoided. This manual provides the best operating instructions under most circumstances, but it is not a substitute for sound judgement. Multiple emergencies, adverse weather, terrain, etc., may require modification of the procedures.

USE

This publication is intended for use by experienced and qualified flight personnel assigned to the F-20A Flight Test Program.

FLIGHT AND OPERATING LIMITATIONS

Flight and operating limitations included herein can be supplemented and/or superseded by Supplemental Flight and Operating Limitations, published under separate cover by Northrop System Safety (Orgn. 3891/82).

PERMISSIBLE OPERATIONS

Permissible operations will be as scheduled by Northrop Flight Test Operations. The flight manual takes a positive approach and normally states what you can do. Unusual operations or configurations are prohibited unless specifically covered herein. Clearance must be obtained before any questionable operation, which is not specifically permitted in this manual, is attempted.

PUBLICATION DATE

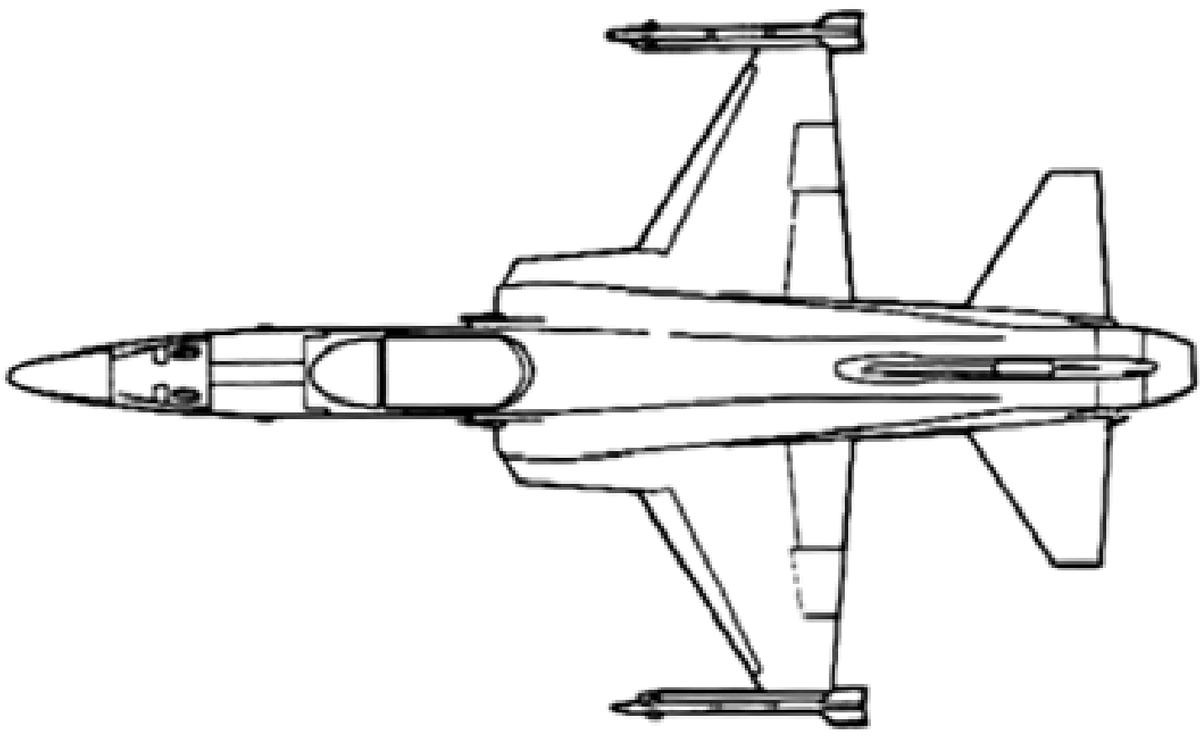
Currency of information contained in this manual is as of the publication date appearing on the title page.

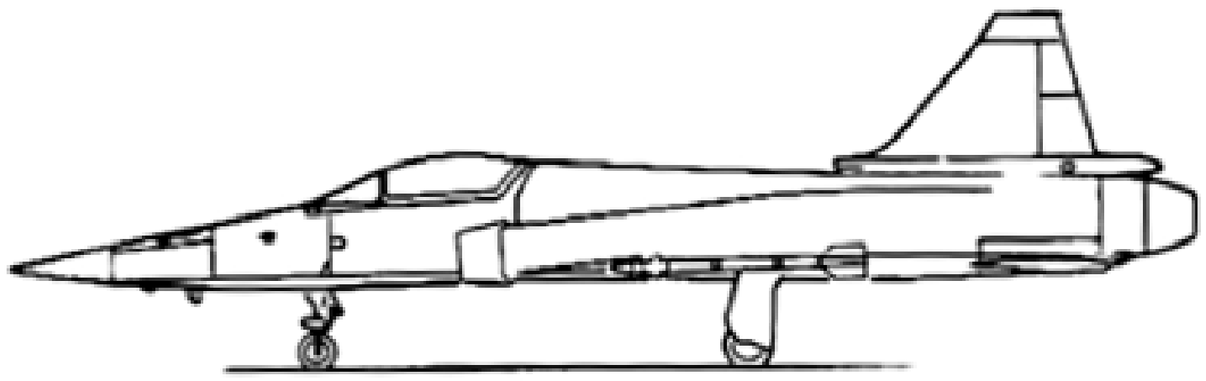
YOUR RESPONSIBILITY — TO LET US KNOW

Comments, corrections, and questions regarding this manual or any phase of the Flight Manual program are welcomed. They are an essential part of the development program. Direct all comments, corrections, or queries to: Northrop Corporation, Aircraft Division, Dept. N8822/76, One Northrop Avenue, Hawthorne, CA., 90250.

F-20A

TACTICAL FIGHTER





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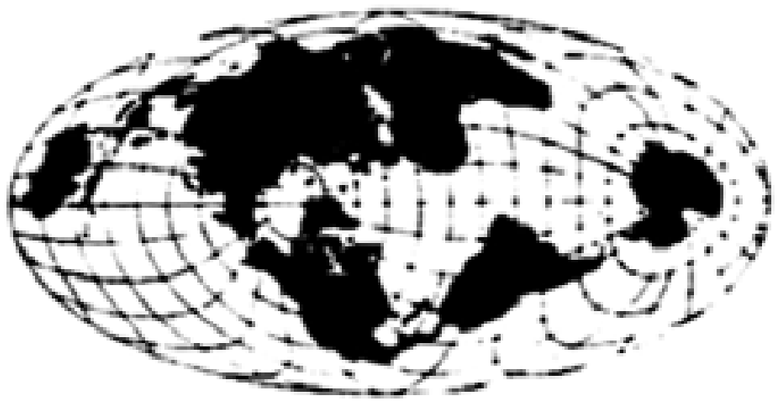

DESCRIPTION AND OPERATION

SECTION I

G01-01-001.011

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AIRCRAFT

The F-20A Tigershark is a single-place, Mach 2 class, multi-role fighter aircraft produced by the Northrop Corporation, Aircraft Division. A 17,000 pound thrust, YF404-GE-100 twin-spool, after-burning, turbofan engine powers the aircraft. Air inlet ducts from both sides of the fuselage join internally to provide engine airflow. A bleed air precooler inlet duct extends forward at the base of the vertical stabilizer. The wing, horizontal tail, and vertical stabilizer are moderately swept back. Automatically actuated leading and trailing edge flaps provide increased combat maneuvering

performance. Hydromechanical flight controls are augmented by an electronic control augmentation system. An integrated digital avionics system provides head-up-display and weapon system control with hands on stick and throttle. Seven external stores stations are provided, five pylon and two wingtip. Deceleration equipment includes a speed brake and a drag chute. The tricycle landing gear has a steerable nosewheel and a two position extendable nose gear strut used for takeoff. The cockpit is enclosed by a manually operated panoramic clamshell canopy.

DIMENSIONS

The overall dimensions with normal tire/strut inflation are:

Span (w/Launcher Rails)	26 ft 8 in
Length	46 ft 6 in
Height	13 ft 10 in
Tread	12 ft 6 in
Wheelbase	17 ft 4 in

See Section II for turning radius and ground clearance.

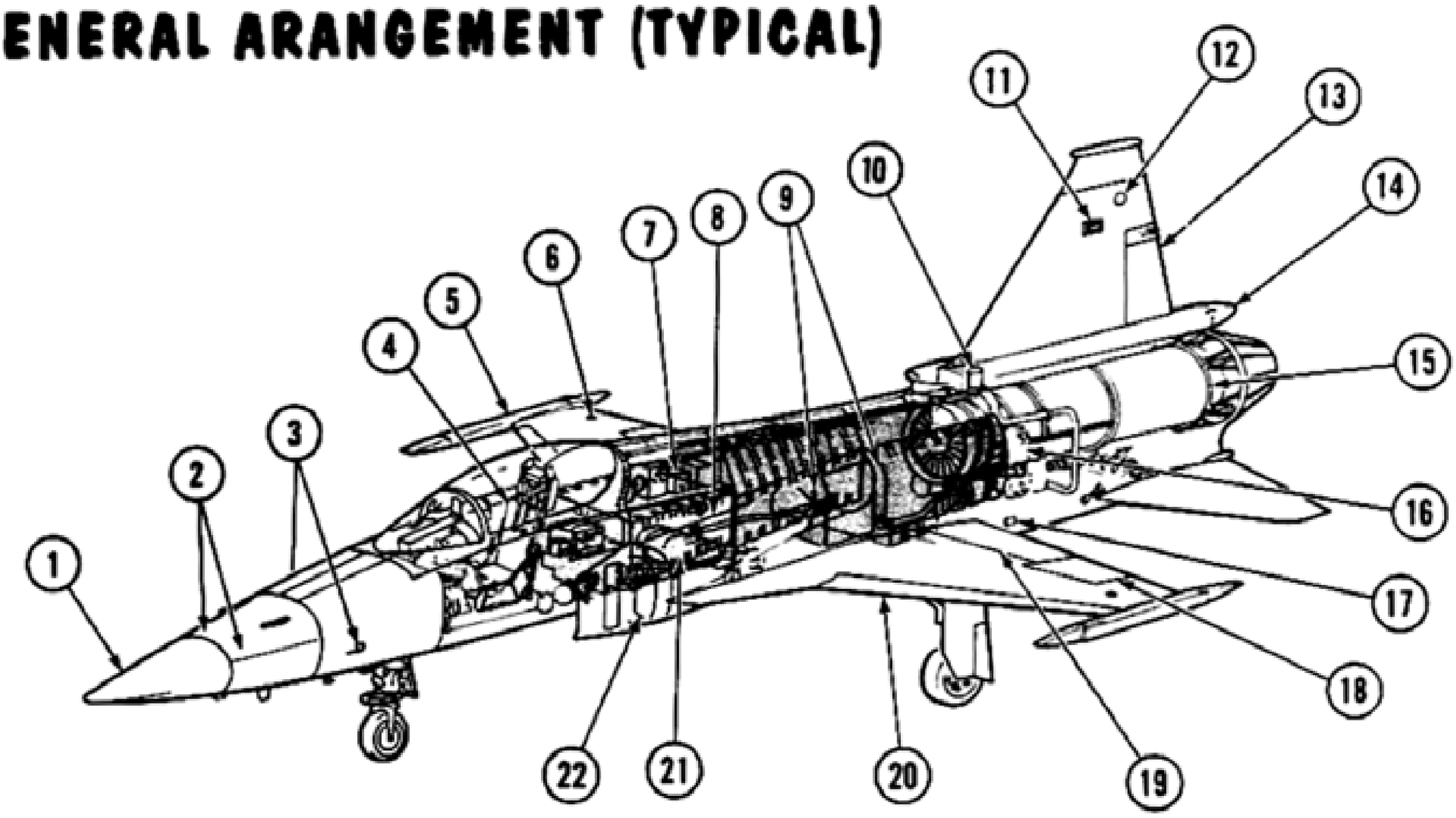
GROSS WEIGHT

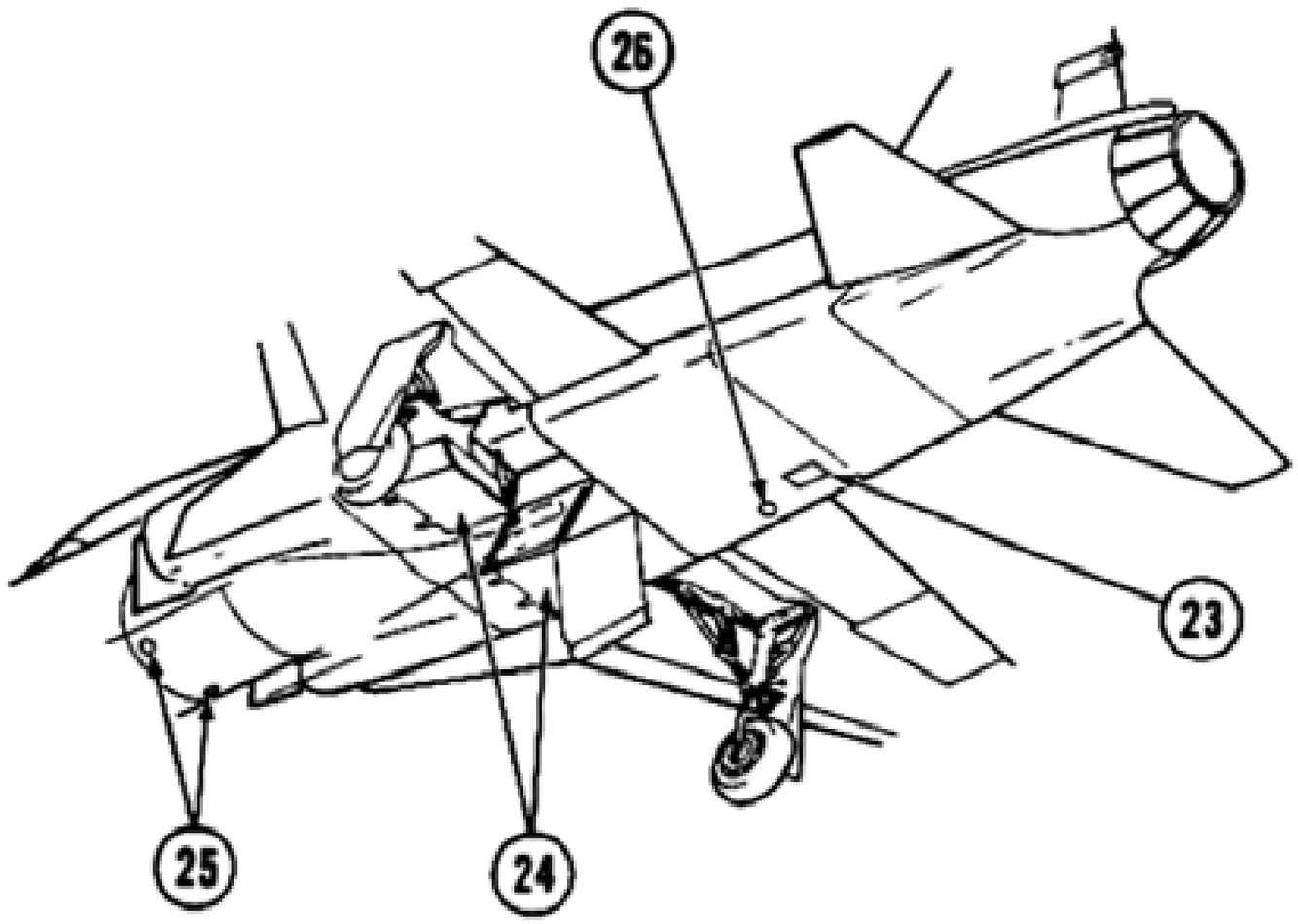
The following approximate gross weights include one pilot, full internal fuel (JP-8), oil, and flight test equipment.

Takeoff Gross Weight	17,890 lb
Maximum Takeoff Gross Weight	26,544 lb

The above gross weights shall not be used for mission planning. For exact aircraft gross weight, refer to the current Form 365F.

GENERAL ARANGEMENT (TYPICAL)





1 RADOME
2 FORWARD AVIONICS EQUIPMENT BAYS
3 PITOT-STATIC BOOMS (LEFT AND RIGHT)
4 EJECTION SEAT
5 TIP LAUNCHER RAIL
6 POSITION LIGHTS (RIGHT, LEFT, TOP AND BOTTOM)
7 AFT AVIONICS EQUIPMENT BAYS
8 FORWARD FUEL TANK
9 AFT FUEL TANK
10 BLEED AIR PRECOOLER
11 ROTATING BEACON
12 TAIL POSITION LIGHT
13 RUDDER
14 DRAG CHUTE COMPARTMENT
15 ENGINE
16 HYDRAULIC RESERVOIR
17 EXTERNAL POWER RECEPTACLE
18 AILERON
19 TRAILING EDGE FLAP
20 LEADING EDGE FLAP
21 FORWARD INVERTED FLIGHT TANK
22 ENGINE AIR INLET DUCT
23 ENGINE STARTER AIR INLET
24 SPEED BRAKE
25 FUSELAGE LIGHTS
26 HYDRAZINE LEAK DETECTOR

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Figure 1-1.

COCKPIT ARRANGEMENT (TYPICAL)

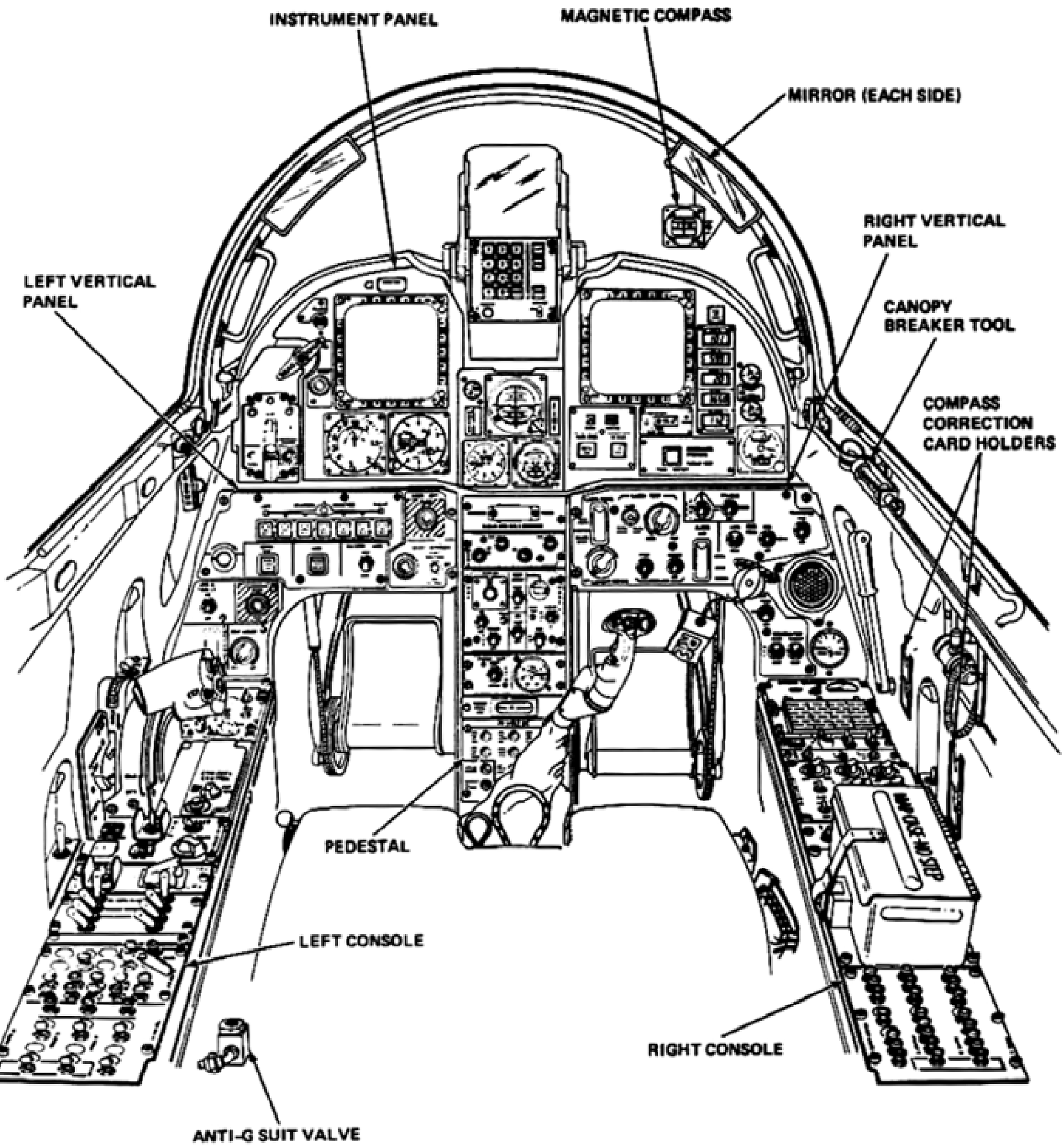

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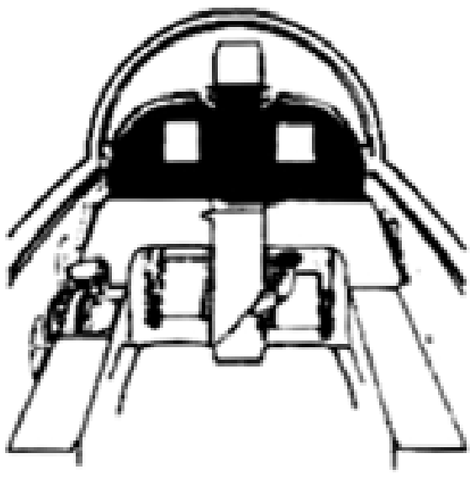
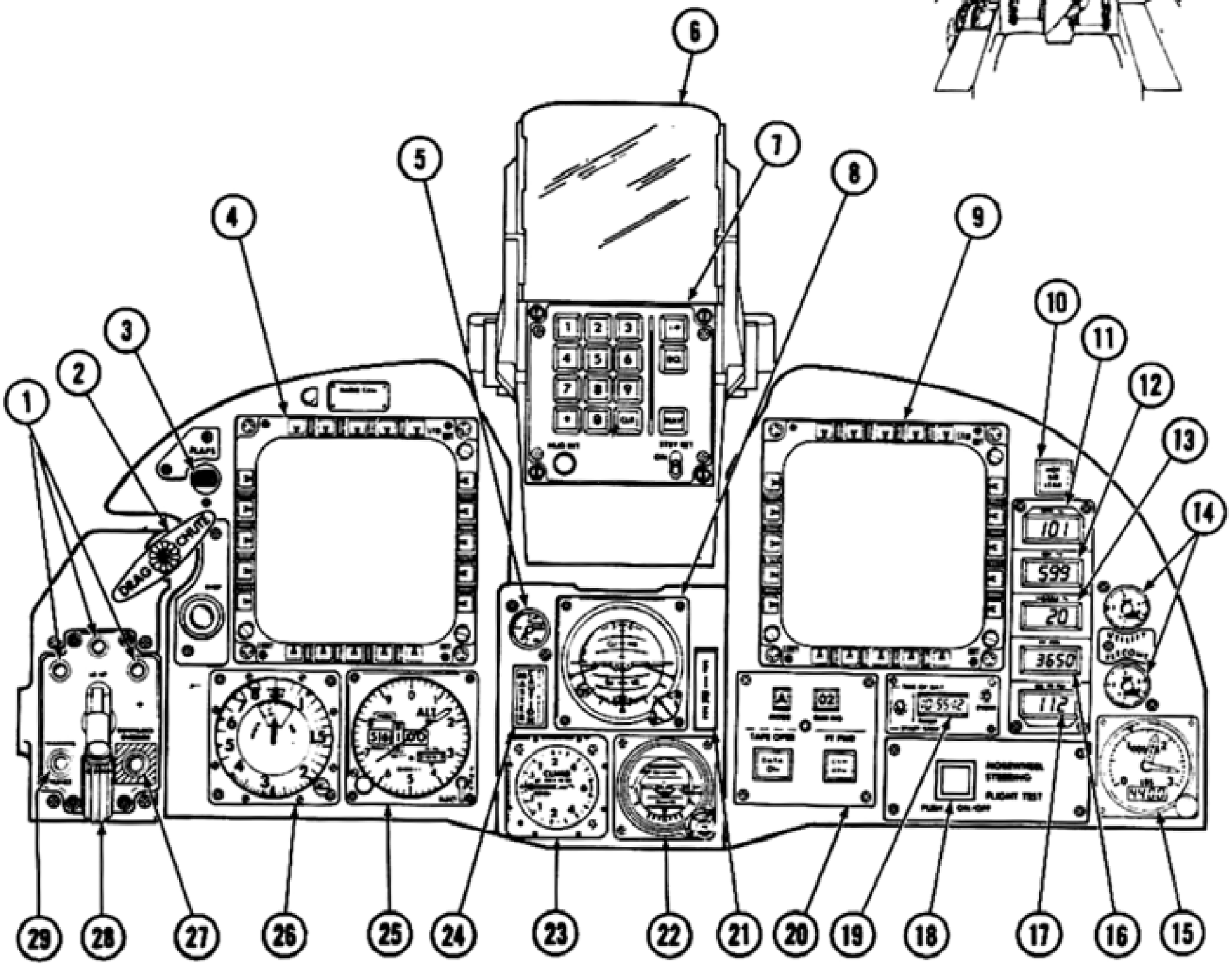
Figure 1-2.

INSTRUMENT PANEL (TYPICAL)





1 LANDING GEAR POSITION INDICATOR LIGHTS
2 DRAG CHUTE T-HANDLE
3 FLAP INDICATOR
4 LEFT DIGITAL DISPLAY INDICATOR
5 PITCH STICK TRIM INDICATOR
6 HUD
7 DATA ENTRY PANEL
8 ALTERNATE ATTITUDE INDICATOR
9 RIGHT DIGITAL DISPLAY INDICATOR
10 HOT AIR LEAK LIGHT
11 ENGINE TACHOMETER
12 EXHAUST GAS TEMPERATURE INDICATOR
13 NOZZLE POSITION INDICATOR
14 HYDRAULIC PRESSURE INDICATORS
15 FUEL QUANTITY GAGE
16 FUEL FLOW INDICATOR
17 OIL PRESSURE INDICATOR
18 NOSEWHEEL STEERING BUTTON/LIGHT
19 CLOCK
20 DATA CONTROL/ALPHANUMERIC DISPLAY
21 FIRE WARNING LIGHT
22 STANDBY ATTITUDE INDICATOR
23 VERTICAL VELOCITY INDICATOR
24 MASTER CAUTION LIGHT
25 ALTIMETER
26 AIRSPEED-MACH INDICATOR
27 GEAR DOWNLOCK OVERRIDE BUTTON
28 GEAR LEVER
29 GEAR AND FLAP WARNING SILENCE BUTTON

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Figure 1-3.

VERTICAL PANELS (TYPICAL)

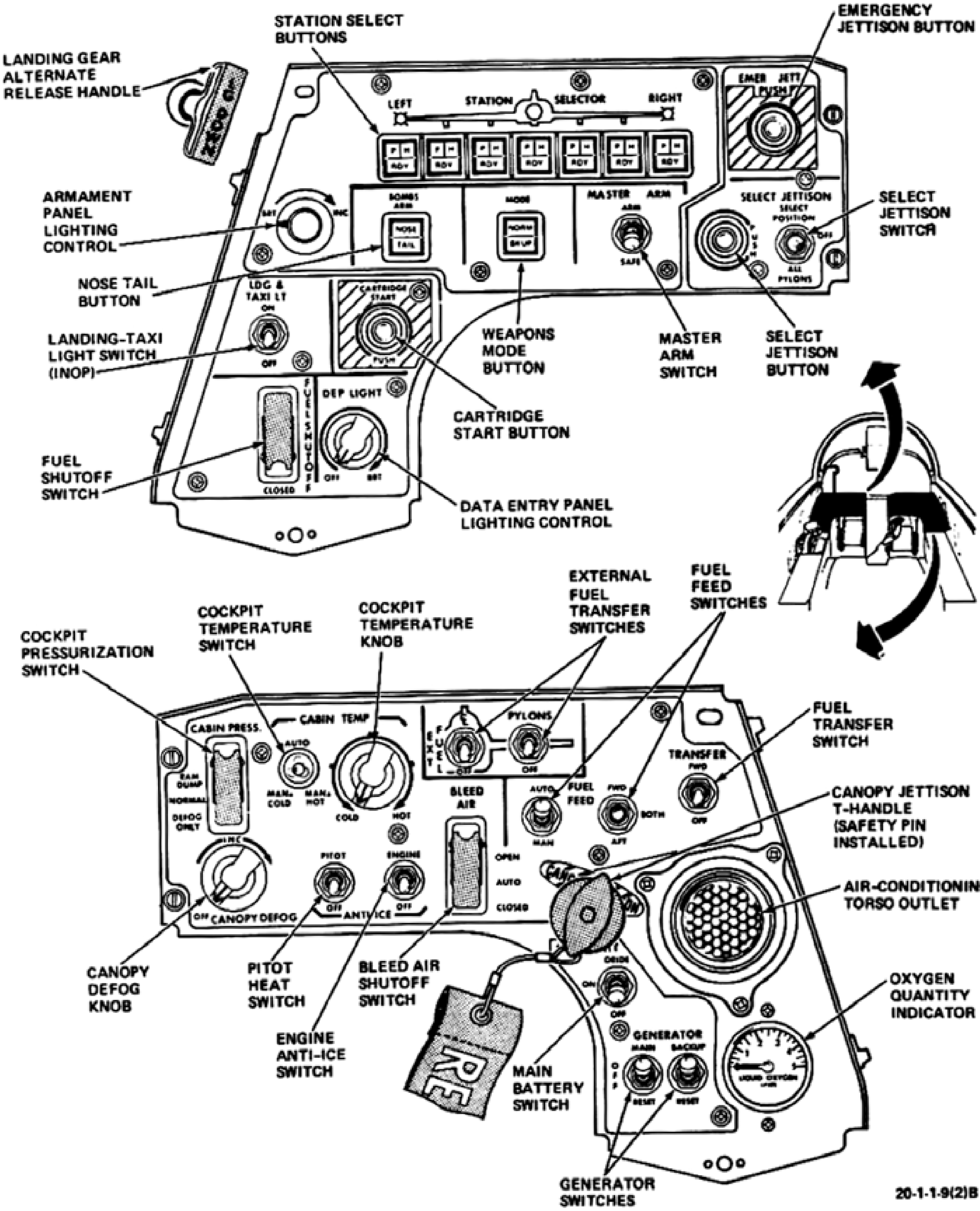


Figure 1-4.

CONSOLES (TYPICAL)

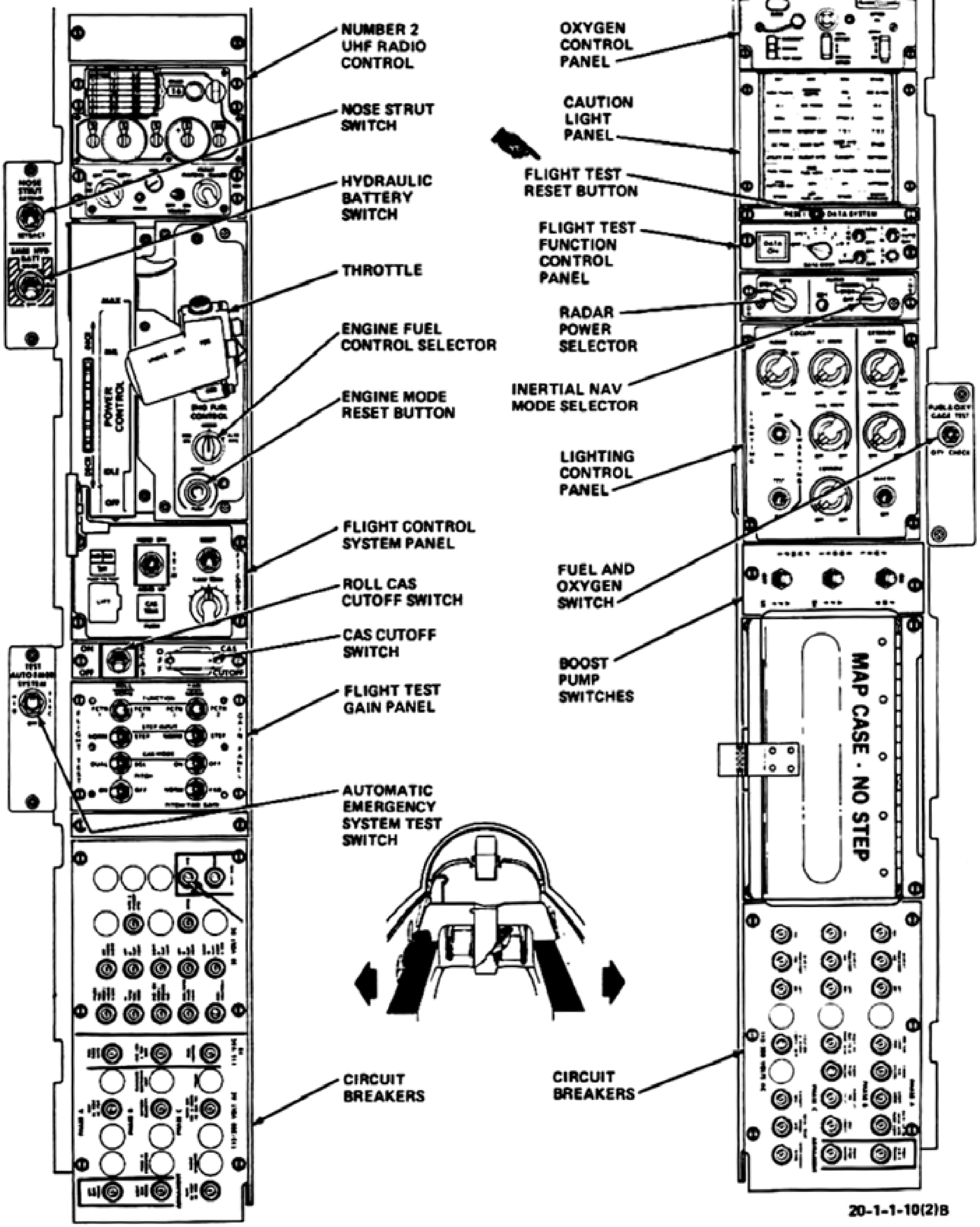
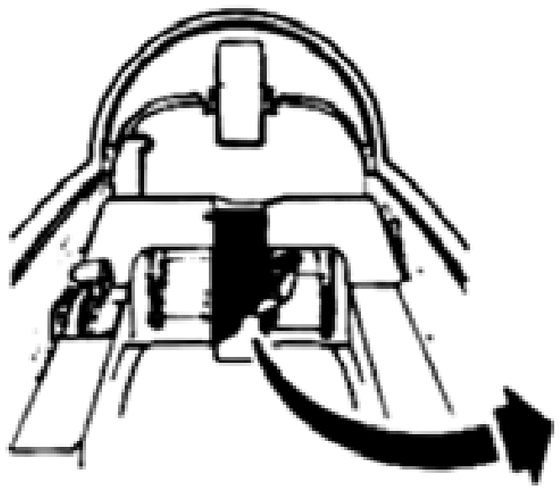


Figure 1-5.

PEDESTAL (TYPICAL)



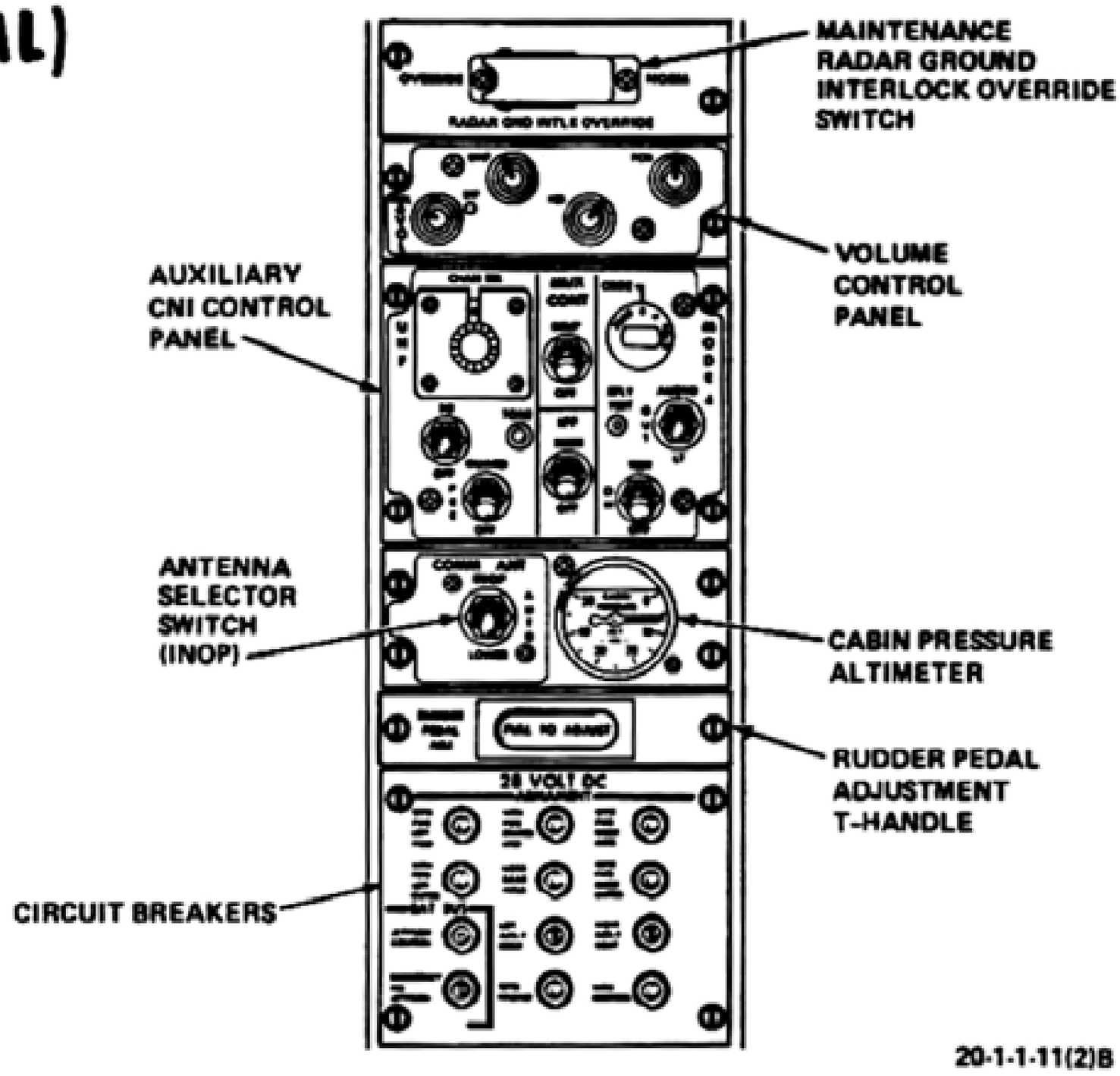


Figure 1-6.

ENGINE

The 17,000 pound thrust YF404-GE-100 engine (figure 1-7) is a low bypass thru-flow turbofan with afterburner. Notable engine features are: excellent throttle response, high durability following foreign object ingestion, high resistance to stall/flameout, high tolerance to inlet airflow distortion, high thrust-to-weight ratio, and low specific fuel consumption. A three stage fan is connected to a single stage turbine thru the hollow compressor shaft to form a rotor mechanically independent of the compressor rotor. The compressor rotor, consisting of a seven stage compressor and a single stage turbine, is located between the fan and the fan turbine. Both the fan and compressor employ variable inlet guide vanes. Fuel and compressor discharge air are mixed and ignited in the combustion chamber. Approximately one third of fan discharge air is bypassed to the afterburner for combustion and cooling. A hydraulically-actuated variable exhaust nozzle is automatically positioned to modulate thrust. Throttle position, compressor discharge pressure, fan and compressor inlet temperature and rpm, altitude and Mach are parameters that are integrated by the main fuel control (MFC) and the digital electrical control unit (ECU) to control normal, starting and afterburner (AB) fuel flow, rpm, and inlet guide vane and nozzle positioning. The compressor turbine rotor drives the engine gearbox. The engine gearbox powers oil pumps, nozzle power unit, engine alternator, aircraft backup generator, engine driven fuel pump, MFC, flight control hydraulic pump, and the AB fuel control and pump.

The engine gearbox drives an airframe mounted accessory gearbox (AMAG) that contains the main generator, utility hydraulic pump, and air turbine starter (ATS). The ATS provides starting torque to the engine when powered by external air on the ground or inflight by the cartridge start mode. Alternate engine control features and redundancy are provided for electrical control, MFC, fan variable geometry, nozzle operation, throttle linkage, and main combustor ignition. These features greatly enhance engine control system reliability by compensating for engine component malfunctions to cause the engine to transfer into a high partial thrust condition instead of experiencing a greater loss of power.

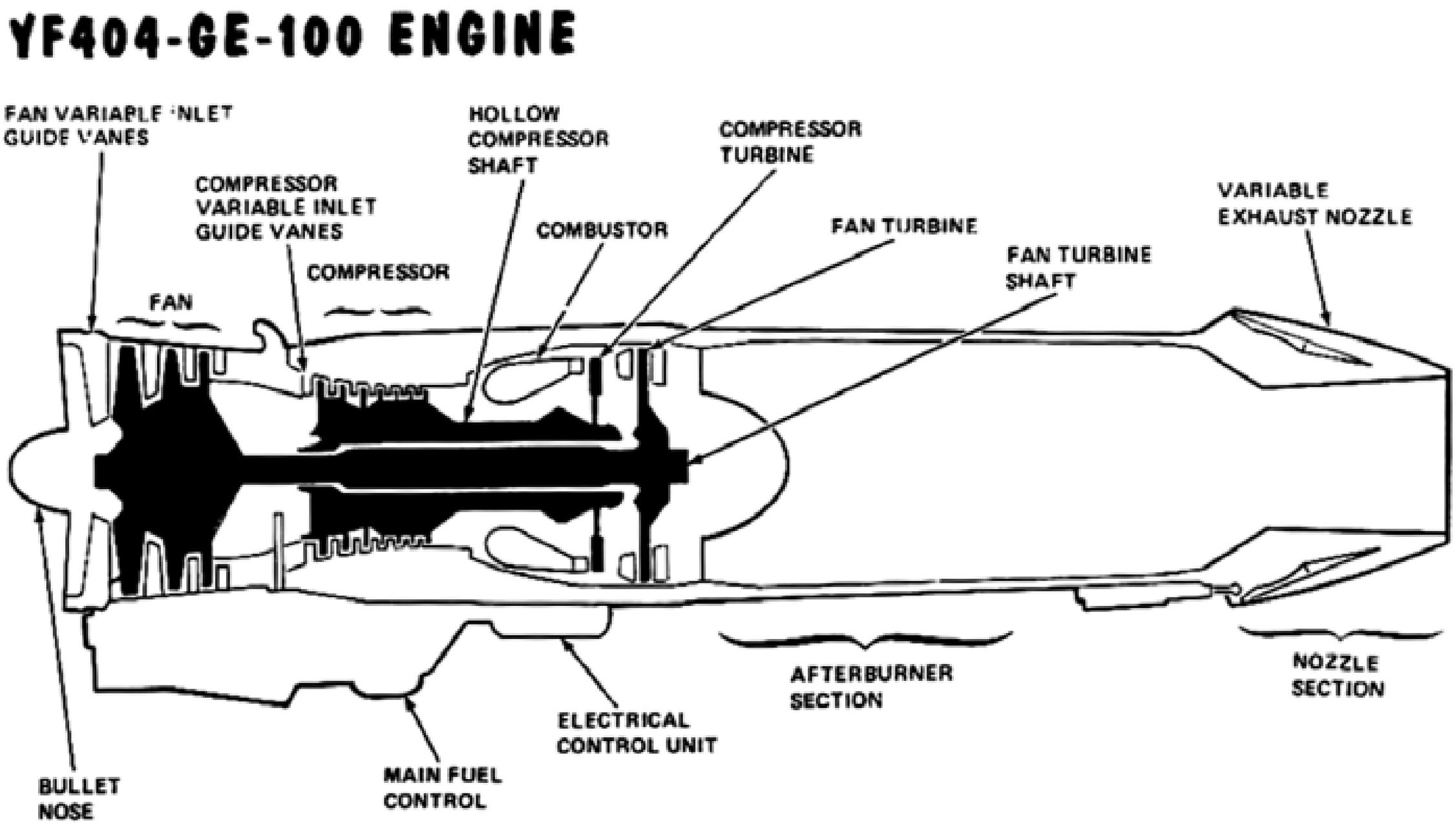


Figure 1-7.

ENGINE AIR INDUCTION SYSTEM

The air induction system consists of two fixed geometry, D-shaped inlets joined internally. The inlets have nine-degree vertical ramps that stand off from the fuselage to prevent boundary-layer ingestion at all design airspeeds and provide inlet stability at high supersonic airspeeds.

ENGINE CONTROL SYSTEM

Normal engine control system operation is provided by coordinated functioning of the MFC, ECU, and AB fuel control. The system schedules fan rotor speed, compressor rotor speed, fan and compressor, variable inlet guide vanes, exhaust nozzle, exhaust gas temperature (EGT), and AB fuel flow. The system also limits maximum fan speed, EGT, and compressor discharge pressure. Throttle movement is mechanically transmitted to the MFC. The MFC functions provide engine starting fuel, speed governing below MIL, acceleration/deceleration fuel scheduling, compressor variable inlet guide vanes, and compressor minimum discharge pressure limiting. Scheduling of nozzle, fan variable inlet guide vanes and AB fuel flow are MFC/ECU functions.

Main Fuel Control

The hydromechanical/electrical MFC is attached to the engine driven fuel pump. The main function of the MFC is to provide regulated fuel flow to the main engine combustor to power the engine. Below MIL power the MFC schedules compressor speed and fuel as a function of throttle position, compressor inlet temperature, and compressor discharge pressure. At MIL power and above, the ECU controls fan speed and EGT, and the MFC schedules compressor variable inlet guide vanes and provides the AB permission signal. In AB operation the ECU schedules AB fuel flow in response to throttle position. The MFC also provides a compressor rpm (also NH or N2) lockup that holds the compressor at near MIL power rpm if throttle is retarded when aircraft airspeed is above 1.4 Mach.

Throttle

The throttle (figure 1-8) is mechanically connected to the MFC, and is electrically connected to the ECU. A friction wheel increases or decreases throttle friction. A throttle disconnect lever on the throttle quadrant below the throttle permits mechanical disconnect of the throttle from the engine power lever. The throttle quadrant has positive stops at OFF, ground/flight IDLE, and MAX. Detent stops are provided for MIL power and minimum AB settings. Inflight, the idle stop is moved forward to the flight idle position. The throttle must be moved outboard and aft of IDLE to be retarded to OFF. The AB is initiated by advancing the throttle forward of the MIL power detent. Throttle grip switches control; flaps, speed brakes, microphone, missile cage/uncage, chaff/flare release, A/G mode select, target designate, undesignate, and radar antenna elevation. Unless throttle is disconnected, throttle position is sensed electrically by the ECU in alternate MFC mode. Throttle OFF position stops engine fuel flow and disables ignition and the dc boost pump.

THROTTLE DISCONNECT LEVER

In the event of a jammed or broken throttle linkage at or above idle, full engine control can be regained by switching engine control to alternate MFC mode and then disconnecting the throttle from its mechanical linkage. The throttle is disconnected from its linkage by moving the throttle disconnect lever (figure 1-8) full aft.

NOTE

- After throttle disccnnect an increase in throttle friction may be necessary for the throttle to remain in a set position.
- With throttle disconnected it is necessary to use the fuel cutoff switch to shut down the engine.
- Do not attempt to reconnect the throttle linkage after inflight disconnect.

Electrical Control Unit

The digital ECU schedules/controls nozzle, fan variable inlet guide vanes, EGT, fan speed, AB fuel metering, main and AB ignition, and provides cockpit instrument signals for EGT and nozzle position. The ECU receives operating parameter signals from engine components and static pressure/Mach signals from the flight control air data unit. The ECU processes this data and outputs signals to control engine operation. The ECU is powered by the engine alternator.

THROTTLE QUADRANT

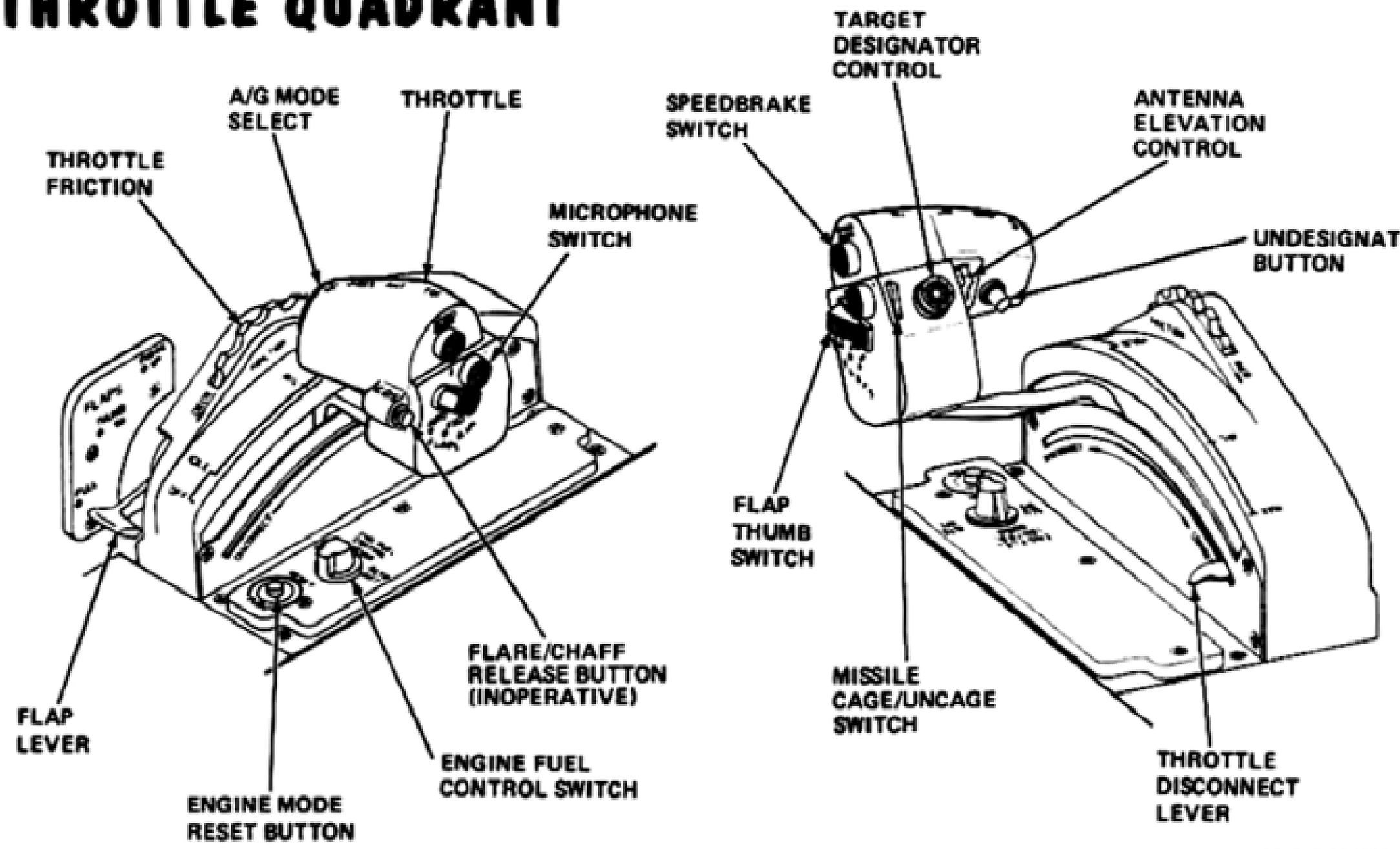


Figure 1-8.

ENGINE BLEED AIR SYSTEM

The engine bleed air system (figure 1-9) provides pressurized air to the hydraulic reservoirs, G-suit, external fuel tanks, canopy seal, precooler jet pump, engine bay cooling jet pumps, radar wave guide, and the environmental control system (ECS). Bleed air from the seventh compressor stage is routed thru a shutoff valve/pressure regulator to the precooler. Outside air passing thru the precooler reduces bleed air temperature. Dual loop temperature sensors can detect hot air leaks from the bleed air duct between the engine and the precooler. When the sensors detect high temperature the hot air leak light illuminates and bleed air is shutoff automatically. Bleed air may also be manually shutoff by the bleed air shutoff switch. Automatic actuation of the bleed air shutoff valve is checked by placing the warning test switch in the TEST position, which illuminates the hot air leak light. With the engine running the valve closes, the hot air leak light illuminates and cockpit air-conditioning/pressurization ceases. The valve is dc electrically actuated and pneumatically operated by bleed air.

Precooler

The precooler located at the base of the vertical stabilizer cools bleed air, main generator cooling oil, and AMAG cooling oil. Below 0.4 Mach and on the ground, the precooler is operated by a bleed air powered jet pump. Above 0.4 Mach an airspeed switch shuts off bleed air to the precooler jet pump, and the precooler operates by ram air only. The bleed air precooler jet pump valve is dc powered and opens when unpowered.

Bleed Air Shutoff Switch

The three position guarded switch (figure 1-9) on the right vertical panel is labeled BLEED AIR. Closing the red guard places the switch in its center AUTO position.

OPEN	Opens bleed air shutoff valve.

BLEED AIR SYSTEM

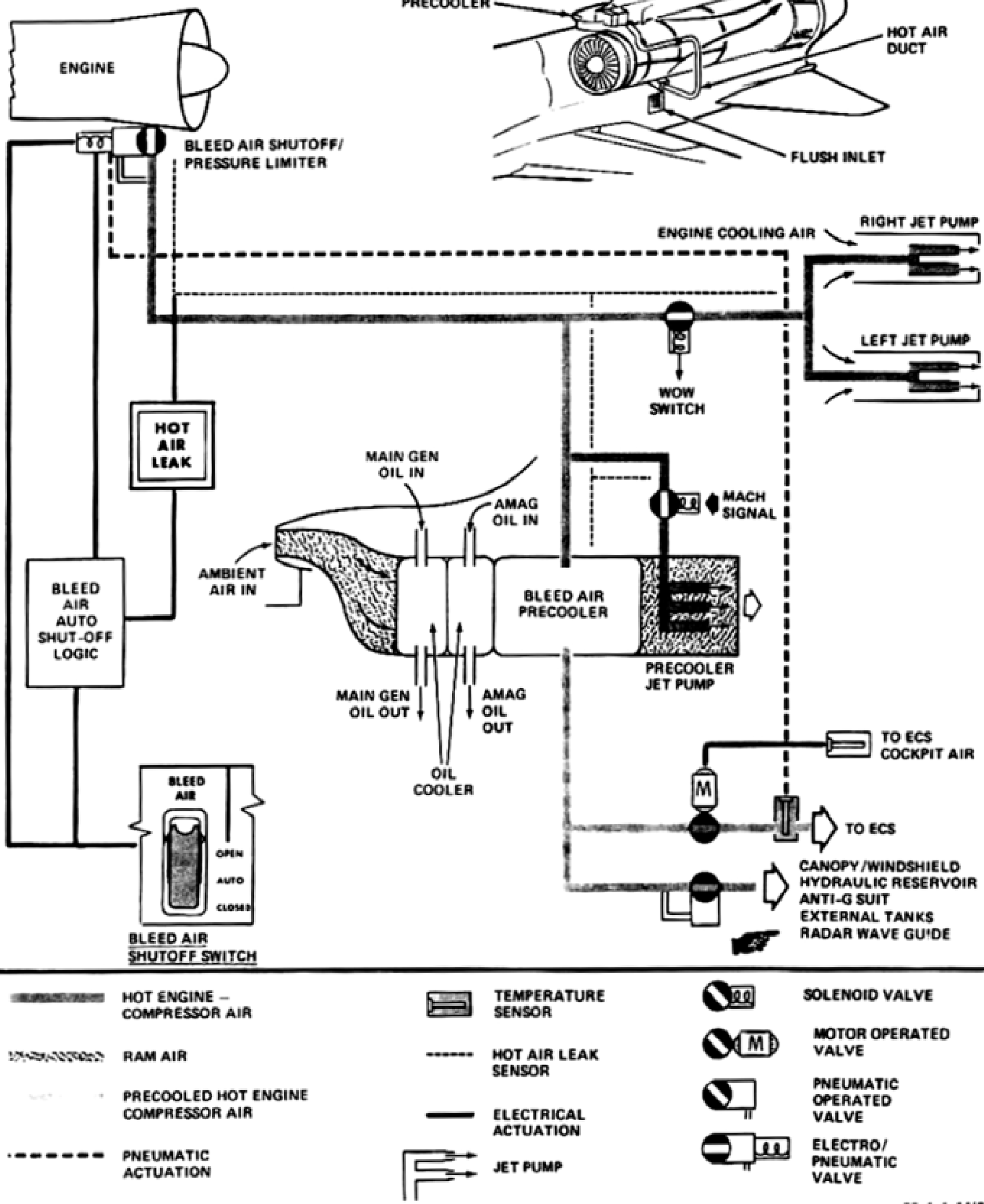


Figure 1-9.

AUTO	In AUTO mode bleed air shutoff valve closes if hot air leak is detected.
CLOSED	Bleed air shutoff valve closes.

Hot Air Leak Light

The light on the instrument panel labeled HOT AIR LEAK, illuminates when an excessive temperature is detected by sensors along the bleed air duct up to the precooler. The hot air leak detection circuit is checked by the warning test switch on the right console lighting control panel. System operation is indicated by illumination of the HOT AIR LEAK light.

ENGINE LUBRICATION SYSTEM

The engine has a self contained, pressurized closed-loop dry sump lubrication system. Oil pressure is monitored by a dc powered oil pressure indicator in the engine instrument group and by an oil pressure light on the caution light panel. See Engine Instruments and Engine Caution Lights, this section.

ENGINE FUEL SYSTEM

The major components of the engine fuel system are the fuel pump, MFC, oil cooler, fan and compressor variable inlet guide vane actuators, AB fuel pump and AB fuel control. Fuel is used for engine combustion and for ECU/oil cooling. Pressurized fuel operates the MFC servos and the fan and compressor variable inlet guide vane actuators.

AFTERBURNER SYSTEM

The engine is equipped with a fully modulated AB where additional fuel may be combusted to increase thrust. The AB fuel control is activated by the MFC and supplies metered fuel thru the AB fuel pump to the AB manifold and spraybars. A flame detector senses positive AB light off and provides a signal to the ECU to allow nozzle operation, permit more than minimum AB fuel flow, and stop ignition. The nozzle provides optimum thrust efficiency and maintains a controlled EGT.

ENGINE ANTI-ICE SYSTEM

Fourth stage compressor air is bled off and ducted through a dc powered valve to the anti-icing manifold on the engine. It is then distributed to the hollow inlet guide vane struts and to the bullet nose. The airflow then exits the struts and is directed toward each inlet guide vane. There is an approximate 5% reduction in thrust with anti-ice on. The anti-ice valve is fail safe to the open position when there is no dc power.

Engine Anti-Ice Switch

The two position switch (⑨ figure 1-10) is labeled ENGINE ANTI-ICE.

OFF	Engine anti-ice valve closed.
ENGINE	Engine anti-ice valve open.

Engine Anti-Ice Advisory Light

The light labeled ENG ANTI-ICE ON, located on the caution light panel, illuminates whenever the anti-ice valve is not fully closed.

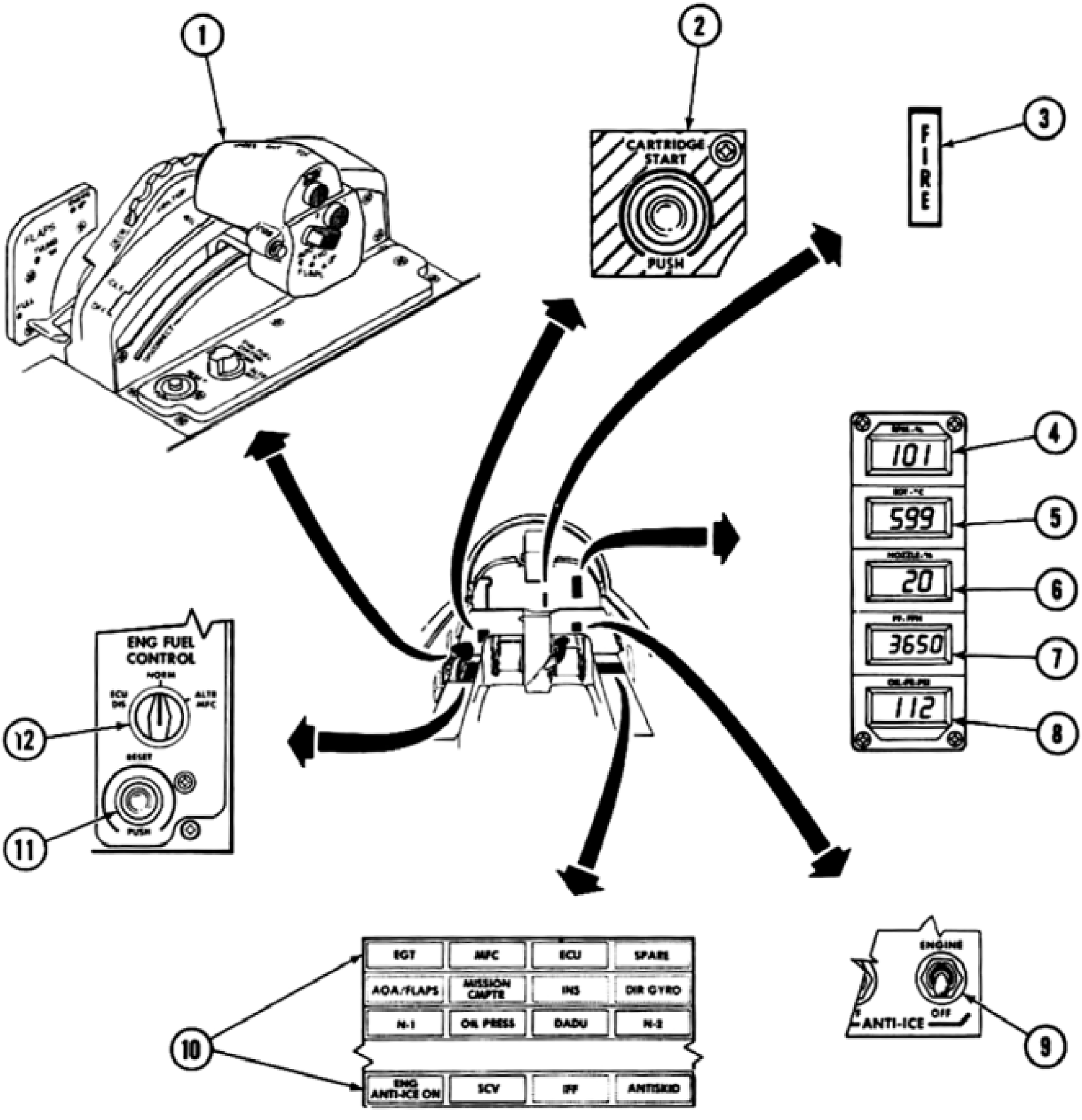
IGNITION SYSTEMS

Main ignition and backup ignition are separate systems without common components.

Main Ignition System

The main ignition has a main combustor igniter and an AB igniter that operate simultaneously. They are powered by the engine alternator. Main ignition for ground or air starts is activated when the throttle is advanced to idle or above and rpm is between 10% and 45%. Main ignition is also activated for AB lightoff, and ceases when lightoff is detected. An automatic relight capability is incorporated for main combustor flameout or AB blowout. With the throttle out of OFF position, the system activates ignition when rpm falls to 45%; or, when flameout or AB blowout logic is activated. Ignition is continuous until relight or until rpm drops below 10%. With AB power setting in the high half of AB range, the system senses AB blowout and activates ignition. Ignition is constant until relight or until throttle is moved out of AB range.

ENGINE CONTROLS/INDICATORS



1	THROTTLE	7	FUEL FLOW
2	CARTRIDGE START BUTTON	8	OIL PRESSURE
3	FIRE WARNING LIGHT	9	ENGINE ANTI-ICE SWITCH
4	TACHOMETER	10	ENGINE CAUTION LIGHTS
5	EXHAUST GAS TEMPERATURE	11	ENGINE MODE RESET BUTTON
6	NOZZLE POSITION INDICATOR	12	ENGINE FUEL CONTROL SELECTOR

20-1-1-15(2) B

Figure 1-10.

Backup Ignition System

Backup ignition is provided by a second combustor igniter powered by the static inverter. Backup ignition is activated thru a 40 second timer when engine rpm decays thru 60% and the throttle is out of the off position. The 40 second timer cycle can be restarted by retarding the throttle to OFF and then forward to IDLE. Backup ignition operates continuously after cartridge start activation, until 60% rpm. Ground test of the backup ignition can be made by starting the engine on backup ignition thru the backup ignition test switch.

BACKUP IGNITION TEST SWITCH

The backup ignition test switch, located behind the pilot's headrest, deactivates main ignition, activates backup ignition, and activates the dc boost pump when the throttle is at idle or higher. The fuel pressure caution light goes out when the dc boost pump runs. On aircraft main battery power the switch is momentary and must be held in the test position to actuate. With external power connected the switch is held in position by an integral dc holding solenoid. It then activates backup ignition thru the 40 second timer and continuous dc boost pump operation, when the throttle is out of OFF position. The switch is deactivated to the off position when the main aircraft generator comes on line or when external power is disconnected.

STARTING SYSTEM

Engine rotation for starting is provided by an air turbine starter (ATS) mounted on the AMAG. A power transmission shaft connects starting torque to the compressor rotor. The ATS is powered on the ground by externally supplied air pressure or by cartridge start in an inflight emergency.

Ground Start

Ground start is accomplished by directing air from an external start cart to the ATS while the dc bus is energized. The dc power unlocks the start control valve (SCV) thru the weight-on-wheels switch. Incoming air opens the SCV and turns the ATS. The SCV closes at 55% rpm or when air supply is stopped. The position of the SCV is monitored by the SCV caution light.

START CONTROL VALVE CAUTION LIGHT

The light on the caution panel labeled SCV, illuminates when the SCV is open. Cartridge start cannot power the ATS when the SCV is open. The SCV illuminates during normal ground start.

Airstart

After an engine flameout, ignition for restart is automatically initiated. Restarting the engine in flight can be accomplished by windmilling if sufficient altitude is available, or by activating cartridge start. Airstart is more probable below 25,000 feet. Engine rpm at or above 15% is required for windmill airstart. Cartridge start is capable of accelerating the engine up to 52% rpm. Alternate MFC shall be selected prior to airstart attempt, when MFC caution light is on. When airstarting in manually selected alternate MFC mode, reset the engine after rpm increases thru 25 percent.

Cartridge Start System

Liquid hydrazine from a sealed cartridge is converted into hot gas energy to power the ATS for airstart assist to increase the airstart envelope. When cartridge start is activated, pressurized nitrogen forces hydrazine into a catalytic chamber where it decomposes into hot gas.

The hot gas is ducted to the ATS to provide starting torque. Cartridge start is precluded from operation on the ground by a weight-on-wheels switch and a ground safety pin. Inflight activation is precluded when engine rpm is above 35%. After a successful restart, hydrazine flow is stopped by an rpm signal or when the main generator comes on line.

NOTE

Up to 30 seconds may be required before the engine produces usable thrust after cartridge start initiation from minimum rpm.

CARTRIDGE START BUTTON

Cartridge start is activated by pushing the momentary button (② figure 1-10) labeled CARTRIDGE START. When cartridge start is activated, and the throttle is at idle or higher, the dc boost pump and backup ignition are also activated. If the button is pushed with rpm higher than 35%, the cartridge will not fire and the button must be pushed again when rpm decreases below 35%.

HYDRAZINE LEAK DETECTOR

The hydrazine leak detector is a silicone base, mustard-orange colored disc visible forward of the starter air inlet door (㉖ figure 1-1). The mustard-orange will turn purple/black in the presence of hydrazine and/or its vapors, indicating a leak.

WARNING

Hydrazine and its fumes are toxic. Care must be taken to avoid inhalation of vapors, or contact with the skin.

ALTERNATE MODES OF ENGINE OPERATION

The engine incorporates design features, which compensate for critical engine component failures, to enable mission continuation or a safe return flight. There are two engine alternate modes that may activate automatically or may be manually selected: alternate MFC and ECU disable modes. Two other modes may individually activate automatically: rpm reset/nozzle closed mode and fan inlet guide vane flip flop mode. RPM reset/nozzle closed mode and flip flop modes are also submodes of ECU disable mode. When an automatic transfer to an alternate mode occurs, an ECU latching circuit may hold the system in the mode. When the system is in ECU disable as a result of rpm below 20%, the system does not latch.

Alternate Main Fuel Control Mode

In this mode, the ECU senses throttle position and actuates the metering valve in the MFC to control fuel flow to correspond with throttle position. This bypasses the mechanical throttle linkage and the hydromechanical computing section of the MFC. Alternate MFC mode compensates for hydromechanical failures in the MFC, compressor overspeed, fan overspeed, throttle mechanical linkage failure, or failure to release from compressor speed lockup. In this mode full engine power is available from IDLE to MAX; however, engine response to throttle movement is slower. Switchover to alternate MFC mode is automatic when the ECU senses MFC caused compressor overspeed, fan overspeed, or low fuel flow. Alternate MFC mode can be selected manually with the engine fuel control switch. If the engine is in automatic ECU disable mode or rpm reset/nozzle closed mode, alternate MFC mode is not available either thru automatic or manual selection. If the engine is in manually selected ECU disable mode, it can still switch into alternate MFC mode if the ECU senses high fan speed with a low fuel flow signal. If the engine is in rpm reset/nozzle closed mode, alternate MFC mode is not available. If throttle mechanical linkage fails in the MIL power range, AB is not available. If throttle linkage fails in AB range, there will be continuous minimum AB fuel flow even if the throttle is retarded below AB range, and AB relight may not be possible. At less than MIL power a white smoke trail may be emitted due to unburned minimum AB fuel flow. In alternate MFC, mode rpm lockup is disabled; therefore in this mode at speeds above 1.4 Mach, do not retard throttle below MIL power.

ECU Disable Mode

ECU disable mode allows partial power operation for certain critical failures in engine control. Thrust can be modulated between idle and approximately 90 percent of MIL thrust (corresponding to throttle positions, idle to minimum AB); however, engine response may be significantly slower. When operating in this mode engine fuel control becomes entirely hydromechanical and the two submodes (rpm reset/nozzle closed and flip flop modes) are

activated. ECU disable is selected manually by the engine fuel control switch or automatically by ECU fault detection logic. Automatic transfer into ECU disable mode results from ECU malfunctions, loss of engine alternator fan speed off-schedule, aircraft dc power loss, electrically caused nozzle failure, sensor failures, or flameout in manually selected alternate MFC mode. The closed nozzle in ECU disable restricts AB, when available. The reset compressor rpm (downward approximately three percent) prevents EGT or fan speed from exceeding limits. Manual ECU disable cannot be selected after the system has automatically transferred into alternate MFC. The system cannot transfer into ECU disable if the nozzle fails to the open position.

Compressor RPM Reset/Nozzle Closed Mode

RPM reset/nozzle closed mode allow safe engine operation after a failure causes fan speed or EGT to exceed scheduled values. When this failure logic activates, rpm decreases approximately three percent and the nozzle closes to the fully closed, zero percent position. Afterburner operation may not be possible but if it is available it is restricted to minimum AB. There are no reliable cockpit indications of AB operation in this submode.

Fan Inlet Guide Vane Flip Flop Mode

In the event of failure of normal positioning of the fully modulated fan variable inlet guide vanes, the ECU can place fan inlet guide vane positioning in flip flop mode. In this failure submode the fan inlet guide vanes are positioned fully closed or to a partially open position depending on rpm and compressor inlet guide vane angle. Flip flop mode is also a submode of ECU disable mode. In flip flop mode, idle to near MAX thrust is available. There is no significant cockpit indication of independent flip flop mode engine operation.

Engine Fuel Control Switch

The switch (⑫ figure 1-10) labeled ENGINE FUEL CONTROL has three positions and must be pushed downward to select ECU disable or alternate MFC.

ECU DIS	Places the engine in ECU disable mode of operation if logic permits.
NORM	Engine in normal mode of operation unless automatic switchover has occurred.
ALTR MFC	Places engine in alternate MFC mode of operation if logic permits.

Engine Mode Reset Button

The ECU latching circuit that holds the system in an alternate mode after an automatic transfer, may be momentarily released by pressing the engine mode reset button (⑪ figure 1-10). This allows engine control to transfer to the mode selected by the engine fuel control switch if the condition causing the auto transfer is no longer present. If the fault is still present the system cannot reset. Reset from flip flop mode may only be accomplished at idle power setting. The engine should be reset after any CAS reset or dc power interruption to insure continuous altitude/Mach input to the ECU. After an automatic engine mode transfer, engine reset should not be attempted unless operation is not suitable for continued safe flight.

PREFLIGHT OF ENGINE ALTERNATE MODES

Preflight check of ECU disable and alternate MFC modes can be accomplished as follows.

ECU Disable Mode

Set idle rpm in normal mode and note nozzle position and RPM. Switch to ECU disable and confirm the following:

RPM	Decreases 0.5% minimum.
NOZZLE	Decreases to 0%.
ECU (caution light)	On.
MASTER CAUTION LIGHT	On.

Switch to NORM and confirm nozzle and rpm increases to normal idle. Caution lights out.

Alternate MFC Mode

Set idle rpm in normal mode. Switch to alternate MFC and note the following:

RPM	Steady between 65% and 69%.

MFC (caution light)	On.
MASTER CAUTION LIGHT	On.

Increase throttle setting and confirm increased rpm.
Decrease throttle setting to idle.
Return mode switch to normal and note:

RPM	Returns to idle indication.
Caution lights	Out.

ENGINE INSTRUMENTS

The dc powered digital engine instrument group is located on the right instrument panel in a vertical column (figure 1-10). See section V for engine parameters.

RPM	The engine tachometer (④ figure 1-10) labeled RPM-%, displays compressor rpm.
EGT	The engine EGT indicator ⑤ is labeled EGT-°C.
NOZZLE	Nozzle position, in percentage open, is displayed on the indicator ⑥ labeled NOZZLE-%.
FUEL FLOW	Total engine fuel flow in pounds/hour, is displayed on the indicator ⑦ labeled FF-PPH.
OIL PRESS	Oil pressure in psi is displayed on the indicator ⑧ labeled OIL-PR-PSI.

ENGINE CAUTION/WARNING LIGHTS

Engine caution/warning lights advise the pilot of system degradation or malfunction, and are located on the caution light panel (⑩ figure 1-10).

LIGHT	CONDITION
DADU	See DADU failure, Section III.
ECU	Engine is in ECU disable mode. Illuminated whenever rpm is less than 20%.
EGT	Fan turbine EGT is over 900°C.
MFC	Engine is in alternate MFC mode.
N-1	Fan rpm is excessive.
N-2	Compressor rpm is excessive.
OIL PRESS	Oil pressure is too high or too low for existing engine operation.
SCV	Start control valve open.

FIRE/OVERHEAT DETECTION SYSTEM

The system consists of a fire warning/overheat light, detection/test circuitry and two sensing loops. The fire warning light (③ figure 1-10) labeled FIRE, provides a visual indication of a fire/overheat condition in the engine bay. The fire warning detection loops are checked by the warning test switch (see Warning, Caution and Indicator Lights, this section).

ENGINE OPERATING CHARACTERISTICS

YF404-GE-100

The engine has two EGT schedules, one for MIL and one for MAX power. The schedules vary as a function of fan inlet temperature and altitude. MAX power EGT may be up to 70°C higher than MIL power EGT.

YF404-GE-100A

The EGT schedules for MIL and MAX power are the same, and vary as a function of fan inlet temperature and altitude.

FUEL SYSTEM

The fuel system (figure 1-11) consists of internal and external tanks, three ac boost pumps, a dc boost pump, tank shutoff valves, float switches, a fuel transfer shutoff valve, fuel quantity indicator, fuel flow indicator, and caution lights. System control is thru external fuel transfer switches, fuel feed switches, boost pump switches, an internal fuel transfer switch and a fuel shutoff switch. Internal fuel is carried in five bladder-type fuselage fuel cells divided into a forward one cell tank and an aft four cell tank. A dc boost pump in the forward tank supplies fuel pressure for airstart. Inflight actuation of the dc boost pump is automatic and continuous when rpm is below 60% or when cartridge start is activated. A weight on wheels switch precludes operation of dc fuel pump on the ground except for ground test. Internal fuel feed is automatically sequenced to maintain desired cg limits, or manual fuel feed sequencing can be selected. Fuel transfer to the forward tank can be selected. Additional fuel may be carried in up to three jettisonable external fuel tanks. External fuel transfers to the internal system by engine bleed air pressure. The fuel system also has tank venting and capability of both pressure and manual fueling.

FUEL QUANTITY

Fuel quantity data for the internal and external fuel systems are shown in figure 1-12. Actual total weight of fuel depends on the specific gravity of the fuel.

EXTERNAL FUEL SYSTEM

External fuel is transferred to the internal system by selecting the PYLONS or centerline external fuel transfer switches, labeled EXT FUEL (④ ⑤ figure 1-13). When all three external tanks are carried, feeding sequence should be pylons first and then centerline. Prior to flight the pilot shall verify that the stores display matches the aircraft external fuel tank configuration. See Stores Display, this section.

Centerline External Fuel Transfer Switch

The switch (④ figure 1-13) labeled EXT FUEL - CL has two positions.

CL	Opens centerline external tank fuel shutoff valve, which allows bleed air pressure transfer of fuel to the internal system.
OFF	Closes centerline external tank fuel shutoff valve.

Pylon External Fuel Transfer Switch

The switch (⑤ figure 1-13) labeled EXT FUEL—PYLONS has two positions.

PYLONS	Opens both pylon tank fuel shutoff valves to allow transfer of fuel to the internal system.
OFF	Closes both pylon fuel shutoff valves.

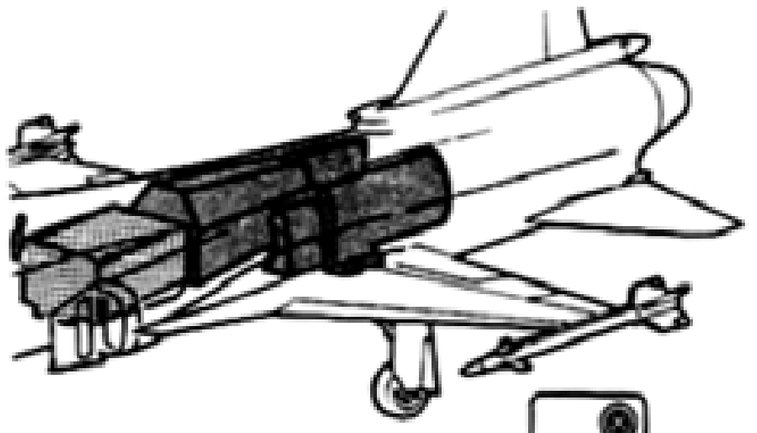
External Tanks Empty Light

The external tanks empty light on the caution light panel (⑭ figure 1-13) labeled EXT TANKS will be illuminated by float switches in selected tank(s). Placing the respective external fuel transfer switch OFF extinguishes the external tanks empty light. After pylon tanks are empty, the external tanks empty light on the caution panel illuminates to indicate transfer is complete. After pylon tank fuel transfer, the pylon tank fuel transfer switch must be deselected to allow re-illumination of the external tanks empty light when the centerline tank completes transfer. If a single wing pylon tank is carried, the external tanks empty light will not illuminate when the tank is thru feeding.

INTERNAL FUEL SYSTEM

Automatic fuel feed sequencing is provided when the fuel feed mode switch is in AUTO and all three boost pump switches are ON. With automatic sequencing selected and full internal fuel, feed schedule is 1500 pounds initially fed from the aft tank system followed by simultaneous feed from both forward and aft tanks to 150 pounds remaining in the aft tank. At this point, a 10-second and a 30-second time delays are activated. After 10 seconds the aft fuel low level caution light comes on. After 30 seconds the aft tank shutoff valve closes. The remaining forward fuel is then fed to the engine. At 700 pounds remaining in the forward tank a float switch causes the forward fuel low level caution light to illuminate. Manual fuel feed selection allows the pilot to schedule fuel feed. Manual selection is necessary to utilize the fuel remaining in the aft tank.

FUEL SYSTEM



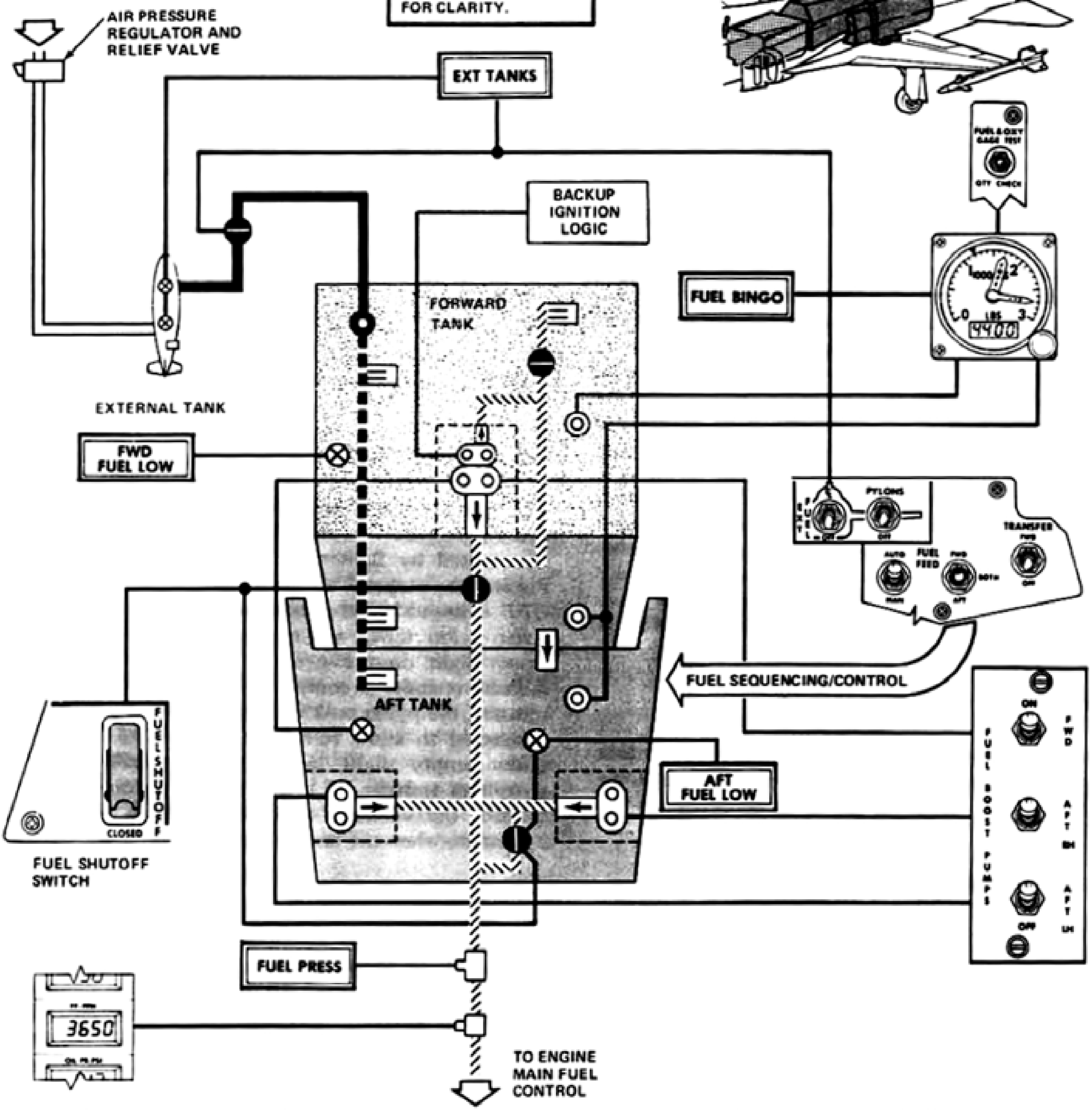
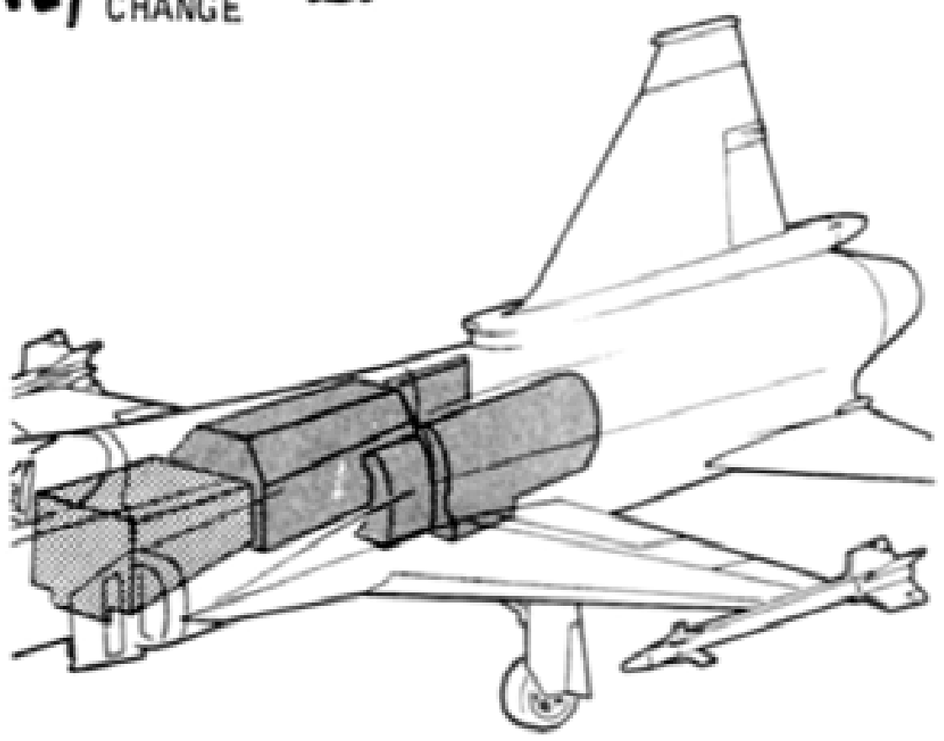


Figure 1-11.

FUEL QUANTITY DATA (TYPICAL) MAJOR CHANGE

	FULLY SERVICED		USABLE	
	GAL	LB	GAL	LB
INTERNAL FUEL				
TOTAL	664	4515	647	4400
FORWARD TANK	257	1747	250	1700
AFT TANK	407	2768	397	2700
EXTERNAL FUEL				
CL W/275 GAL	275	1870	273	1856
2 INBDS EACH W/260 GAL	524	3563	520	3536
MAXIMUM FUEL				
INTERNAL & CL W/275 GAL & 2 INBDS EACH W/260 GAL	1463	9948	1440	9792

(GI1002) SUBTRACT 300 LB USABLE FROM AFT TANK AND TOTALS, FOR FLIGHT TEST EQUIPMENT.



DATA BASIS

- CAPACITIES ESTIMATED FOR STANDARD DAY CONDITION.
- SINGLE-POINT REFUELING LEVEL RAMP ATTITUDE.
- JET A-1 OR JP-8 – 6.8 LB/US GAL.

20-1-1-17(1)B

Figure 1-12.

NOTE

If the last 150 pounds of fuel in the aft tank is manually sequenced, cavitation and engine fuel starvation could result from an ac power loss.

Fuel system controls and indicators are shown in figure 1-13.

Fuel Feed Mode Switch

The fuel feed mode switch ⑥ is a two position lever lock type, and is the left switch of two switches labeled FUEL FEED.

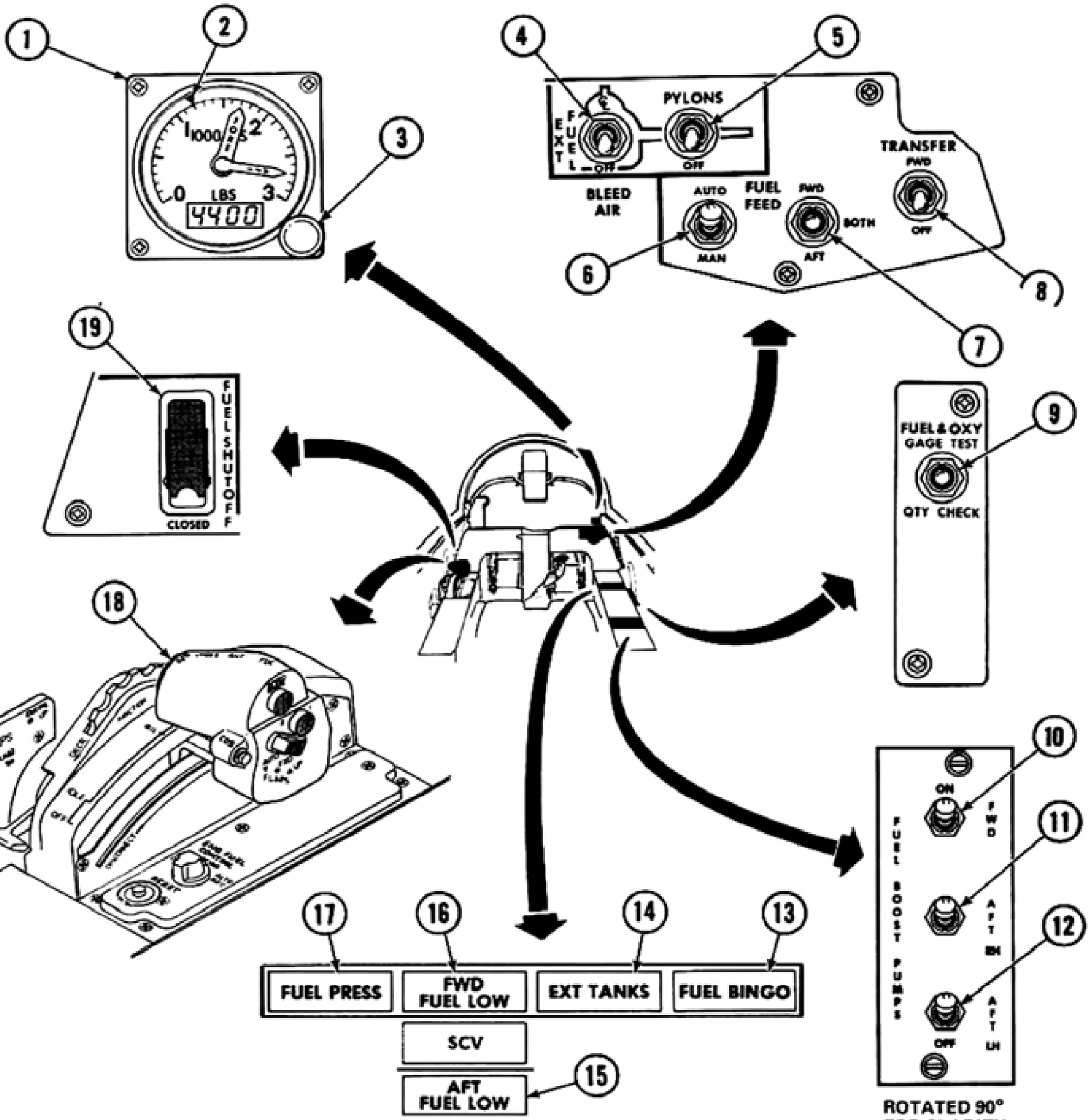
AUTO	Normal, automatic fuel feed in effect. Manual fuel feed selector switch de-activated. Pull out and up to AUTO position.
MAN	Activates manual fuel feed selector switch. Pull out and down to manual position.

Manual Fuel Feed Selector Switch

The manual fuel feed selector ⑦ is a three-position switch, which controls fuel feed when the fuel feed mode switch is in the manual position. This is the right hand switch of the two switches labeled FUEL FEED.

FWD	Fuel is fed to the engine from the forward tank only. Aft tank shutoff valve is closed.
BOTH	Fuel is fed from both tanks. Enables fuel transfer switch when fuel feed mode switch is at MANUAL.
AFT	Fuel is fed to the engine from the aft tank only. Forward tank shutoff valve is closed.

FUEL SYSTEM CONTROLS/INDICATORS



1 FUEL QUANTITY GAGE
2 BINGO SET BUG
3 BINGO FUEL SET KNOB
4 CENTERLINE EXTERNAL FUEL TRANSFER SWITCH
5 PYLONS EXTERNAL FUEL TRANSFER SWITCH
6 FUEL FEED MODE SWITCH
7 MANUAL FUEL FEED SELECTOR SWITCH
8 FUEL TRANSFER SWITCH
9 FUEL AND OXYGEN SWITCH
10 FORWARD BOOST PUMP SWITCH
11 RIGHT AFT BOOST PUMP SWITCH
12 LEFT AFT BOOST PUMP SWITCH
13 BINGO FUEL CAUTION LIGHT
14 EXTERNAL TANKS EMPTY LIGHT
15 AFT FUEL LOW CAUTION LIGHT
16 FORWARD FUEL LOW CAUTION LIGHT
17 FUEL PRESSURE CAUTION LIGHT
18 THROTTLE
19 FUEL SHUTOFF SWITCH

20-1-1-18(2)B

Figure 1-13.

WARNING

In manual forward or aft fuel feed, switch must be repositioned before selected tank is depleted or engine fuel starvation will result.

NOTE

In a low fuel state, in manual feed, forward and aft tanks should be maintained at approximately equal fuel levels.

Fuel Shutoff Switch

Fuel flow to the engine can be stopped by a two-position guarded emergency fuel shutoff switch ⑲ labeled FUEL SHUTOFF.

Normal	(Guard closed) Fuel tank shutoff valves are controlled by automatic fuel sequencing, and/or fuel feed switches.
CLOSED	(Guard open) Closes fuel tank shutoff valves, stopping fuel flow.

NOTE

The switch should be used only in an emergency as damage to engine driven fuel pump and main fuel control can occur.

Fuel Transfer Switch

In the event of a pitch control augmentation system (CAS) failure, it is desirable to move the cg forward. The fuel transfer switch ⑧ labeled TRANSFER, is provided for this contingency. Fuel feed mode switch must be in MANUAL and the manual fuel feed selector switch must be in BOTH. The solenoid-held fuel transfer switch automatically turns off when the aft tank reaches 150 pounds of fuel remaining or when the dc boost pump is energized.

FWD	Fuel transferred from the aft to the forward tank.
OFF	Transfer stops.

NOTE

After forward fuel transfer, fuel feed switches must be repositioned to prevent unwanted feed of the remaining fuel in the aft tank.

Boost Pump Switches

Boost pumps can be individually turned on or off by the three boost pump switches, figure 1-13. Each lever lock switch has two positions, ON (outboard) and OFF (inboard).

Boost Pumps Operational Check

Boost pumps can be checked by first turning off all three pumps, selecting manual/BOTH fuel feed and then individually turning on each boost pump. The fuel pressure caution light extinguishes to indicate selected boost pump operation. Between each boost pump selection it may take up to 15 seconds for the fuel pressure light to re-illuminate when boost pumps are off. After completion of check, turn on all (3) boost pumps and place fuel feed switches to AUTO/BOTH.

Fuel Pressure Caution Light

Failure of the boosted fuel feed system is indicated by the fuel pressure caution light ⑰, labeled FUEL PRESS. Illumination of this light indicates fuel feed is not in boosted flow. Only the engine driven fuel pump is operating. A ten second time delay is incorporated to prevent momentary light flashing due to pressure surges.

FUEL QUANTITY INDICATING SYSTEM

Fuel quantity indications are displayed by a fuel quantity gage, a bingo fuel light, and two fuel low level lights. The system displays internal fuel quantities only.

Fuel Quantity Gage

The dc powered fuel quantity gage ① has two pointers, which indicate fuel remaining in the respective tanks. The digital readout window indicates total internal fuel remaining.

Bingo Fuel Set Knob

The bingo fuel set knob ③ on the fuel quantity gage moves the bingo set bug ② to any setting between zero and 3000 pounds of fuel. When total internal fuel reaches the value selected, the bingo fuel caution light illuminates.

Bingo Fuel Caution Light

The light on the caution panel ⑬, labeled FUEL BINGO, illuminates to indicate internal fuel remaining is at the value selected by the pilot with the bingo fuel set knob.

Fuel Low Level Caution Lights

FORWARD FUEL LOW LEVEL CAUTION LIGHT

The light on the caution panel labeled FWD FUEL LOW ⑯ indicates fuel remaining in forward tank is 700 pounds or less.

AFT FUEL LOW LEVEL CAUTION LIGHT

The light on the caution panel labeled AFT FUEL LOW ⑮ indicates fuel remaining in aft tank is less than 150 pounds.

Fuel and Oxygen Switch

The switch ⑨, labeled FUEL & OXY, has three positions and is springloaded to the center. Rotation of the oxygen quantity indicator pointer provides an operational check of the inverter on the ground or in flight. The oxygen caution light illuminates when the pointer reaches 0.5 liter.

GAGE TEST	Forward and aft fuel tank quantity pointers and totalizer go to half scale. Oxygen quantity pointer decreases to zero.
Center	Neutral position, nonfunctional.
QTY CHECK	Indicates forward, aft, and total internal fuel quantities, and oxygen quantity.

FUELS

The YF404-GE-100 engine is designed to perform throughout the flight envelope using JP-4, JP-5, or JP-8 fuels provided the fuel density adjustment is set for the respective fuel.

FUEL VENTING

Fuel may vent overboard while transferring fuel from external tanks if a fuel level shutoff valve has failed. External fuel transfer should not be attempted on the ground when either internal tank is full.

WARNING

Fuel venting during ground operation is a fire hazard.

If fuel venting occurs on ground or in flight, discontinue fuel transfer from external tank(s) until fuel quantity indicator indicates less than total capacity. If in a climb, level aircraft and do not climb to a higher altitude until internal fuel quantities have been reduced.

JETTISON SYSTEM

The jettison system (figure 1-14) provides selective and salvo jettison of pylon carried stores, selective jettison of wingtip stores and salvo jettison of pylons. The system is powered by the essential dc bus or the battery. Controls consist of an emergency jettison button, and a select jettison switch and button. Seven station select buttons are used when selective jettison is required. Stores and pylons (if jettisonable) can be jettisoned on the ground, or in flight with gear up or down regardless of battery switch position.

EMERGENCY JETTISON BUTTON

The button (figure 1-14) labeled EMER JETT is a press momentary type and is hot at all times.

PUSH	Salvo-jettisons stores from all pylons.

JETTISON SYSTEM

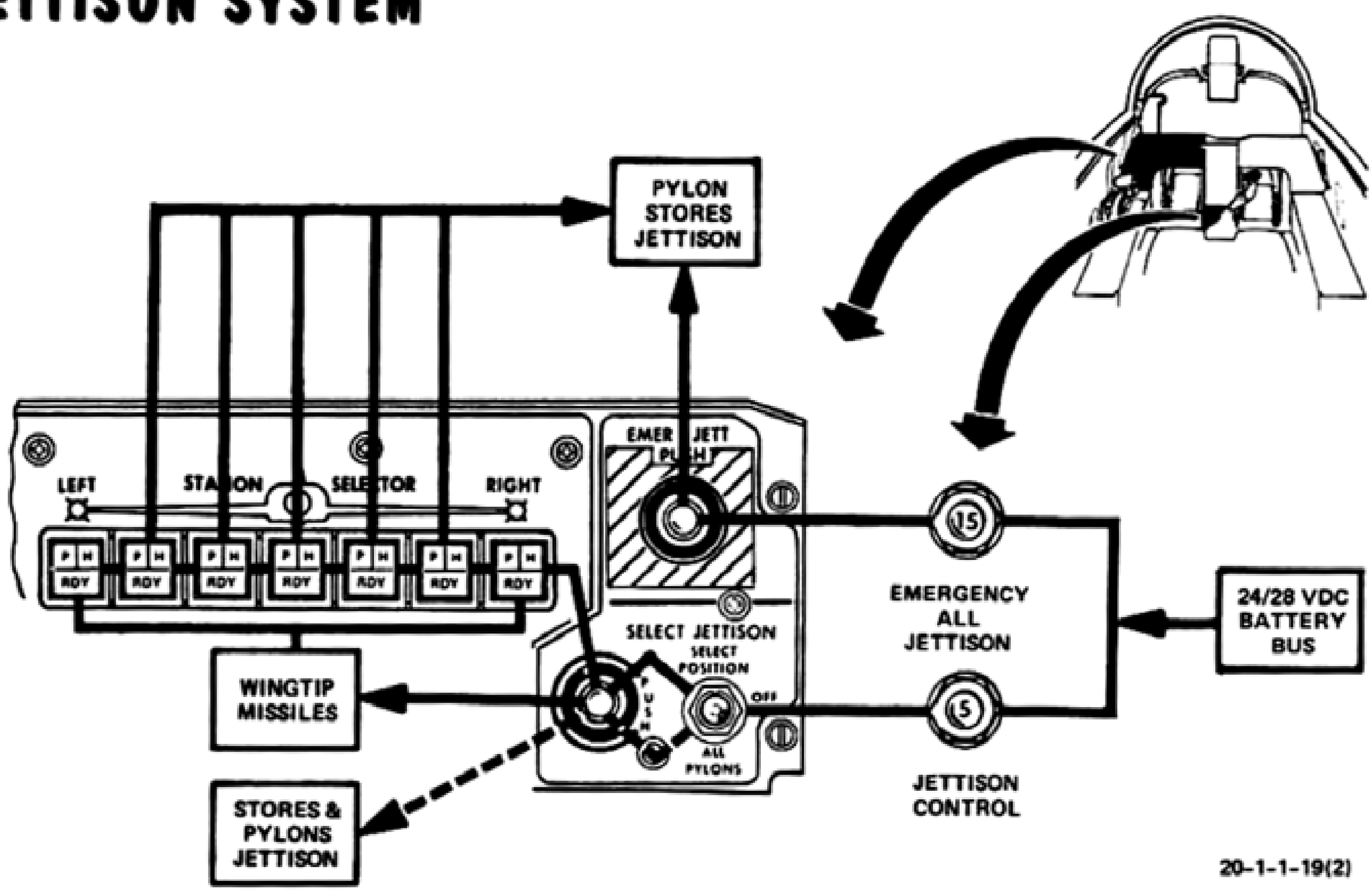


Figure 1-14.

SELECT JETTISON SWITCH AND BUTTON

The switch labeled SELECT JETTISON has three positions.

OFF	Disconnects electrical power to select jettison circuits.
SELECT POSITION	(Pull out and up) Completes jettison circuits to pylons and wingtips selected by station select buttons.
ALL PYLONS	(Pull out and down) Completes jettison circuits to all pylon stores and pylons.

The button labeled SELECT JETTISON is a press momentary type.

PUSH	With select jettison switch up, jettisons stores from selected station(s) (ready light illuminated). With switch down, jettisons stores from all pylons, followed by jettison of all pylons (if jettisonable).

STATION SELECT BUTTONS

The seven station select buttons are labeled STATION SELECTOR. The five pylon station, and two wingtip station select buttons are selective jettison switches. With the select jettison switch at SELECT POSITION, pressing any or all station select buttons illuminates the respective ready light (RDY) and completes the jettison arming circuitry to the selected station(s).

When wingtip station jettison is selected, the missile rocket motor fires conventionally. The missile remains unarmed, and flies an unguided trajectory.

ELECTRICAL SYSTEM

Electrical power is supplied by an ac (figure 1-15) and a dc (figure 1-16) system. A flight test power system supplies power exclusively to flight test systems. External ac power can be supplied to the aircraft thru a power receptacle. A main or a backup generator can supply ac power when the engine is operating. In flight an emergency static inverter supplies essential ac power when both generators are inoperative. Two transformer rectifiers supply dc power to normal aircraft systems. A third transformer rectifier supplies dc power exclusively to flight test systems. Essential dc power can be supplied by the main battery. The hydraulic battery supplies only the emergency hydraulic pump motor (see Hydraulic System, this section). A flight test battery supplies flight test dc power when not being supplied by the flight test transformer rectifier. Cockpit circuit breaker panels are shown in figures 1-18 and 1-19.

AC POWER SYSTEM

AC power is supplied by the main 40KVA 400 Hz generator which receives engine torque from the airframe mounted accessory gear box. There is also a backup 5KVA 292 to 480 Hz generator on the engine gear box. Both generators produce 115/200-volt three-phase power. The main generator normally carries the full electrical load, supplying the four ac buses and the dc system through the transformer rectifiers. Control of ac power is through the main and backup generator switches. Operation is monitored by two generator lights on the caution panel.

Generator Protective Circuits

Each generator has a protective circuit which will switch it off line if unacceptable power is sensed. Failure of main generator monitoring circuit will trip the respective warning flag on the engine temperature cycle counter (ETCC). The ETCC is located on the cockpit aft shelf.

Static Inverter

Inflight a static inverter automatically powers the essential ac bus when both generators are off line. The inverter receives 24-vdc battery power and converts it to 115-vac 400 Hz. On the ground with battery only, the inverter is activated when the fuel and oxygen switch is held at GAGE TEST or QTY CHECK position. Automatic functioning of the static inverter is checked on the ground with engine running or external power connected, by positioning the automatic emergency system test switch to ELEC and observing the AC PWR caution light. If the light illuminates, the inverter or its circuitry is faulty. A manual backup for inflight activation of the inverter is provided by the override position of the main battery switch.

DC POWER SYSTEM

DC power is normally supplied by two 100 ampere transformer-rectifiers (TR), which receive their ac power from the No. 2 main ac bus. Each TR can power all dc buses when the main generator is on line and can power the essential dc bus when the backup generator is on line. Two lights on the caution panel monitor TR functioning. The main battery provides power to the essential dc bus upon engine flameout or upon loss of both TRs. The hydraulic battery can provide power to the emergency hydraulic pump motor to power the flight control hydraulic system during an engine flameout and allow time for accomplishment of airstart procedures. The hydraulic battery is connected to the dc essential bus for charging only. The essential dc bus powers the automatic and manual emergency hydraulic pump turn on circuitry. Both the main and hydraulic batteries are protected by automatic overheat detection circuitry to prevent overcharging. Each battery has a separate control switch and each is monitored by separate lights on the caution panel.

Flight Test Power System

Flight test dc power is normally supplied by a 100 ampere transformer-rectifier which receives ac power from the No. 1 main ac bus. A 13-ampere hour flight test battery provides dc to flight test systems when no power is received from the flight test transformer-rectifier. Switchover to battery power is automatic when flight test transformer-rectifier ceases functioning. Flight test systems receive dc power thru the flight test data mode selector. A flight test power light monitors dc power to flight test systems.

AUTOMATIC EMERGENCY BACKUP SYSTEM

Following a flameout both generators are automatically disconnected from the ac buses, at 58% rpm for the backup and 55% for the main. The main battery then assumes the full load of the

AC POWER SYSTEM

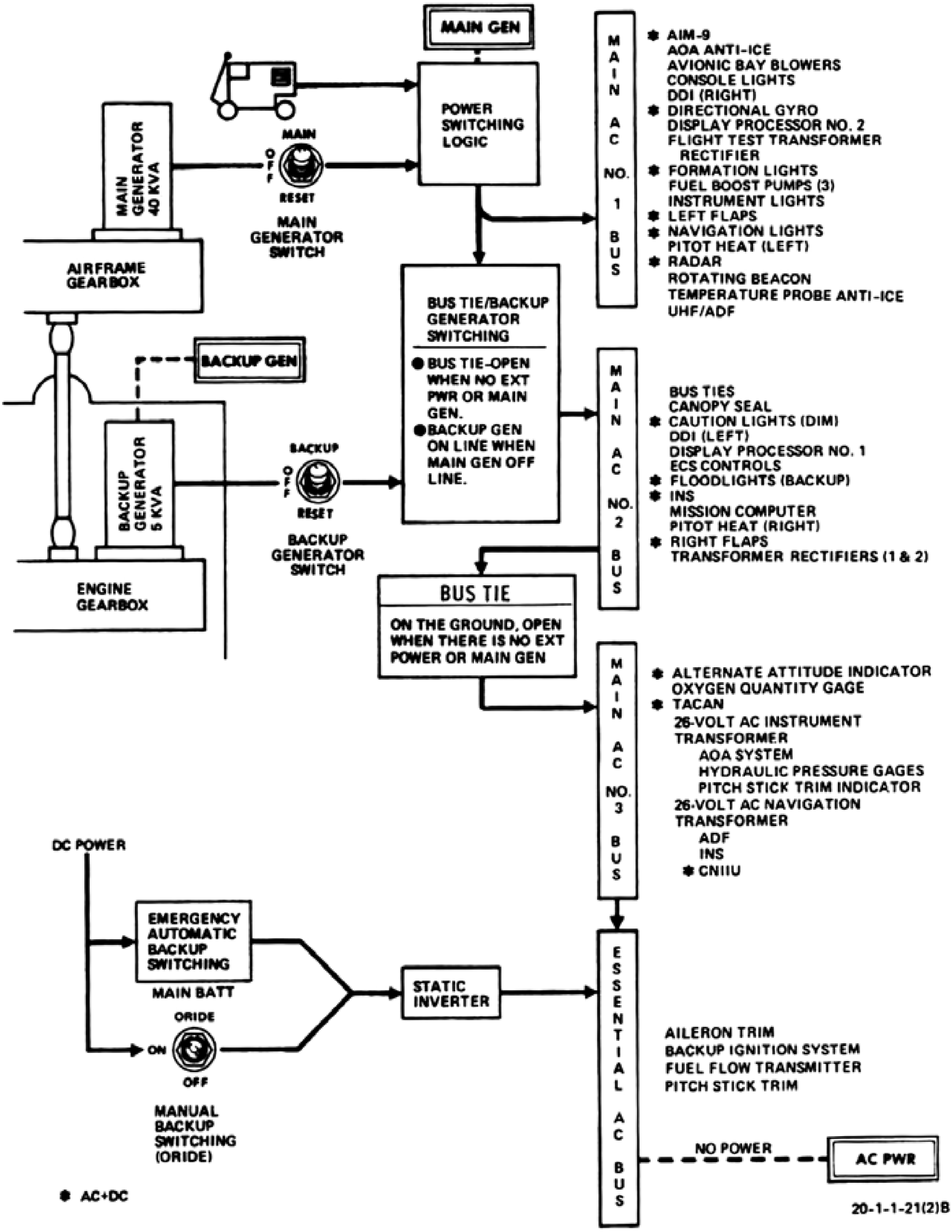


Figure 1-15.

DC POWER SYSTEM

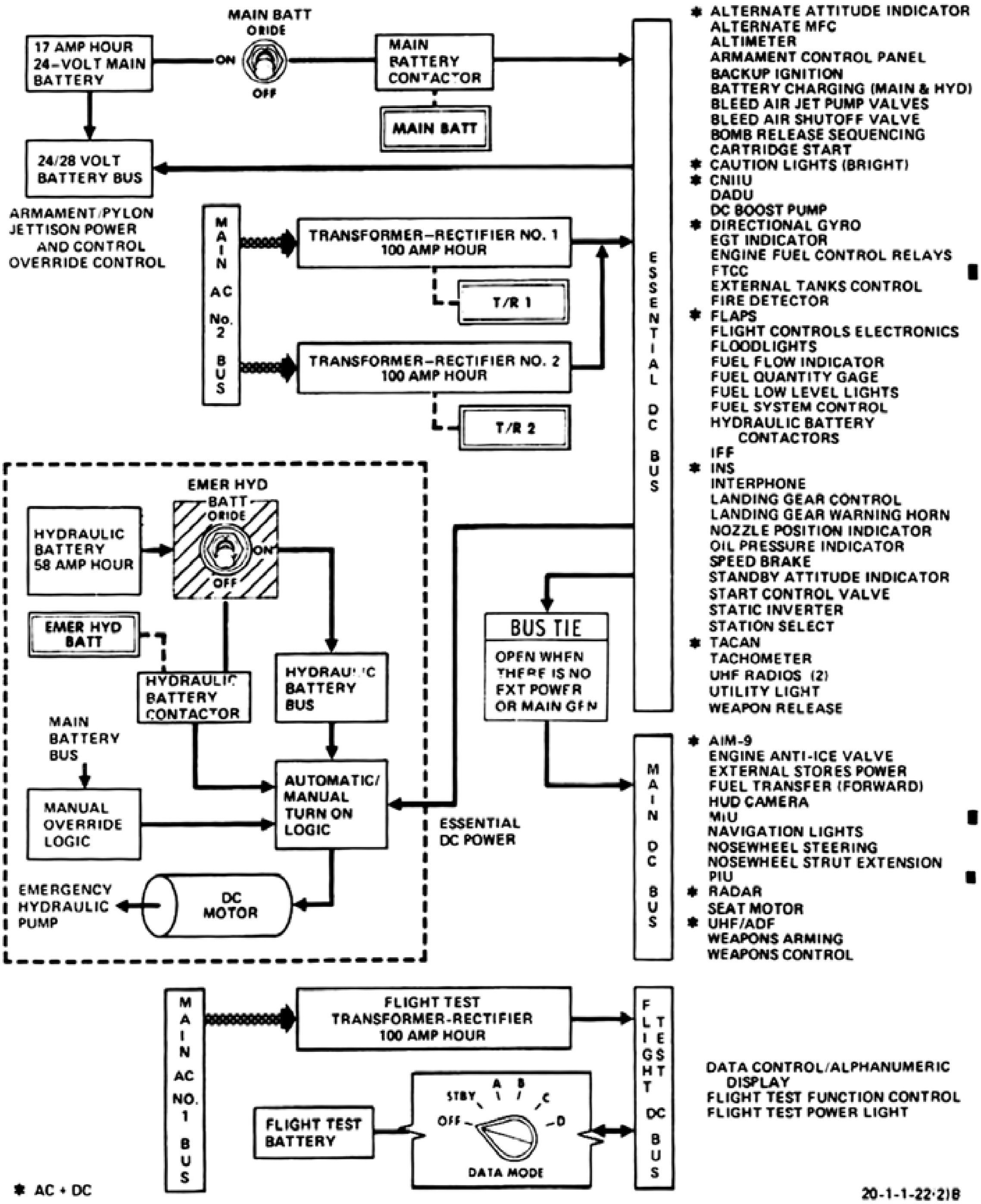


Figure 1-16.

essential dc bus. Automatic turn on circuitry to the emergency hydraulic system is powered by the dc essential bus. When engine rpm drops to 20%, automatic turn on circuitry turns on the emergency hydraulic pump motor. After engine restart the emergency hydraulic system turns off automatically as rpm increases above 20%. At 58% the main generator will come back on line and energize all buses, extinguishing the generator caution light. As rpm increases thru 61% the backup generator signals acceptable power to the backup generator control unit, which will extinguish the backup generator caution light.

MANUAL EMERGENCY BACKUP SYSTEM

In the event the automatic systems fail to function, manual switching is available to energize the essential dc bus, turn on the static inverter, and the emergency hydraulic pump with the override positions on the respective battery switches. If an engine flameout occurs with a failed main battery, windmill rpm must be maintained by airspeed indication to assure hydraulic power to the flight controls. With the main battery failed, emergency hydraulic automatic and manual turn on are not available. In this condition only windmill airstart is available as cartridge start is disabled. Ignition for windmill airstart with the main battery dead is provided by the engine alternator.

ELECTRICAL SYSTEM CONTROLS/INDICATORS

Location of electrical system controls/indicators are shown in figure 1-17.

Hydraulic Battery Switch

This three position lever lock switch is labeled EMER HYD BATT ①.

ORIDE	Turns on emergency hydraulic pump motor by closing a direct circuit from the hydraulic battery. Switch must be pulled out and forward to ORIDE.
ON	Closes circuit from hydraulic battery to the hydraulic battery bus, arming the automatic turn on circuit.
OFF	Opens all circuits to battery. Switch must be pulled out and aft to OFF.

Flight Test Power Light

The light ② on the data control/alphanumeric display labeled FT PWR, illuminates when flight test systems are receiving dc power from either the flight test transformer-rectifier or the flight test battery.

Main Battery Switch

This three position lever lock switch ③ is labeled MAIN BATT.

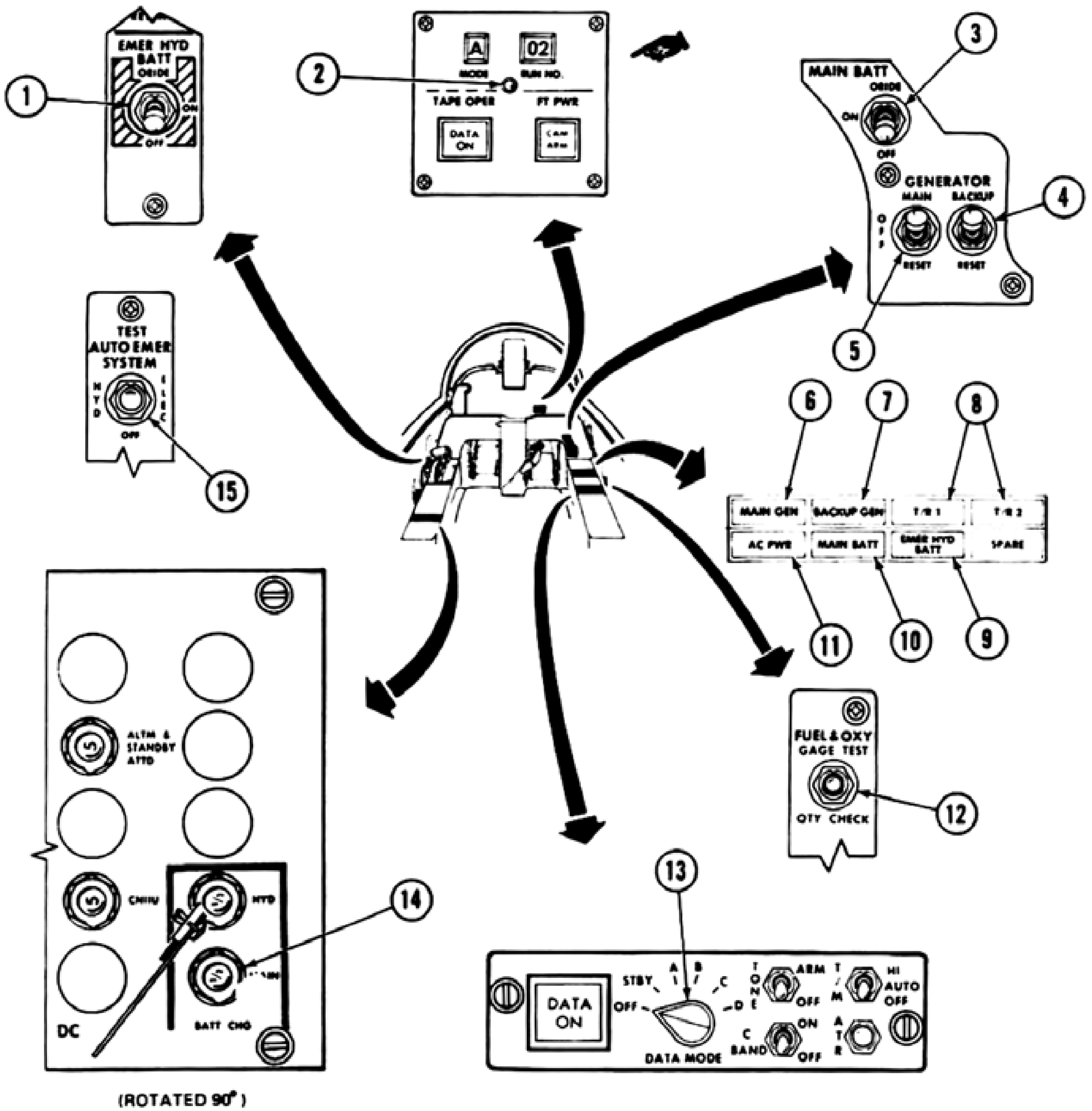
ORIDE	Maintains a direct circuit from the main battery to the essential dc bus and closes a direct circuit from the essential dc bus to the static inverter. Switch must be pulled out and then up to ORIDE.
ON	Closes main battery circuit to the essential dc bus.
OFF	Main battery disconnected from dc essential bus. Switch must be pulled out and down to OFF.

Backup Generator Switch

The lever lock switch ④ labeled GENERATOR BACKUP has three positions.

BACKUP	Closes circuit to automatic switching logic. Generator is in the standby mode. Switch must be pulled out and up to BACKUP position.
OFF	Backup generator disconnected from all electric circuitry.
RESET	Resets backup generator protective circuitry. Momentary switch must be pulled out and down to RESET position, and then out and up to BACKUP.

ELECTRICAL SYSTEM CONTROLS/INDICATORS



(ROTATED 90°)

1 HYDRAULIC BATTERY SWITCH
2 FLIGHT TEST POWER LIGHT
3 MAIN BATTERY SWITCH
4 BACKUP GENERATOR SWITCH
5 MAIN GENERATOR SWITCH
6 MAIN GENERATOR CAUTION LIGHT
7 BACKUP GENERATOR CAUTION LIGHT
8 T/R 1 & T/R 2 CAUTION LIGHTS
9 HYDRAULIC BATTERY CAUTION LIGHT
10 MAIN BATTERY CAUTION LIGHT
11 AC POWER CAUTION LIGHT
12 FUEL & OXYGEN SWITCH
13 DATA MODE SELECTOR
14 MAIN BATTERY CHARGING CB
15 AUTOMATIC EMERGENCY SYSTEM TEST SWITCH

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Figure 1-17.

Main Generator Switch

The lever lock switch (⑤ figure 1-17) is labeled GENERATOR-MAIN, and has three positions.

MAIN	Connects main generator to ac buses. Switch must be pulled out and up to MAIN position.
OFF	Main generator disconnected from ac buses.
RESET	Resets main generator protective circuitry. Momentary switch must be pulled out and down to RESET, then out and up to MAIN.

Main Generator Caution Light

The caution light ⑥ is labeled MAIN GEN. It illuminates when the main generator is not providing acceptable power to the main ac buses.

Backup Generator Caution Light

The caution light ⑦ is labeled BACKUP GEN. It illuminates when acceptable backup power is not available to power the ac backup generator's designated buses (see figure 1-15).

Transformer-Rectifier Caution Lights

The two caution lights ⑧ are labeled T/R 1 and T/R 2. They illuminate to indicate low voltage or non-operation of the respective TR.

Hydraulic Battery Caution Light

The caution light labeled EMER HYD BATT ⑨ illuminates when the hydraulic battery is disconnected from the hydraulic dc bus (hydraulic battery contactor open).

Main Battery Caution Light

The caution light labeled MAIN BATT ⑩ illuminates when the main battery is disconnected from the essential dc bus (main battery contactor open) or when the main battery charging circuit breaker is open.

AC Power Caution Light

The caution light (⑪ figure 1-17) labeled AC PWR illuminates to indicate an unpowered essential ac bus.

Fuel and Oxygen Switch

The switch ⑫ labeled FUEL & OXY has three positions and is spring loaded to the center neutral position.

GAGE TEST	Oxygen quantity indicator pointer rotates counterclockwise toward zero. Pointer rotation provides operational check of static inverter. Oxygen caution light will illuminate when pointer reaches 0.5 liter. Fuel indicators go to half scale.
QTY CHECK	Indicates forward, aft and total fuel quantities and oxygen quantity.

Flight Test Data Mode Selector

The rotary switch (⑬ figure 1-17), labeled DATA MODE, has six positions.

OFF	No power to flight test systems.
STBY	No power to flight test systems.
A,B,C, or D	Flight test systems receive dc power.

Main Battery Charging CB

A switch within the main battery charging cb, labeled MAIN BATT CHG ⑭ causes the main battery caution light to illuminate when the cb is open. The main battery charging cb opens when it senses high charging current, indicating a possible low battery charge state.

Automatic Emergency System Test Switch

The switch labeled TEST AUTO EMER SYSTEM (⑬ figure 1-17) provides a ground check of the emergency hydraulic pump automatic turn on circuitry and the automatic electrical switching circuitry. The check can be accomplished before or after engine start with TR 1 or 2 operating. The switch has 3 positions.

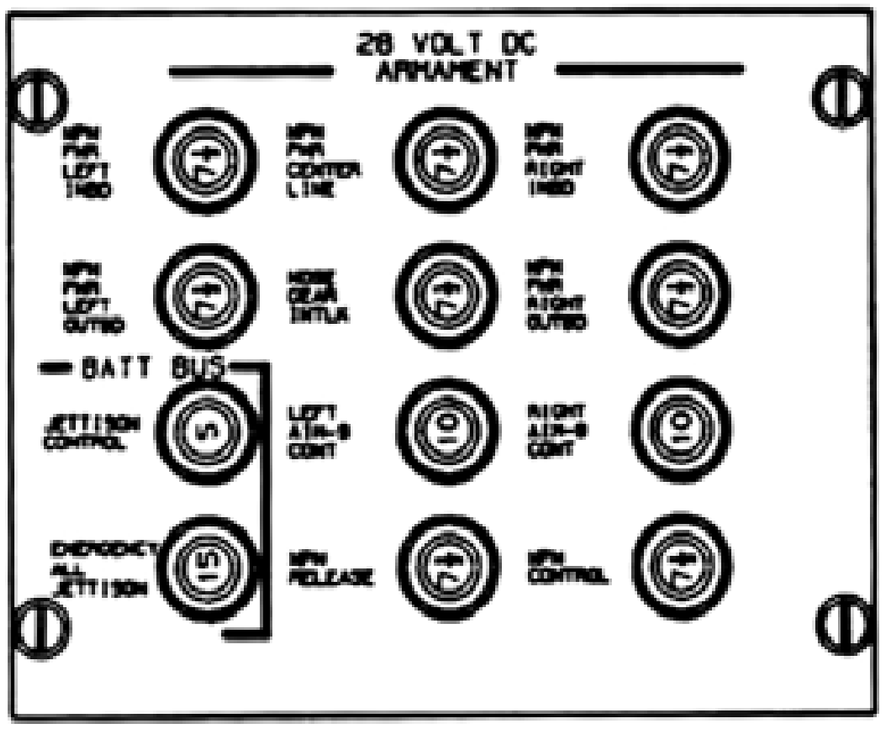
HYD	Checks emergency hydraulic pump automatic turn on circuitry.
OFF	Test circuits open.
ELEC	Checks automatic circuit that powers the essential dc bus, turns on the static inverter, and circuitry to the essential ac bus.

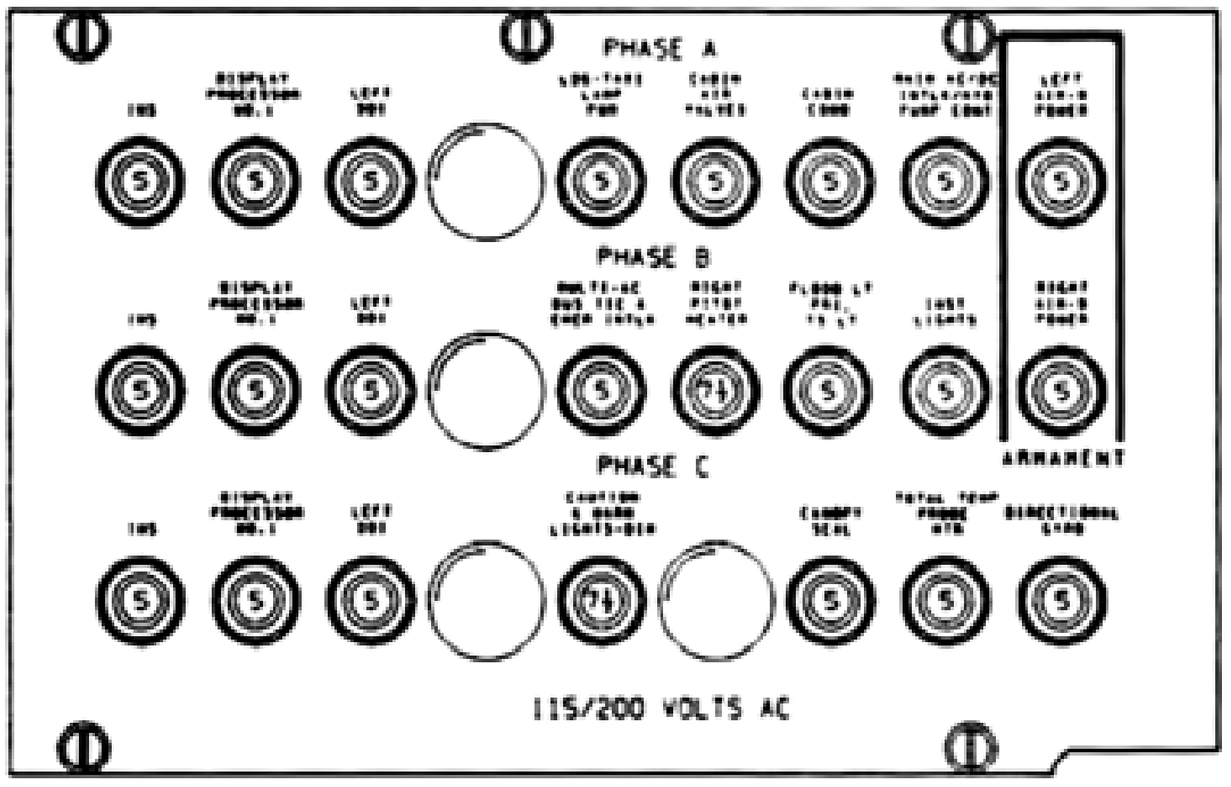
Before engine start the hydraulic test is confirmed by hydraulic pressure indication and flight control hydraulic caution light out. After engine start nonillumination of the flight control hydraulic caution light confirms test. Turn off of the ac power caution light confirms automatic electrical switching circuitry.

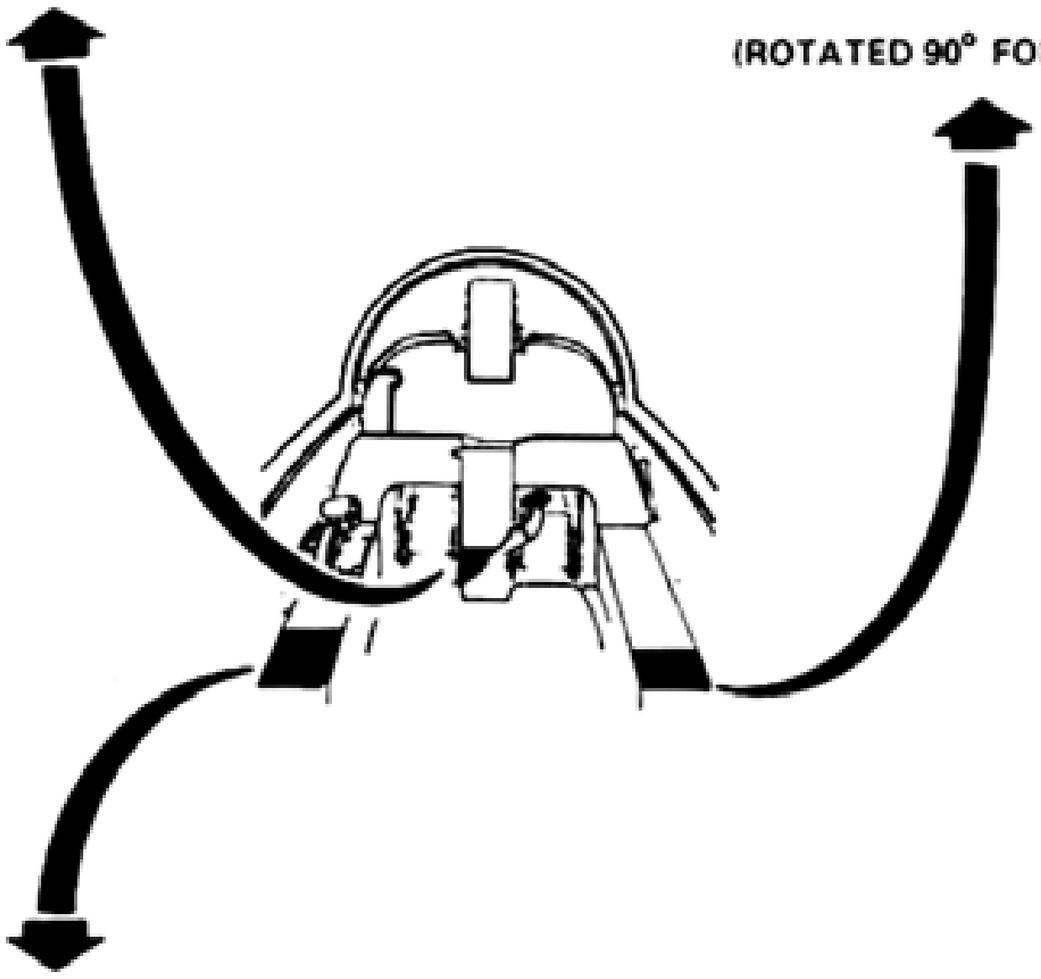
ELECTRICAL SYSTEM OPERATION

The normal operating positions of the generator switches are labeled MAIN and BACKUP. Switches should be in these positions prior to engine start. When engine rpm reaches 58%, the electrical control unit will connect the main generator to to the ac buses if acceptable power is sensed. The backup generator is in a standby condition and remains off line when main generator power is on line. Automatic protective circuitry drops the main generator off line if it senses unacceptable power. If a momentary condition has caused the main generator to drop off line, it can be reset by moving the generator switch to RESET and then back to MAIN. Reset will occur only if the electrical control unit senses acceptable ac power. Only two resets should be attempted. With the backup generator switch in the BACKUP position the backup generator automatically powers main ac bus No. 2 when the main generator goes off line. With the main generator inoperative, main ac bus No. 1 and the main dc bus are not powered. On the ground with the main generator off and no external power, main ac bus No. 3 is also unpowered. The backup generator also has protective circuits and may be reset. If both the main and backup generators are inoperative, only the main battery is available to power the essential dc bus and the essential ac bus thru the static inverter. In this condition, all unnecessary equipment should be turned off as limited power is available. If the main generator is on line, a single TR can provide power to all dc buses. If both TRs fail, the battery is the only source of power to the essential dc bus. However, in this condition the generator continues to supply the essential ac bus and the static inverter remains off. Static inverter failure precludes backup ignition for airstart. However, normal ignition is still provided by the engine alternator. A ground power cart can supply all buses when the engine is not running or with the engine running when the main generator switch is in the OFF position.

CIRCUIT BREAKER PANELS (TYPICAL)







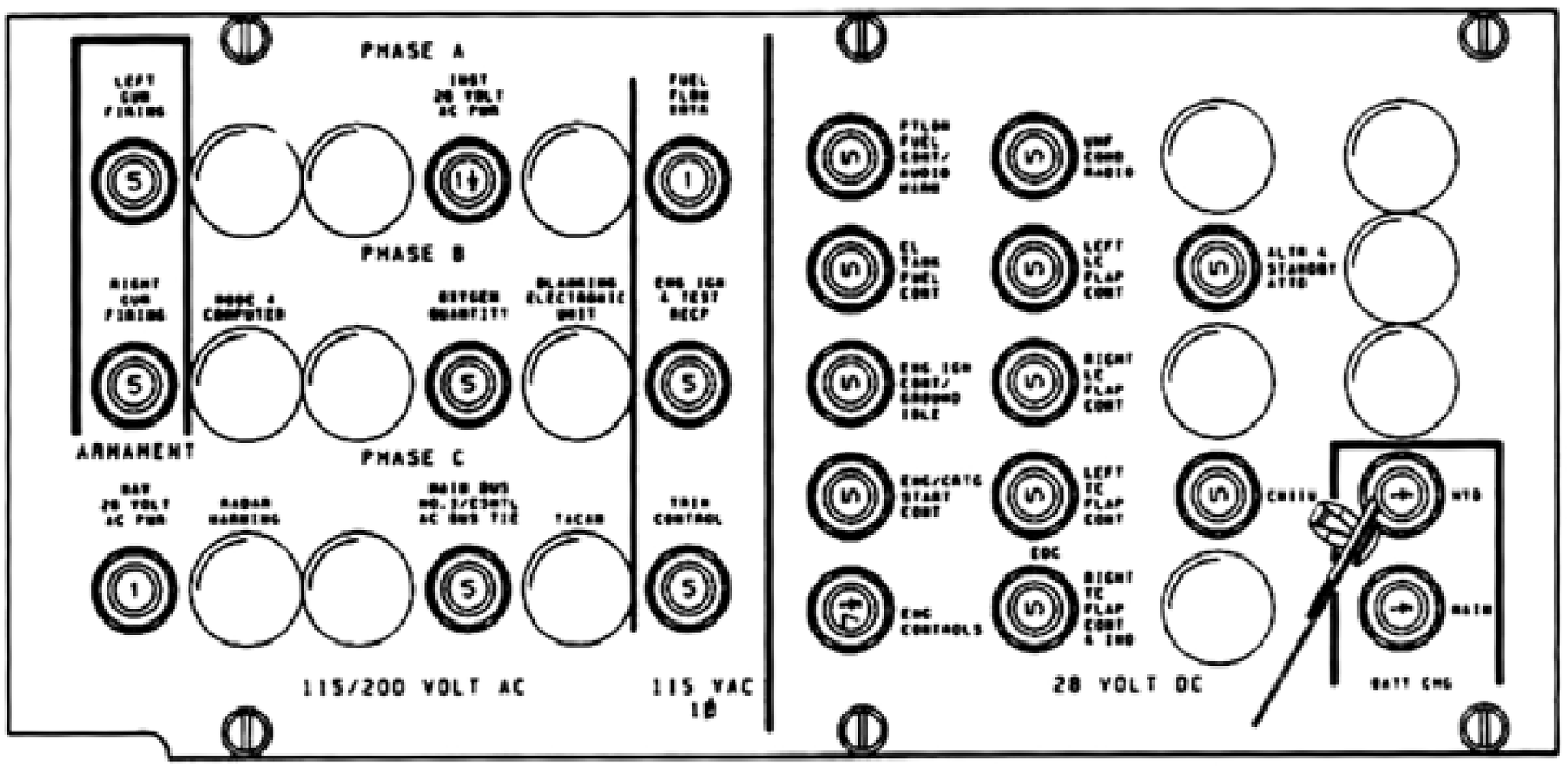


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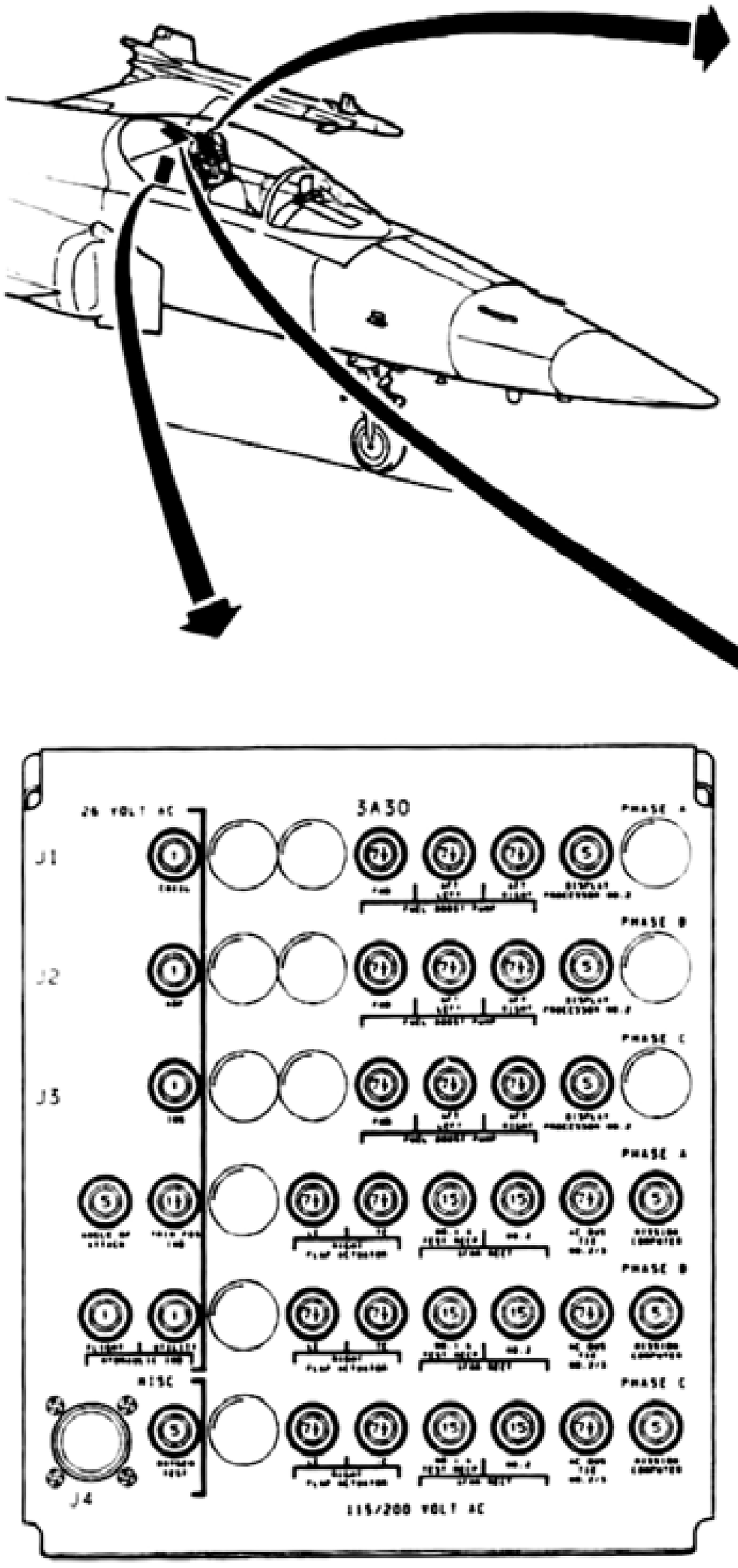
Figure 1-18.

CIRCUIT BREAKER PANELS (TYPICAL)

BEHIND SEAT



20-1-1-24(2) A

Figure 1-19.

HYDRAULIC SYSTEM

The hydraulic system (figure 1-20) consists of two independent systems: the flight control hydraulic system and the utility hydraulic system. In addition, an emergency hydraulic pump can provide backup hydraulic pressure to the flight control hydraulic system.

FLIGHT CONTROL AND UTILITY HYDRAULIC SYSTEMS

Both hydraulic systems operate at 3000 psi and each is powered by a positive displacement piston type hydraulic pump. The airframe mounted accessory gearbox drives the utility hydraulic pump and the engine gearbox drives the flight control hydraulic pump. Both systems provide hydraulic power for the flight controls and the pitch control augmentation. The utility hydraulic system, in addition to providing hydraulic power for the flight controls and pitch control augmentation, provides power for the landing gear, gear doors, speed brake, wheel brakes, two-position nose gear strut, nosewheel steering, and roll and yaw control augmentation. The flight control hydraulic system contains an accumulator to maintain system pressure during peak demands.

Hydraulic Pressure Indicators

The two hydraulic pressure indicators (figure 1-3) on the instrument panel labeled UTILITY and FLT CONT, indicate hydraulic pressure in each system. The indicators are ac powered. See Section V for indicator markings and pressure limits.

Hydraulic Pressure Caution Lights

The two caution lights (figure 1-20) on the caution light panel labeled UTILITY HYD and FLIGHT HYD come on when the respective system pressure drops to 1500 psi or below, and go out automatically when pressure of approximately 1800 psi is restored.

EMERGENCY HYDRAULIC SYSTEM

The emergency hydraulic pump provides backup emergency hydraulic pressure to all functions normally supplied by the flight control hydraulic pump. The system components include an emergency hydraulic pump powered by a dc motor, a 24-volt dc hydraulic battery, automatic turn on circuitry, hydraulic battery switch, hydraulic battery caution light, and a ground test switch. The system provides for ground test of the emergency hydraulic pump and the automatic turn on circuits before flight. The test function uses 28-volt dc power from the aircraft TR units. See Electrical System, this section, for description of electrical supply to the emergency hydraulic pump.

Emergency Hydraulic System Operation

On the ground, before engine start and with external power connected, the system is checked by positioning the automatic emergency test switch to HYD. This activates automatic turn on logic and runs the emergency hydraulic pump. The flight control hydraulic pressure indicator displays the pressure generated by the emergency hydraulic pump.

In flight, with the hydraulic battery switch on, if engine rpm drops to 20% or below, turn on logic automatically activates the emergency hydraulic pump. When engine rpm increases above 20%, the pump automatically turns off. However, if the EMER HYD BATT caution light is on, automatic turn on of the emergency hydraulic pump is not available. In this case, the emergency hydraulic pump can be manually turned on by placing the hydraulic battery switch to ORIDE.

HYDRAULIC SYSTEMS

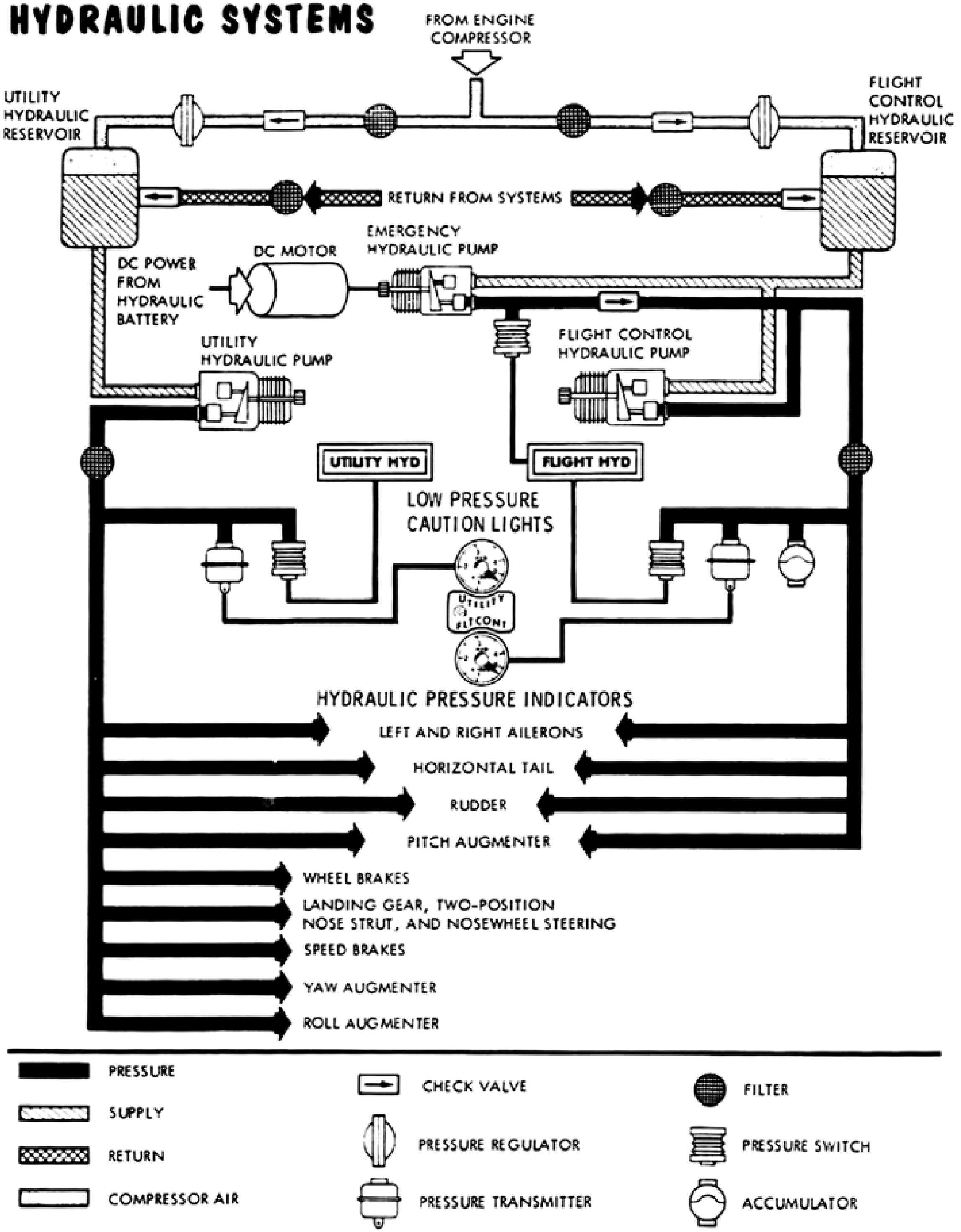


Figure 1-20.

LANDING GEAR SYSTEM

The landing gear system provides normal extension and retraction of gear, alternate extension of gear, nose gear strut hike-dehike, and nosewheel steering. The landing gear is extended and retracted by utility hydraulic system pressure electrically controlled by the landing gear lever. Retraction time is 9 seconds with nose gear strut hiked and 6 seconds with nose gear strut dehiked. Gear extension time is 6 seconds. The main gear is held in the retracted position by individual uplocks hydraulically actuated. The nose gear uplock is contained within the gear dragbrace mechanism. All gears are held down by hydraulic pressure on the gear actuators and locked in the down position by springloaded overcenter downlocks. Three green lights, a red warning light, and an audible warning beeper heard thru the headset are provided to indicate when the gear is in a safe or unsafe position. Gear alternate extension is provided in case of utility hydraulic system or electrical malfunction.

NOSE GEAR STRUT HIKE-DEHIKE

The nose gear strut can be extended (hiked) 13 inches or retracted (dehiked) on the ground by the nose strut switch. Full hiking of the strut will add approximately 3 degrees to the pitch attitude, which shortens takeoff ground runs. The nosewheel is steerable in the hiked and dehiked positions; however, steering response may be slower during transit. Automatic gear strut dehike occurs anytime aircraft weight is off the main gear, regardless of the position of the gear lever. The strut fully dehikes before it enters the wheel well.

NOSEWHEEL STEERING

The nosewheel steering system provides directional control and shimmy damping during ground operations. Steering control is electrically activated (main dc bus), and powered by utility hydraulic system pressure. Steering is available with aircraft weight on right main gear and controlled by movement of rudder pedals. Shimmy damping is available when nosewheel steering is not activated. Damping is provided by hydraulic fluid trapped within the steering actuator and is independent of utility hydraulic system pressure.

GEAR ALTERNATE EXTENSION

The gear alternate extension system provides gear extension should normal extension fail. Alternate extension can be accomplished with gear lever up or down. With gear lever down, and after all gear fully extended, the three green indicator lights illuminate and the gear lever red warning light will go out. With gear lever up, the red warning light will remain on. After alternate extension, the gear doors remain open and nosewheel steering is inoperative. To reset gear to normal system, recycle the gear lever.

LANDING GEAR CONTROLS AND INDICATORS

Location of landing gear controls and indicators are depicted in figure 1-21.

Gear Position Indicator Lights

The three green lights ① illuminate when each respective gear is down and locked.

Gear Downlock Override Button

The button ② labeled DOWNLOCK OVERRIDE is a push and hold type. On the ground, the button enables the gear lever to be raised to LG UP position. In flight with gear down, the button enables the gear lever to be raised to LG UP position in the event the locking solenoid fails to release gear lever.

Auxiliary Nosewheel Steering Button (If Installed)

The button/light ③ labeled NOSEWHEEL STEERING is a momentary push type, which activates steering and illuminates an integral green light. Nosewheel steering is activated until depressing the button a second time, which deactivates steering and extinguishes the light. The button is powered thru a weight-on-wheels switch, and can only be activated on the ground. The light does not illuminate when steering is activated by the stick grip nosewheel steering button. System activation by the auxiliary nosewheel steering button shall be used only for taxi operations.

LANDING GEAR CONTROLS/INDICATORS

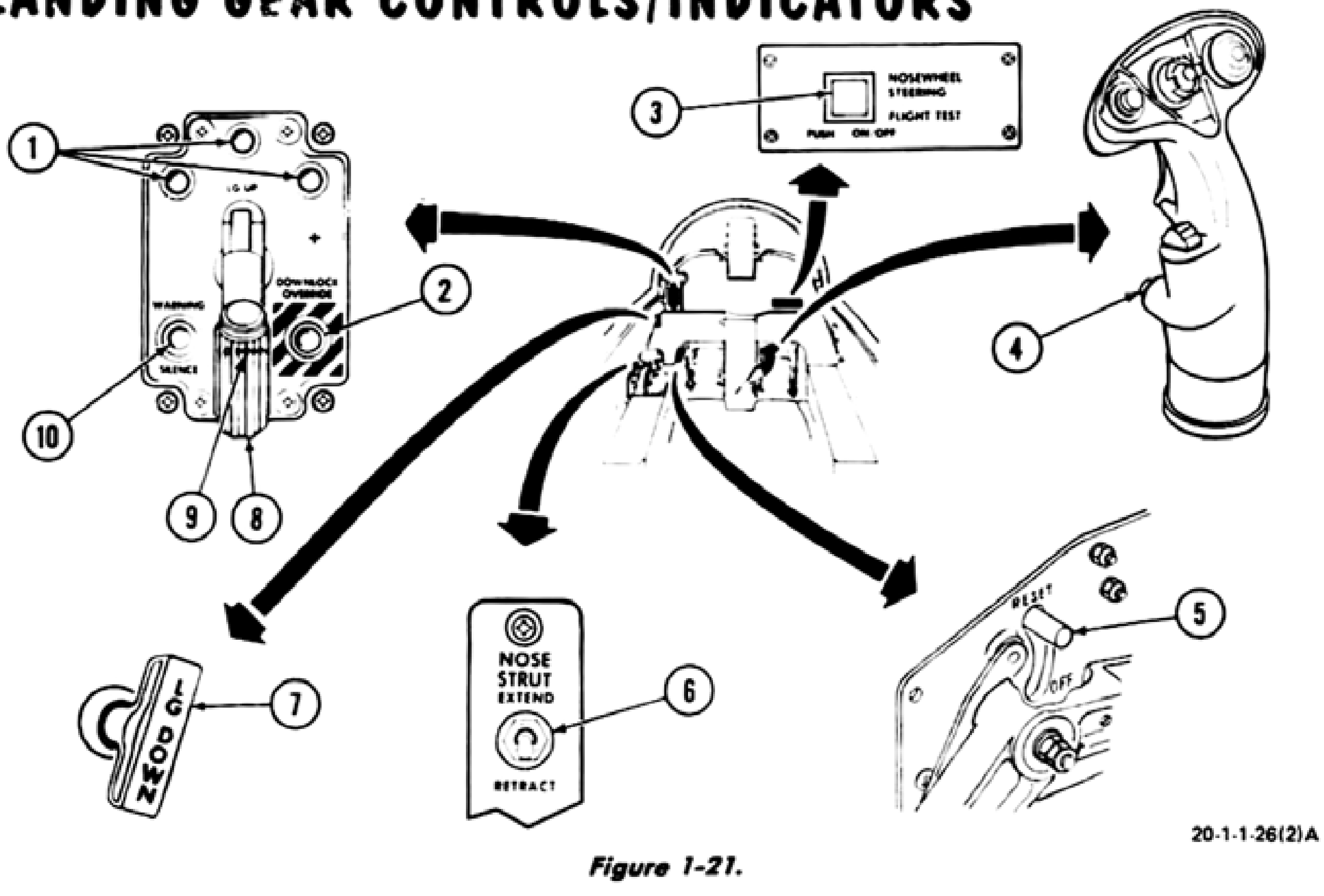


Figure 1-21.

Nosewheel Steering Button

The button ④ must be depressed and held as long as nosewheel steering is desired. Inflight, the button functions as an alternate microphone switch for the number one UHF radio.

Gear Alternate Release Reset Control

The control ⑤ resets landing gear to the normal system after gear alternate extension and is used primarily on the ground for maintenance purposes.

RESET	Resets gear to normal system.
OFF	No function

On the ground the gear safety pins should be installed before using the reset control, to prevent possible gear collapse. In flight, after gear alternate extension, the reset control may be used to reset the gear to normal system if cycling of gear lever fails to reset gear.

Nose Strut Switch

The two position switch ⑥ is labeled NOSE STRUT.

EXTEND	Hikes nose gear strut.
RETRACT	Dehikes nose gear strut.

After positioning to EXTEND, the switch stays at EXTEND until strut automatically dehikes when the right main gear is off the ground or, during gear retraction, in which case, the switch automatically returns to RETRACT.

Gear Alternate Release Handle

The D-handle ⑦ labeled LG DOWN must be pulled out approximately 10 inches and held until gear unlocks. Pulling the handle disconnects utility hydraulic system pressure and electrical power to release the main gear uplocks, main gear inboard door locks, nose gear, and nose gear forward door to allow the gear to extend, assisted by gravity and airloads. If the handle is improperly stowed, not fully in and in vertical position, it may prevent gear normal retraction/extension and cause loss of nosewheel steering.

Gear Lever

The lever (⑧ figure 1-21) has two positions.

LG UP	Retracts gear.
LG DOWN	Extends gear.

Gear Lever Warning Light

The red warning light in the gear lever handle ⑨ illuminates when one or more gears are unsafe or when one or more gear doors are open with the gear lever up. The red light and the gear audible warning beeper will activate at altitudes below 9,500 feet, at an airspeed below 210 ± 10 KIAS, with throttle below approximatly 85% rpm. On the ground, with the gear lever down, the red light and beeper will activate when the main gear doors are opened by the gear door switch in the right wheel well.

Gear and Flap Warning Silence Button

The button ⑩ labeled WARNING SILENCE is a momentary push type, which silences the audible warning beeper.

WHEEL BRAKE SYSTEM

Each main wheel is equipped with a hydraulically operated multiple-disc power brake assembly. Brakes are operated by conventional toe-type brake pedals (rudder pedals) and use utility hydraulic system pressure to operate brake control valves. Proper brake disc operating clearances are automatically provided when the brake pedals are momentarily pressed hard while engine is running. Should the utility system fail, the brake valve acts as a brake master cylinder, and brake pressure is proportional to the amount of foot pressure applied to the brake pedal. After utility system failure, unlimited mechanical brake applications are still available.

DRAG CHUTE SYSTEM

The drag chute system consists of a variable-porosity continuous-ribbon deceleration parachute packed in a deployment bag and stowed in an aircooled cylindrical compartment at the base of the rudder, and a T-handle to deploy the chute.

DRAG CHUTE HANDLE

The drag chute T-handle on the instrument panel (② figure 1-3) is mechanically connected to the drag chute release mechanism. To deploy the chute, the handle is pulled straight out (without turning) to the first stop (approximately 3-1/4 inches). To avoid inadvertent jettisoning of the drag chute, ensure that handle is pulled to first stop and locked without rotation. Initial movement of the handle latches the drag chute to the aircraft. Further movement of the handle unlocks the tail cone fairing latch, allowing the spring-loaded pilot chute to deploy and withdraw the drag chute into the airstream. The handle will lock in the deployed position. The drag chute can be jettisoned by turning the T-handle 90-degrees clockwise and pulling it out to the next stop (approximately an additional 3-1/4 inches). The handle is under spring tension during the final pull to jettison chute. When released, the handle will retract to the first stop. To stow, rotate the handle counterclockwise and push it in.

SPEED BRAKE SYSTEM

An electrically-controlled, hydraulically-actuated speed brake is located under the fuselage center section. The speed brake is powered by the utility hydraulic system and controlled by a three-position speed brake switch on the throttle. The variable position speed brake has a full extension of 45° without a centerline (CL) store and 30° with a CL store. After release or jettison of a CL store, full speed brake extension is obtained by cycling the speed brake switch. High airspeeds may prevent full extension. The speed brake and horizontal tail are mechanically interconnected to minimize trim change during speed brake operation.

SPEED BRAKE SWITCH

The switch labeled SPEED BRAKE, (figure 1-8) has three unlabeled positions.

Aft	Opens the speed brake (out).
Center	Center position neutralizes hydraulic pressure.
Forward	Closes the speed brake (in).

Intermediate speed brake positions can be obtained by short intermittent actuation of the switch. For the open and intermediate speed brake positions, the switch should be returned to center position (neutral) after positioning speed brake.

WING FLAP SYSTEM

The wing flap system consists of leading and trailing edge flaps used for takeoff and landing, loiter, and maneuvering. The flap system provides automatic flap positioning in two flap thumb switch settings: AUTO and FXD. Manual flap positioning is available in the flap thumb switch setting UP and in the flap lever settings EMERG UP and FULL. Automatic flap scheduling is computed by the DADU as function of AOA and airspeed. The scheduling logic then positions the flaps thru relays and limit switches (figure 1-23). Each flap surface is

operated by an ac electrical actuator. The left leading and trailing edge flap actuators are powered by main ac bus No. 1. The right leading and trailing edge flaps are powered by main ac bus No. 2. The left and right leading edge flaps and left and right trailing edge flaps are mechanically interconnected. On each side, the leading and trailing edge flaps are electrically interconnected and, in turn, are mechanically interconnected to the horizontal tail operating mechanism to automatically minimize trim change when the flaps are operated.

FLAP CONTROLS AND INDICATORS

The flaps are controlled by either the flap lever on the throttle quadrant or by the flap thumb switch on the throttle (figure 1-22). The flap lever is the overriding control when at EMERG UP or FULL setting. When the flap lever is at THUMB SW, it transfers flap control to the flap thumb switch. The flap thumb switch has two settings which provide automatic flap positioning (AUTO and FXD). The third flap thumb switch setting, UP, directly positions the flaps to up. A flap indicator on the instrument panel provides visual indication of flap position and/or lever/switch setting.

Flap Lever

The lever (① figure 1-22) is labeled FLAPS and has three settings.

EMERG UP	Flaps retract (up).
THUMB SW	Transfers flap control to flap thumb switch.
FULL	Flaps fully extend.

Flap Thumb Switch

The switch (② figure 1-22) is labeled FLAPS and has three settings. This switch has control of the flaps when the flap lever is in the THUMB SW setting.

UP	Flaps retract (up).
FXD	Permits automatic flap positioning at quarter flaps or half flaps for optimum loiter flight. Flaps automatically retract to up at high speed.
AUTO	Permits automatic operation of flaps scheduled by airspeed and AOA.

Flap Indicator

This indicator (④ figure 1-22) shows the flap position when the flap lever is at EMERG UP or FULL, and when the flap lever is at THUMB SW with the flap thumb switch in the UP setting. The indicator also shows FULL any time the landing gear is down and the thumb switch is in AUTO setting. When AUTO or FXD are selected, the indicator shows AUTO or FXD unless the landing gear is down in AUTO setting. The indicator shows barber pole when the flaps are manually repositioning or when electrical power is removed.

AOA/FLAPS Caution Light

The light on the caution light panel labeled AOA/FLAPS illuminates upon failure of either one or both channel of the DADU. Failure of either channel of the DADU disables the AUTO setting on the flap thumb switch.

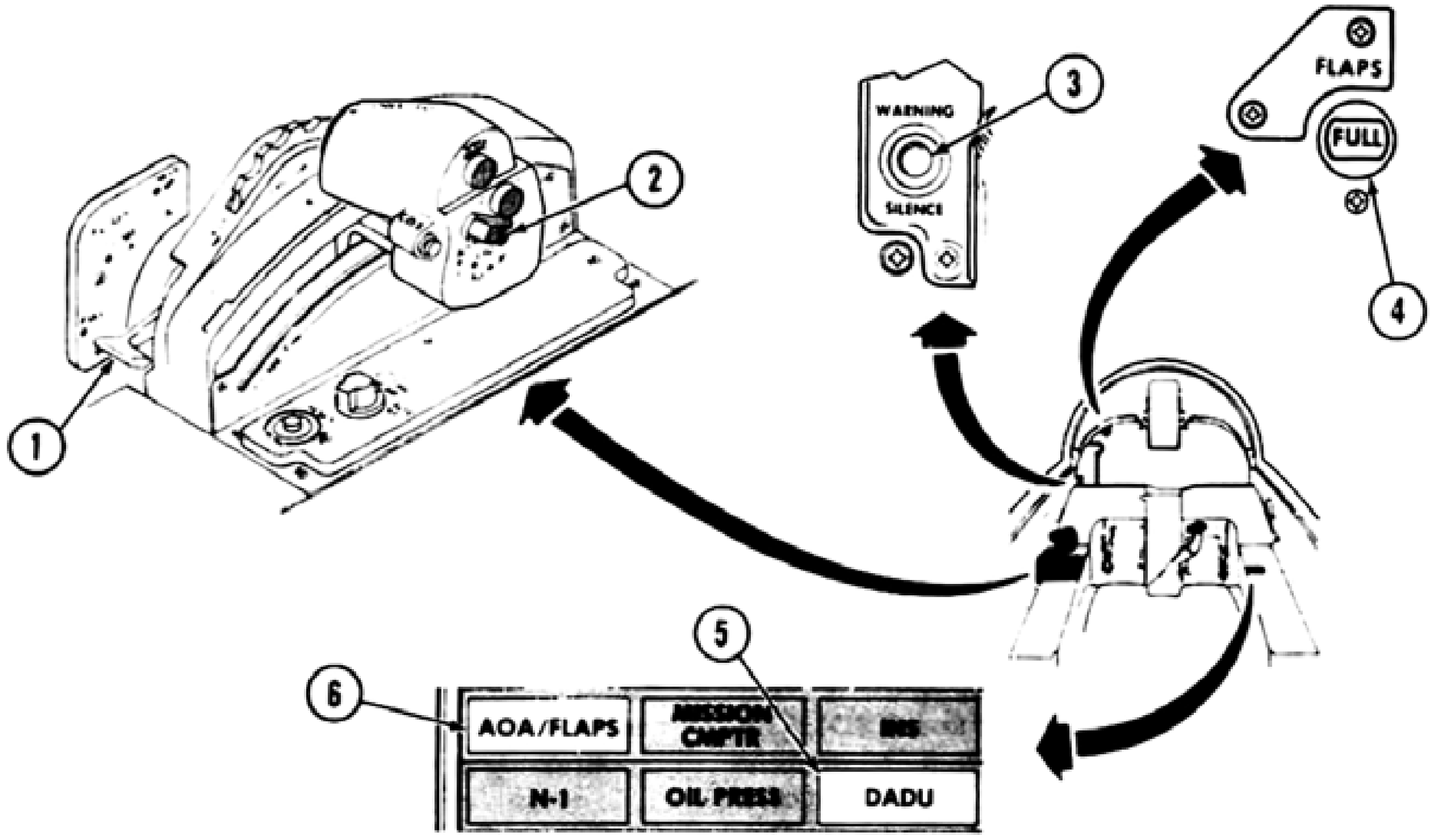
DADU Caution Light

The light on the caution light panel labeled DADU illuminates upon failure of both channels of the DADU. Failure of the DADU disables both the AUTO and FXD settings on the flap thumb switch.

AUTOMATIC FLAP OPERATION

Automatic flap positioning occurs in each of the two flap thumb switch settings, AUTO and FXD. When in either AUTO or FXD setting and above 550 KIAS or 0.95 IMN, the DADU prevents extension of the flaps. If flaps are extended when approaching 550 KIAS or 0.95 IMN, they automatically retract to up. If flaps do not retract to up upon reaching 550 KIAS or 0.95 IMN, a steady audible warning signal is generated. The

WING FLAP SYSTEM CONTROLS/INDICATORS



SWITCH/LEVER SETTINGS	FLAP POSITIONS	INDICATIONS
UP, EMERG UP, AUTO, FXD.	0° UP 0°	AUTO FXD UP
FXD.	0° 1/4 8°	FXD
AUTO, FXD.	12° 1/2 8°	AUTO FXD
AUTO	18° 3/4 16°	AUTO
AUTO, FULL	24° FULL 20°	AUTO FULL

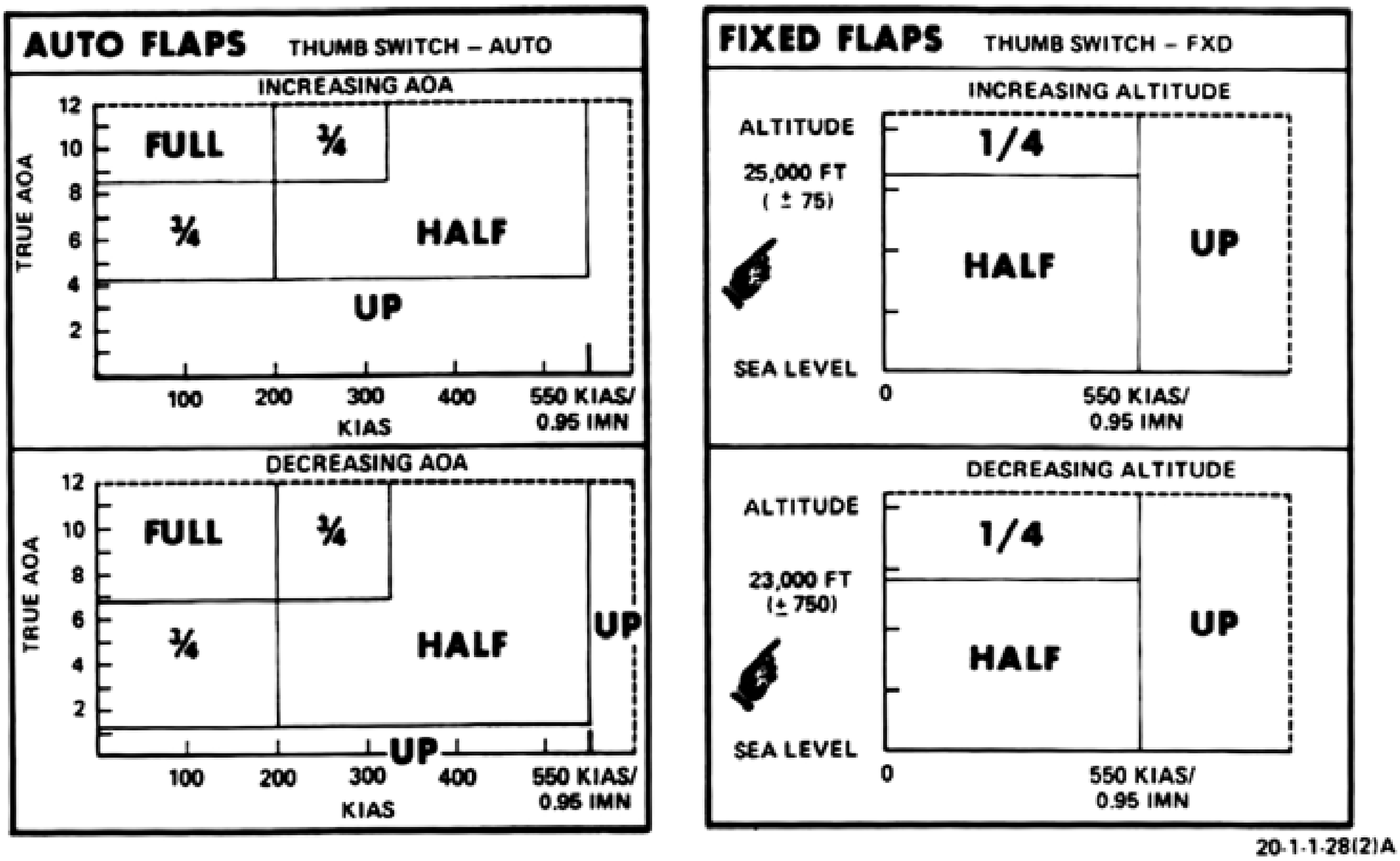
BARBER POLE APPEARS:

A. ELECTRICAL POWER REMOVED.
B. DURING FLAP REPOSITIONING.

20-1-1-27(2)B

Figure 1-22.

FLAP SHIFT SCHEDULE



20-1-1-28(2)A

Figure 1-23.

audible warning can be silenced by retracting the flaps or pushing the warning silence button next to the landing gear lever.

Flap Thumb Switch AUTO Setting

The AUTO setting for automatic flap operation may be selected for all phases of maneuvering flight from takeoff to landing. Flaps should be positioned UP for cruise range. In the AUTO setting, flaps are automatically positioned to up, half, three-fourths or full by signals from the DADU. In AUTO the flaps automatically position to full whenever the landing gear is down. With the gear down, the flap indicator transitions from AUTO to FULL. See figure 1-23 for flap shift schedule in the AUTO setting. Failure of the DADU disables the AUTO setting and if in the AUTO setting the flaps freeze in the attained position.

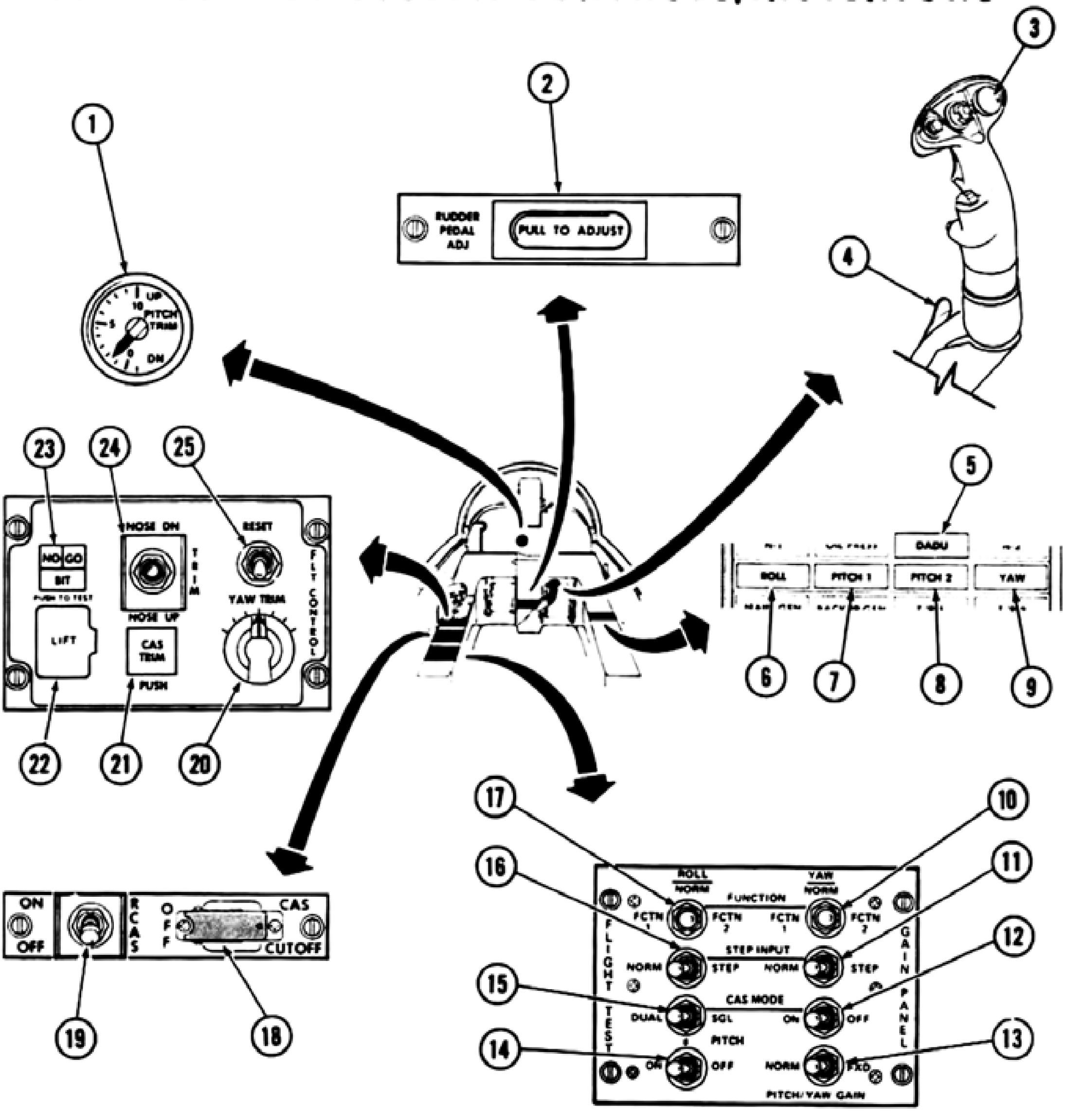
Flap Thumb Switch FXD Setting

This setting provides automatic flap positioning for improved fuel consumption rates and buffet control when an external stores loaded aircraft is flown at reduced speed for maximum endurance. In FXD setting, flaps are automatically positioned to half flaps or quarter flaps depending on altitude. See figure 1-23 for flap shift schedule in FXD setting.

FLIGHT CONTROL SYSTEM

The flight control system (FCS) consists of a conventional hydromechanical system augmented by an electrical control augmentation system (CAS). The aircraft primary control surfaces (ailerons, rudder, and an all movable horizontal tail) are positioned by hydromechanical actuators thru stick and rudder pedal movement. The CAS provides pitch, roll and yaw augmentation thru electrohydraulic and electromechanical actuators. These systems work together to provide aft cg performance benefits and superior handling qualities. Artificial feel springs provide simulated aerodynamic forces to the control stick and rudder pedals. Electric stick trim actuators move the neutral stick position for pitch and aileron trim. At times during the flight test program, roll CAS is deactivated. See figure 1-24 for location of controls and indicators.

FLIGHT CONTROL SYSTEM CONTROLS/INDICATORS



1	PITCH TRIM INDICATOR
2	RUDDER PEDAL ADJUST T-HANDLE
3	STICK TRIM BUTTON
4	CAS RESET PADDLE SWITCH
5	DADU CAUTION LIGHT
6	ROLL CAS CAUTION LIGHT
7	PITCH CAS ONE CAUTION LIGHT
8	PITCH CAS TWO CAUTION LIGHT
9	YAW CAS CAUTION LIGHT
10	YAW FUNCTION SWITCH
11	YAW STEP INPUT SWITCH
12	YAW CAS SWITCH
13	GAIN SWITCH
14	PITCH CAS SWITCH
15	ROLL CAS MODE SWITCH
16	ROLL STEP INPUT SWITCH
17	ROLL FUNCTION SWITCH
18	CAS CUTOFF SWITCH
19	ROLL CAS CUTOFF SWITCH
20	RUDDER TRIM KNOB
21	CAS TRIM INDICATOR BUTTON
22	MAINTENANCE TEST COVER
23	BUILT-IN-TEST BUTTON
24	TRIM SWITCH
25	CAS RESET SWITCH

20-1-1-29(2)B

Figure 1-24.

CONTROL STICK

The control stick incorporates a pitch and aileron trim button, weapon release button, trigger, nosewheel steering/microphone button, a CAS reset paddle switch, an A/A weapons select switch, and a sensor control switch.

RUDDER PEDALS

The rudder pedals operate conventionally and are adjustable. They are also used for brakes and nosewheel steering.

Rudder Pedal Adjust T-Handle

Pulling the rudder pedal adjust T-handle (② figure 1-24) releases both rudder pedals, which are forced aft by spring pressure. Pushing the rudder pedals forward to the desired position and stowing the T-handle, achieves adjustment.

PITCH TRIM INDICATOR

The pitch trim indicator ① displays pitch stick trim in increments of nose up or nose down.

HYDROMECHANICAL FLIGHT CONTROL SYSTEM

The hydromechanical portion of the FCS consists of conventional mechanical inputs to dual hydraulic actuators. Each control surface is powered by both the flight control hydraulic system and the utility hydraulic system. The horizontal tail, ailerons, and rudder receive hydromechanical inputs from the pilot at all times. Full rudder deflection 50% of aileron, and 60% of horizontal tail authority are available from the hydromechanical system. The remainder of horizontal tail and aileron authority is provided by the CAS.

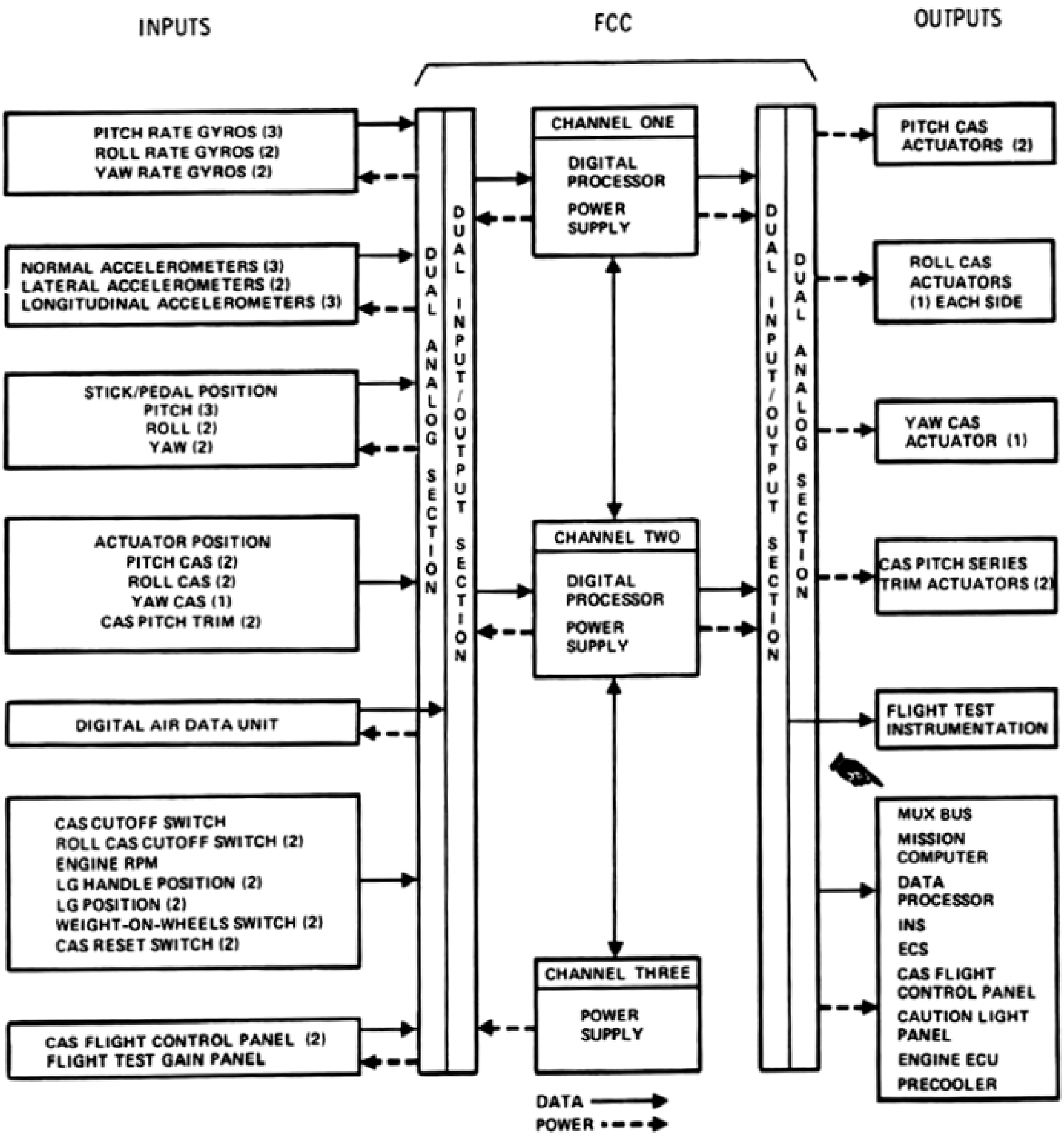
CONTROL AUGMENTATION SYSTEM

The CAS is controlled by a dc powered flight control computer (FCC) (figure 1-25). The FCC is the main computational element in the CAS, containing both digital, analog, and power functions. The FCC provides power to, and receives input signals from the digital air data unit (DADU), aircraft rate and acceleration sensors, stick and rudder pedal position sensors, and cockpit control panels. The FCC processes inputs and sends signals to CAS actuators; which, together with hydromechanical actuators, position the control surfaces to provide stability enhancement and superior handling qualities. Pitch CAS actuation consists of dual electrohydraulic actuators acting in concert with dual electromechanical CAS pitch series trim actuators (figure 1-26). The pitch CAS actuators are powered by both the flight control hydraulic system and utility hydraulic system. The roll and yaw CAS actuators are powered by the utility hydraulic system. Aircraft signals from the landing gear system are sent to the FCC to modify CAS computations. All components of the CAS are either double or triple redundant with the exception of the single yaw CAS actuator and the roll CAS actuator on each wing. Location of CAS controls and indicators are depicted in figure 1-24.

PITCH CONTROL

Pitch control is achieved by pilot commanded hydromechanical input plus pitch CAS commanded stabilizer deflection. An electrical crossfeed from the lateral stick position into the pitch axis is used to modify pitch rate during high roll rate maneuvers to control load factor excursions, and, in conjunction with yaw CAS operation, reduce the effect of roll coupling. Acceleration feedback is used to minimize aircraft pitching motion during rapid thrust changes to provide gear down speed stability. Little or no trim correction is required for changes in airspeed, altitude, or configuration with the gear up. With gear down, trimming is required. Failure of a single pitch CAS channel or certain component failures or combination of component failures equivalent to a single pitch CAS channel failure are indicated by illumination of the PITCH 1 light on the caution panel. Illumination of this light indicates that another component failure or combination of failures could cause shutdown of the pitch CAS. This is indicated by illumination of the PITCH 2 caution light. Depending on which components have failed, aircraft handling qualities with an illuminated PITCH 1 light remain essentially normal. In this condition the pilot should consider forward transfer of fuel to move the cg forward, as the normal aft cg profile established for a functioning pitch CAS could result in marginal handling qualities with a failed pitch CAS. In event of total pitch CAS failure, the mission should be terminated and the aircraft landed.

FLIGHT CONTROL COMPUTER FUNCTIONS



- REDUNDANCY SHOWN IN PARENTHESES.
- FCC CHANNEL THREE POWERS THE THIRD SENSOR IN TRIPLEX SENSOR ASSEMBLIES.
- CAS FLIGHT CONTROL PANEL IS DOUBLE REDUNDANT IN FUNCTION ONLY.

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Figure 1-25.

PITCH CONTROL INTEGRATION

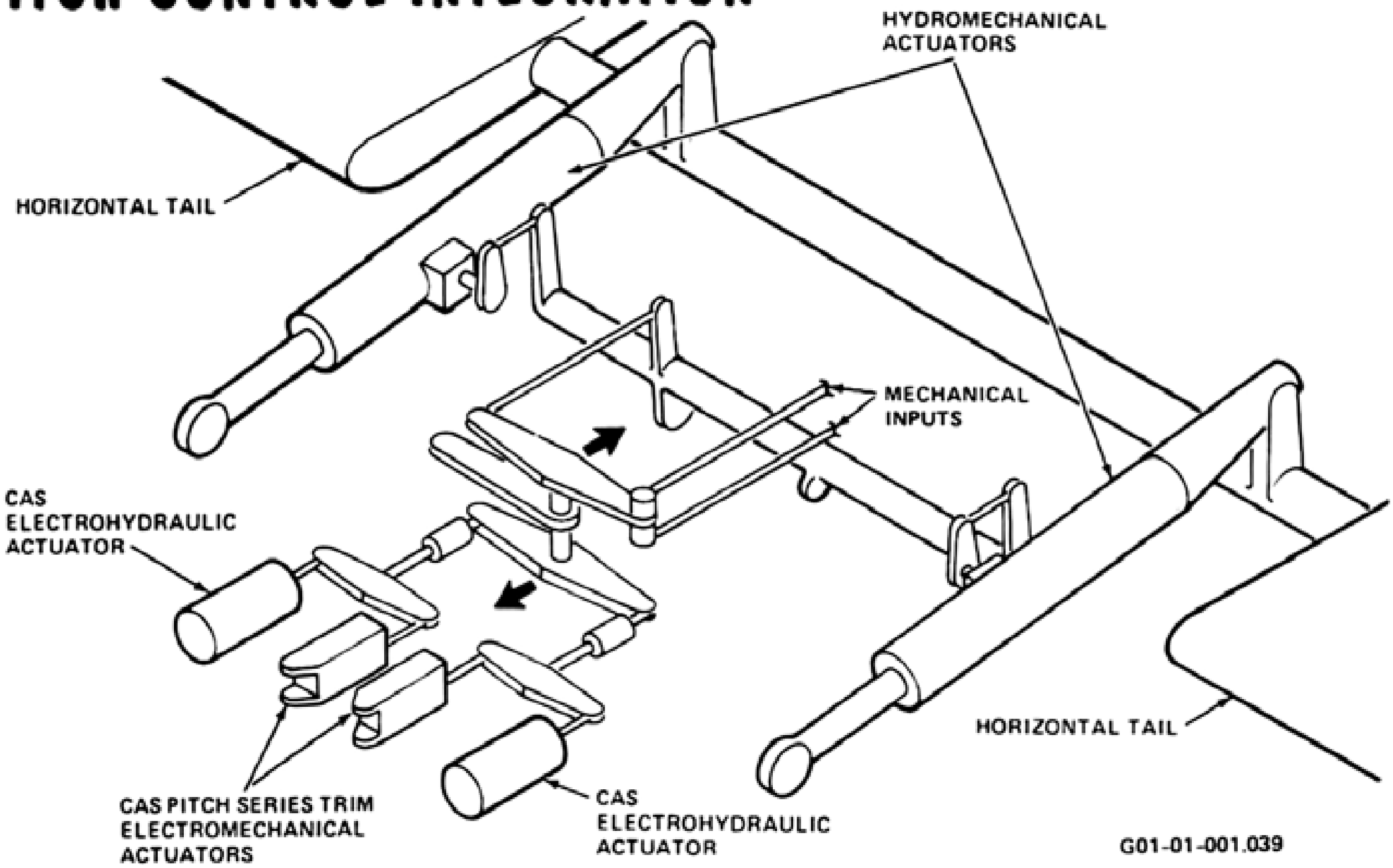


Figure 1-26.

ROLL CONTROL

Hydromechanical aileron inputs are augmented by a high authority roll CAS to enhance roll characteristics. Electrohydraulic roll CAS actuators act in series with the hydromechanical aileron actuators and are powered by the utility hydraulic system. Failure of the roll CAS is indicated by the ROLL light on the caution light panel (⑥ figure 1-24). When roll CAS is deactivated, the roll CAS caution light does not illuminate even during test. With the roll CAS inoperative, sufficient control remains for aircraft maneuvering (except for obtaining maximum roll rates) and landing. When the system is deactivated, full roll control is available.

Roll CAS Switch

The channel guarded lever lock switch (⑲ figure 1-24) labeled R CAS is used to turn off roll CAS.

ON	Roll CAS on.
OFF	Roll CAS off.

YAW CONTROL

Hydromechanical rudder inputs are augmented by a high authority CAS to achieve high directional stability at all AOA and to control vertical tail loads. Yaw CAS uses rudder pedal position input and yaw rate and acceleration feedbacks to compute the necessary CAS series input to the rudder. The yaw CAS interconnects roll stick position to rudder, and pitch stick position to rudder, to reduce adverse yaw, minimize roll coupling, and improve roll rate at high AOA. The yaw CAS controls vertical tail loading by reducing total rudder deflection as a function of airspeed. The single yaw CAS electrohydraulic actuator is in series with the dual hydromechanical actuator. The yaw CAS actuator is powered by the utility hydraulic system and provides rudder trim, controlled by the rudder trim knob on the cockpit flight control panel. The light on the caution panel labeled YAW illuminates when the yaw CAS is inoperative.

CAUTION

With yaw CAS inoperative, large or abrupt rudder inputs shall be avoided to prevent overstressing the vertical tail.

Yaw (Rudder) Trim Knob

The knob (㉘ figure 1-24) labeled YAW TRIM changes rudder trim through the yaw CAS actuator. The knob sends a rudder reposition signal to the FCC, which then sends a signal to reposition the yaw CAS actuator. The knob rotates 60 degrees in either direction, corresponding to right or left rudder trim deflection of 4 degrees in either direction.

CAS Reset Switch

The switch ㉕ labeled RESET allows the pilot to attempt inflight clearance of failures within the CAS. Reset can occur if a transient condition has caused a CAS malfunction and the condition no longer exists. This momentary type two position switch is springloaded to a neutral position. On the ground the RESET switch returns the CAS to normal operation, initializes pitch CAS control logic, and moves the pitch CAS trim actuators to a takeoff trim setting. If yaw trim is within one-half degree of center, the light in the CAS trim button illuminates for three seconds to indicate CAS ready. After any CAS reset, the engine must be reset.

CAS Reset Paddle Switch

This momentary switch ④ duplicates the functions of the CAS RESET switch.

Pitch/Yaw CAS Trim Indicator Button

The button ㉑ labeled CAS TRIM is both a momentary press switch and an indicator light. The light in the button illuminates for three seconds to indicate pitch/yaw CAS takeoff trim is established. CAS takeoff trim can be verified by pressing the CAS trim indicator button, which illuminates if takeoff trim has been established. In flight the button is nonfunctional.

Takeoff Trim

Takeoff trim requires both pitch stick trim and pitch/yaw CAS takeoff trim. Pitch stick trim is set to the appropriate pitch trim indicator setting for aircraft cg. CAS takeoff trim is established by centering the yaw trim knob and activating the CAS reset switch. Aileron trim is established visually.

Trim Switch

The flight control panel trim switch ㉔ labeled TRIM, is a momentary three position switch, springloaded to the center position.

NOSE DOWN	Drives CAS pitch series trim actuators toward nose down position.
Center	Neutral position.
NOSE UP	Drives CAS pitch series trim actuators toward nose up position.

The switch provides a direct dc electrical path to the CAS pitch series trim actuators, bypassing the FCC, for use in event of dual CAS pitch failure. Repositioning the CAS pitch series trim provides additional nose up or nose down pitch control authority for the hydromechanical system.

CAS Cutoff Switch

The guarded switch (⑱ figure 1-24), labeled CAS CUTOFF, has two positions.

On (guard closed)	CAS in normal operating mode.
OFF (guard open)	Interrupts power to all CAS actuators.

CAS Built-In-Test

The button ㉓ labeled BIT initiates the preflight BIT. Pressing the button initiates a comprehensive check of the CAS, illuminates six caution lights

■ (AOA/FLAPS, DADU, ROLL, PITCH 1, PITCH 2, and YAW), illuminates the white BIT in-progress indicator light in the BIT button, and momentarily illuminates the NO and GO lights to check their integrity. If the CAS checks good, a green GO light illuminates after 27 seconds. If there is a system fault, the yellow NO light illuminates. The BIT in progress light, the GO lights, and the CAS caution lights remain illuminated after the BIT is complete, until the RESET switch is actuated. The reset switch causes the system to discontinue BIT and returns the CAS to flight mode. A NO light cannot be cleared by RESET. Both preflight and maintenance BIT are disabled in flight. The CAS also has a continuous self test mode, which operates at all times aircraft power is on. Both continuous and initiated BIT modes provide failure detection and isolation. The BIT verifies that all components are electrically connected and checks DADU function, motion sensors, FCC operation, and commands and checks the electromechanical pitch CAS series trim actuator motors. Illumination of the BIT light after engine shutdown indicates there has been a failure of a noncritical component.

FLIGHT TEST GAIN PANEL

The flight test gain panel (figure 1-24) provides the capability to output logic discretes for flight test computation and control. Separate switches allow independent disengagement of pitch or yaw CAS. The CAS mode switch provides for selection of single or dual channel operation. Function switches allow changes in control logic and the pitch/yaw/(roll) gain switch allows reversion from variable air data scheduling to fixed values. All functions on the flight test gain panel have a five second phase in time. See flight test supplemental instructions for operation of flight test gain panel.

PITOT-STATIC SYSTEM

The Pitot-static system supplies both impact and static air pressure to the DADU and the airspeed/Mach indicator. The altimeter and vertical velocity indicator receive only static pressure from the system.

ALTIMETER

The AAU-34/A altimeter (figure 1-3) indicates up to 80,000 feet, and is settable to sea level pressures from 28.10 to 31.00 inches of mercury. The altimeter provides altimeter setting to the system for display on the HUD and DDIs and for system pressure altitude computations. Altimeter setting is displayed on the HUD for five seconds whenever setting is changed. In A/G or NAV modes altimeter setting appears on the HUD for five seconds when passing 18,000 feet either after ascending thru 16,000 feet or after descending thru 20,000 feet. The altimeter functions in the (PNEU) operating mode, indicated by the PNEU flag, and displays uncorrected pressure altitude

Altimeter Mode Lever

The lever on the lower right corner of the altimeter is nonfunctional.

AIRSPEED/MACH INDICATOR

The AVU-8 airspeed/Mach indicator (figure 1-3) indicates airspeed in knots from 80 to 850 and in Mach number from 0.5 to 2.2 and is driven by the Pitot-static system. The indicator has an index setting pointer controlled by a knob in the lower right corner of the instrument.

DIGITAL AIR DATA UNIT (DADU)

The DADU converts aircraft supplied Pitot-static, angle-of-attack (AOA), and temperature information into usable electrical signals and sends them to the FCC and the flap control. The flap control uses these signals to automatically position the flaps. The FCC uses these signals to perform CAS gain scheduling computations, and also sends signals to the engine ECU, ECS, multiplex bus (MUX BUS), mission computer, and display processor.

DADU CAUTION LIGHT

The DADU caution light on the caution light panel indicates a dual channel DADU failure. In this condition, the CAS, engine ECU, and ECS revert to fixed gains. Failures within the Pitot-static system may cause erroneous inputs to the DADU that are not indicated by caution light illumination.

DADU FUNCTIONS

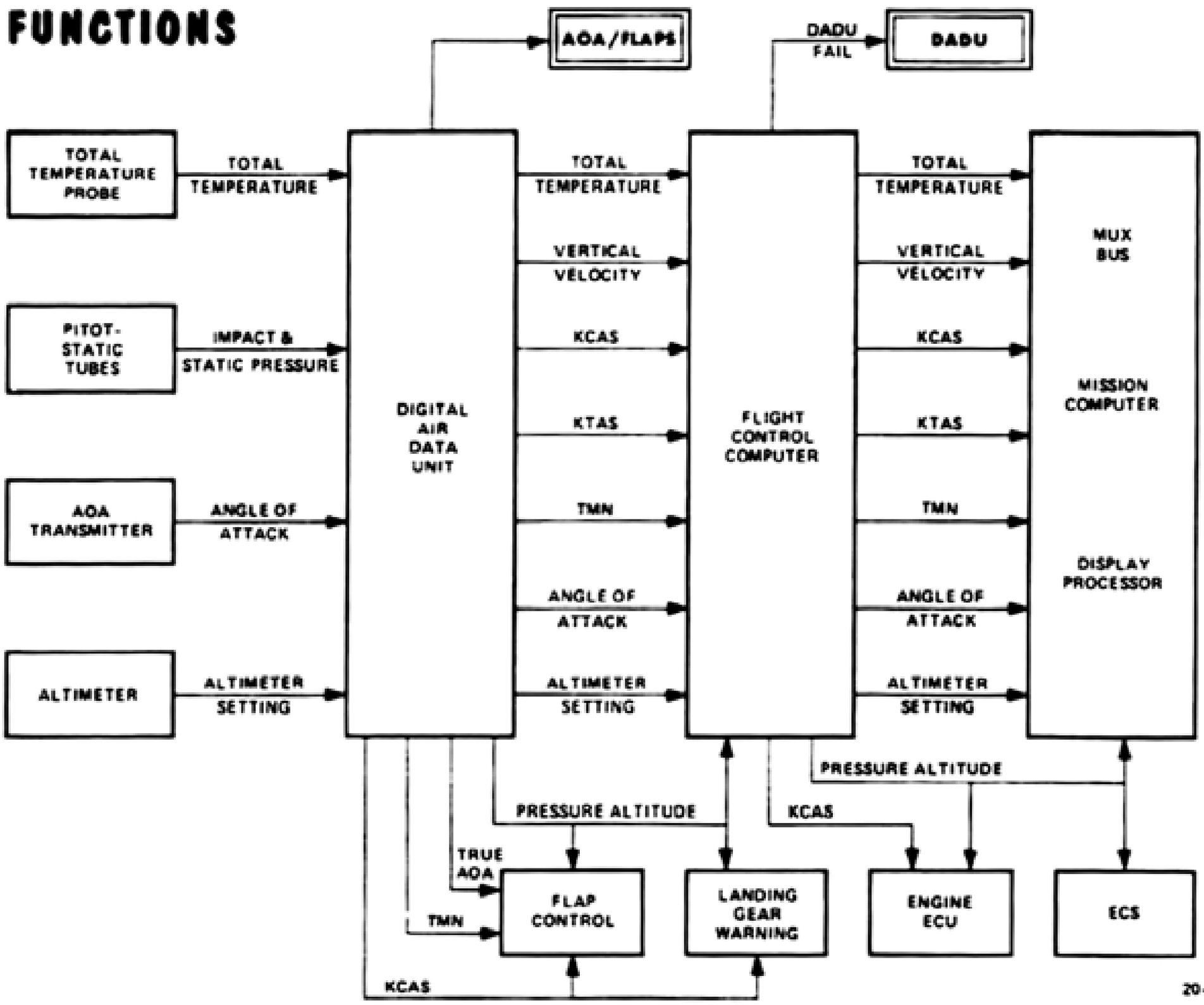


Figure 1-27.

INTEGRATED CONTROL/DISPLAY SYSTEM

The integrated control/display system consists of a head-up display (HUD), two digital display indicators (DDI), a data entry panel (DEP), a display processor (DP), a multiplex bus (MUX BUS), a mission computer (MC), an armament control panel/processor (ACP), pylon and missile control units (PIU/MIU), and controls on the stick and throttle. These units interface to provide control and display of navigation, weapons delivery, stores management, and aircraft attitude information to the pilot, figure 1-28. The integrated control/display system operates in three master modes, navigation (NAV) mode, air-to-air (A/A) mode, and air-to-ground (A/G) mode.

MISSION COMPUTER

The mission computer (MC) is a programmable, general purpose computer with stored program and core memory. Pilot entered navigation coordinates, weapons delivery data, and radio, IFF, and TACAN selections are stored, even after power interruption. The MC provides integrated avionics control, BIT, and status monitoring. It also provides data processing for control and display management, navigation, and weapons delivery. The MC interfaces with avionics equipment thru the dual MUX BUS. Failure of the mission computer causes the backup bus controller in the INS to assume bus control. Backup bus control may be selected by the bus control switch labeled MUX CONT on the auxiliary CNI control panel, figure 1-6.

Bus Control Switch

The leverlock switch labeled MUX CONT has two positions.

BKUP	Selects INS backup MUX bus control. Disables mission computer.
OFF (Normal)	Normal MUX bus control.

In backup MUX bus control operation the HUD is navigation display, the left DDI is an HSD and the right DDI is a RADAR display. The IDX label appears in backup bus control, however the IDX pushbutton is non-functional.

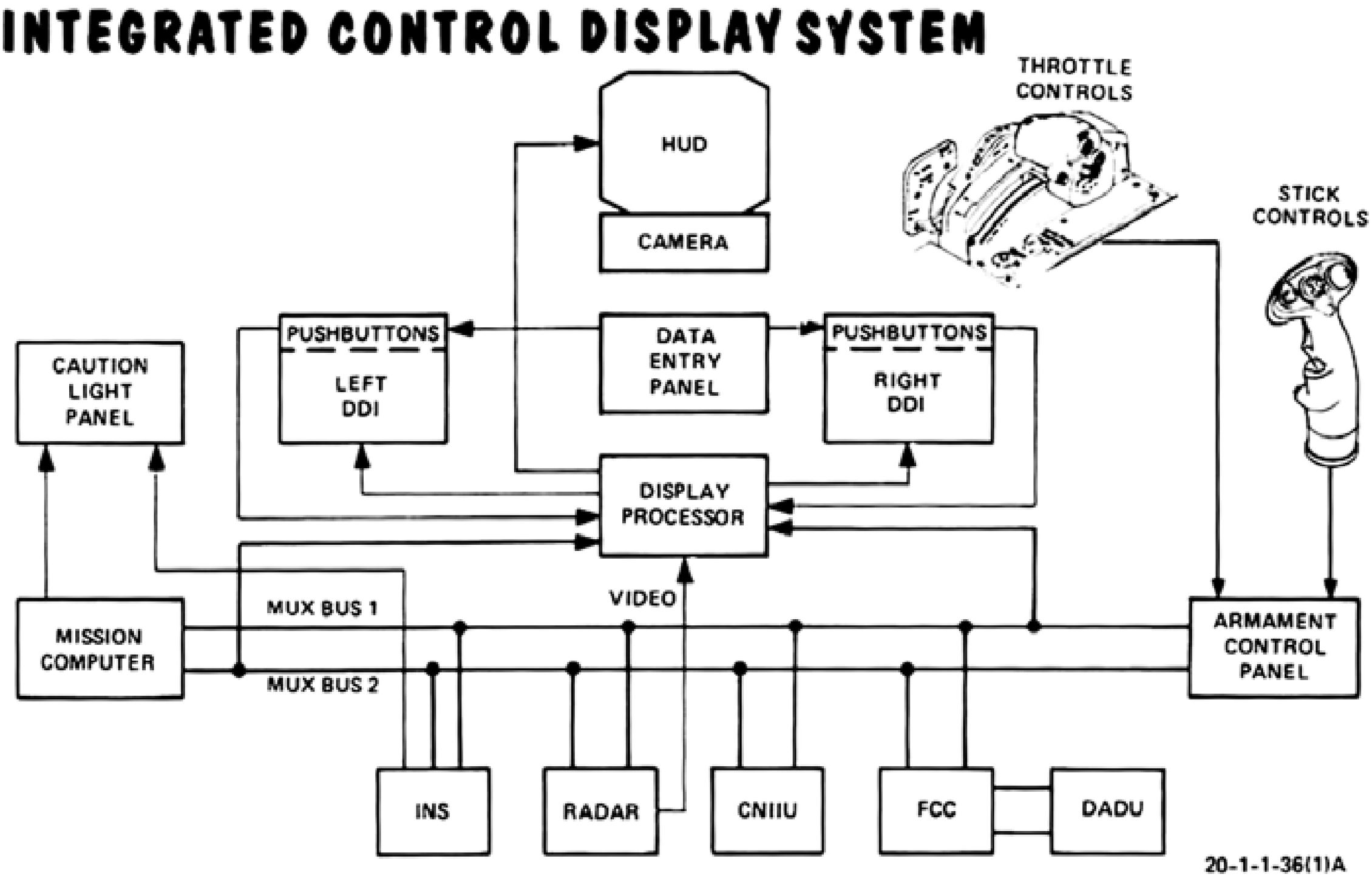


Figure 1-28.

DISPLAY PROCESSOR

The display processor (DP) interfaces the HUD and both DDIs to the MUX BUS and is responsible for display symbol generation. All displays are generated within the DP for the HUD and DDIs while information for the displays comes from the MC thru the MUX BUS. The DP is dual redundant thru the use of two symbol generator channels. A single symbol generator channel failure of the DP causes loss of one of the DDIs.

DATA ENTRY PANEL

The DEP (figure 1-29) is used to enter numeric navigation, communication, and tactical data into the mission computer. The DEP has a numerical keyboard for numbers zero thru 9, and a decimal point. As numbers are entered, they appear in the DDI scratchpad(s). Numbers are transferred from the scratchpad into the system by pressing the appropriate DDI pushbutton. The clear button labeled CLR, erases incorrect data from the scratchpad. Pressing once erases the last entry, and pressing again erases the entire scratchpad entry. Radar displays have no scratchpad provision.

Other controls on the DEP are the IFF I/P button, HUD intensity knob, HUD declutter selector, navigation mode selector and a standby reticle switch.

NAVIGATION MODE SELECT

The momentary pushbutton (figure 1-29) labeled NAV, selects navigation master mode. Upon selection of NAV mode, the HUD presents a NAV or approach display, the left DDI presents an HSD and the right DDI presents a radar display.

HUD

The HUD (figure 1-30) presents images on a combining glass in the pilot's forward field of view, focused at infinity. The HUD provides a flight reference and weapons delivery display. The display is dependent on master mode and weapon selected. Basic flight data are presented in all display modes. HUD imagery may also be selected

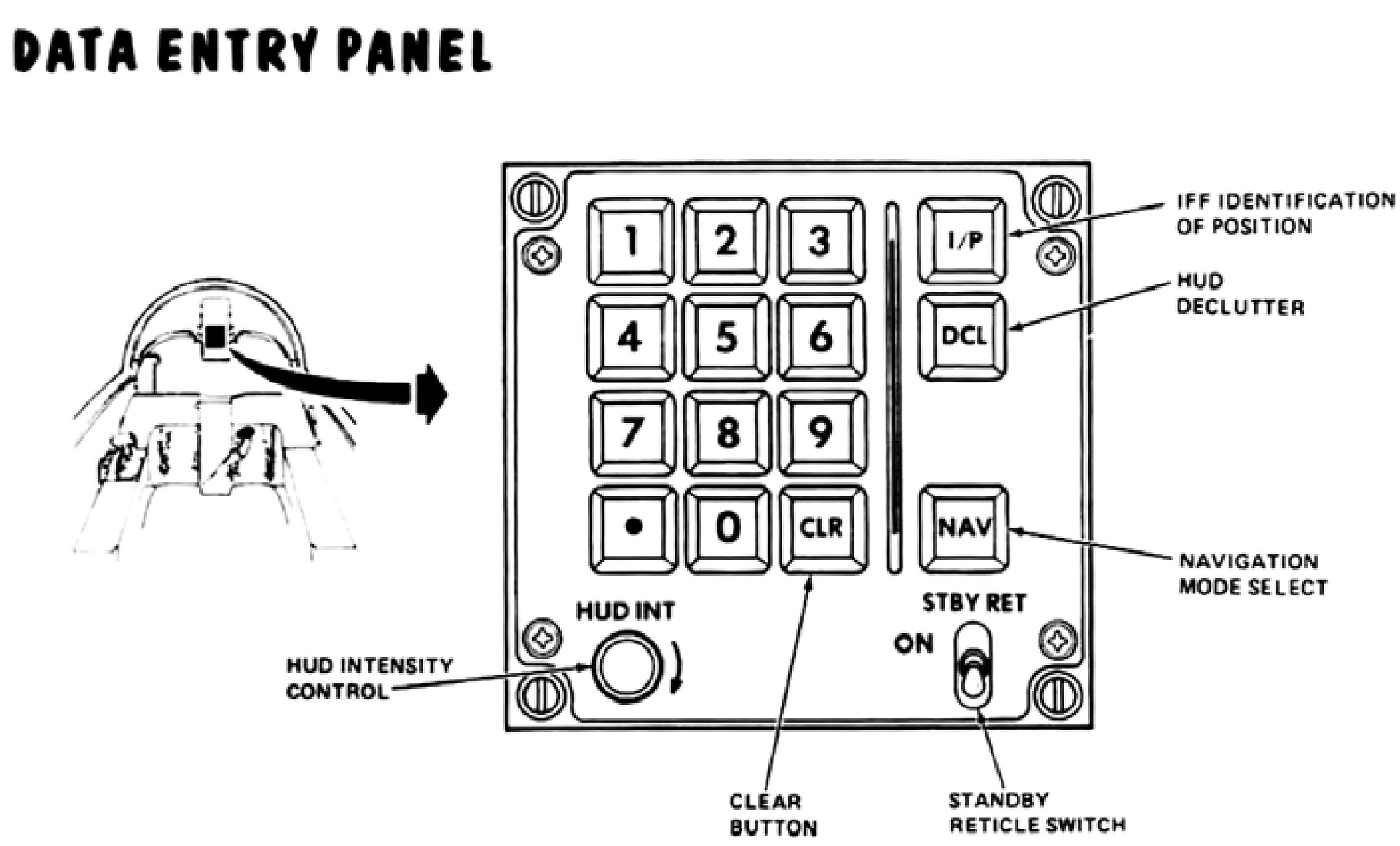
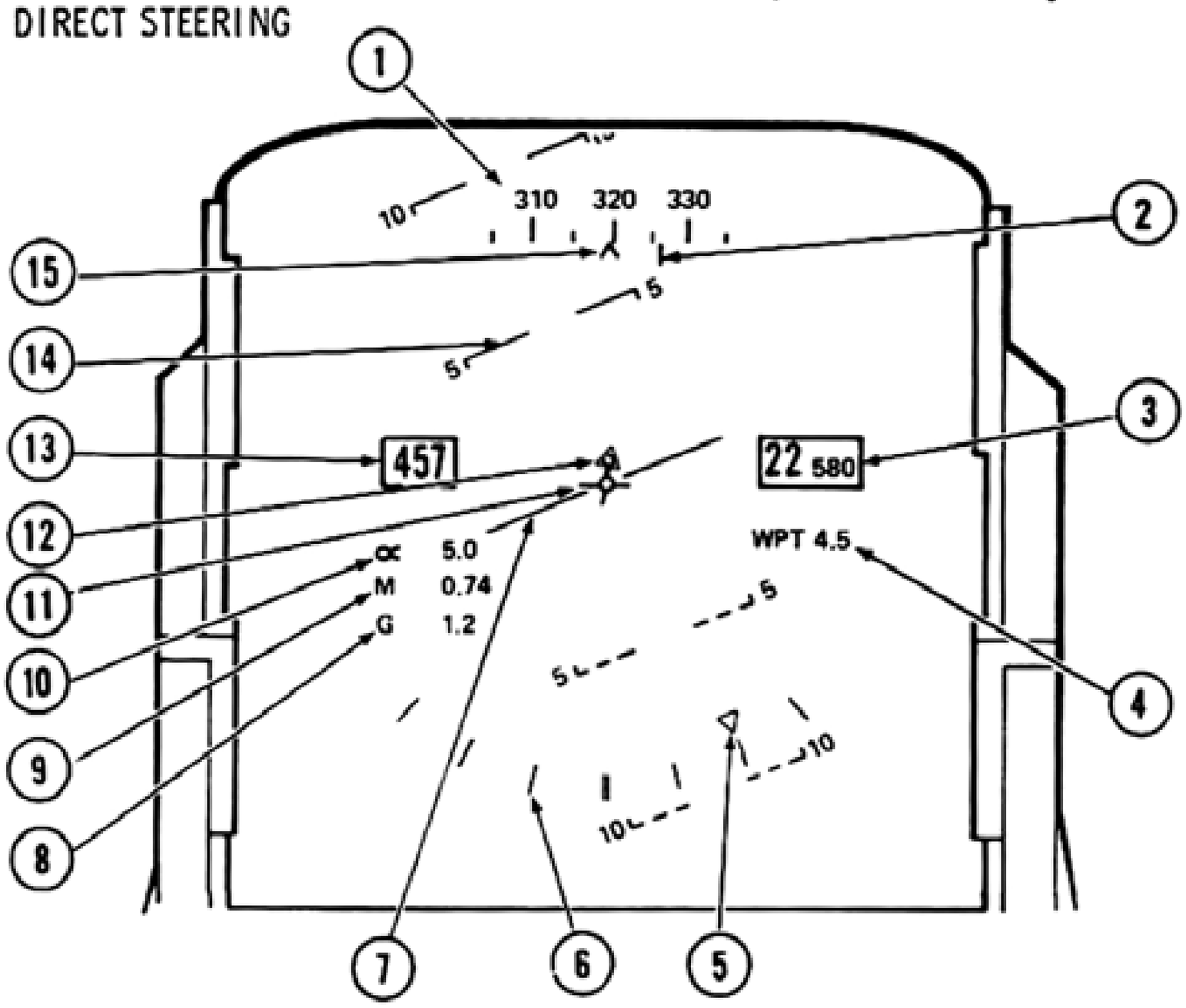


Figure 1-29.

HUD NAVIGATION MODE (TYPICAL)

DIRECT STEERING



1 HEADING SCALE
2 COMMAND HEADING MARK
3 PRESSURE ALTITUDE
4 RANGE TO SELECTED WAYPOINT
5 BANK POINTER
6 BANK SCALE
7 HORIZON BAR
8 LOAD FACTOR
9 MACH
10 ANGLE-OF-ATTACK
11 FLIGHT PATH VECTOR
12 STEERING ARROW
13 AIRSPEED
14 PITCH SCALE
15 HEADING POINTER

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Figure 1-30.

to be displayed on either DDI. Weapons delivery data is presented on the HUD when an air-to-air (A/A) or air-to-ground (A/G) weapon selection is made. HUD controls located on the DEP are HUD declutter, HUD intensity, and the standby reticle switch. The NAV mode selector is also on the DEP.

Hud Declutter

The momentary pushbutton (figure 1-29) labeled DCL is a stepping switch. After initial power-up, the HUD starts in the approach display mode (figure 1-32). Starting in the full display mode, the HUD declutter stepping switch causes the following:

DCL (first push)	Aircraft mach number and load factor (G) eliminated from HUD.
DCL (second push)	Additionally to HUD declutter one deletions, climinates boxes around altitude and airspeed, heading scale, heading pointer, command heading mark, distance to waypoint, range to TACAN, bank scale and bank pointer.
DCL (third push)	HUD cycles to full display.

Hud Intensity Knob

The knob (figure 1-29) increases HUD symbols light intensity when turned clockwise.

Hud Standby Reticle Switch

The two position switch (figure 1-29) labeled STBY RET, selects a HUD standby reticle. See weapons delivery system, this section.

Hud Navigation Mode

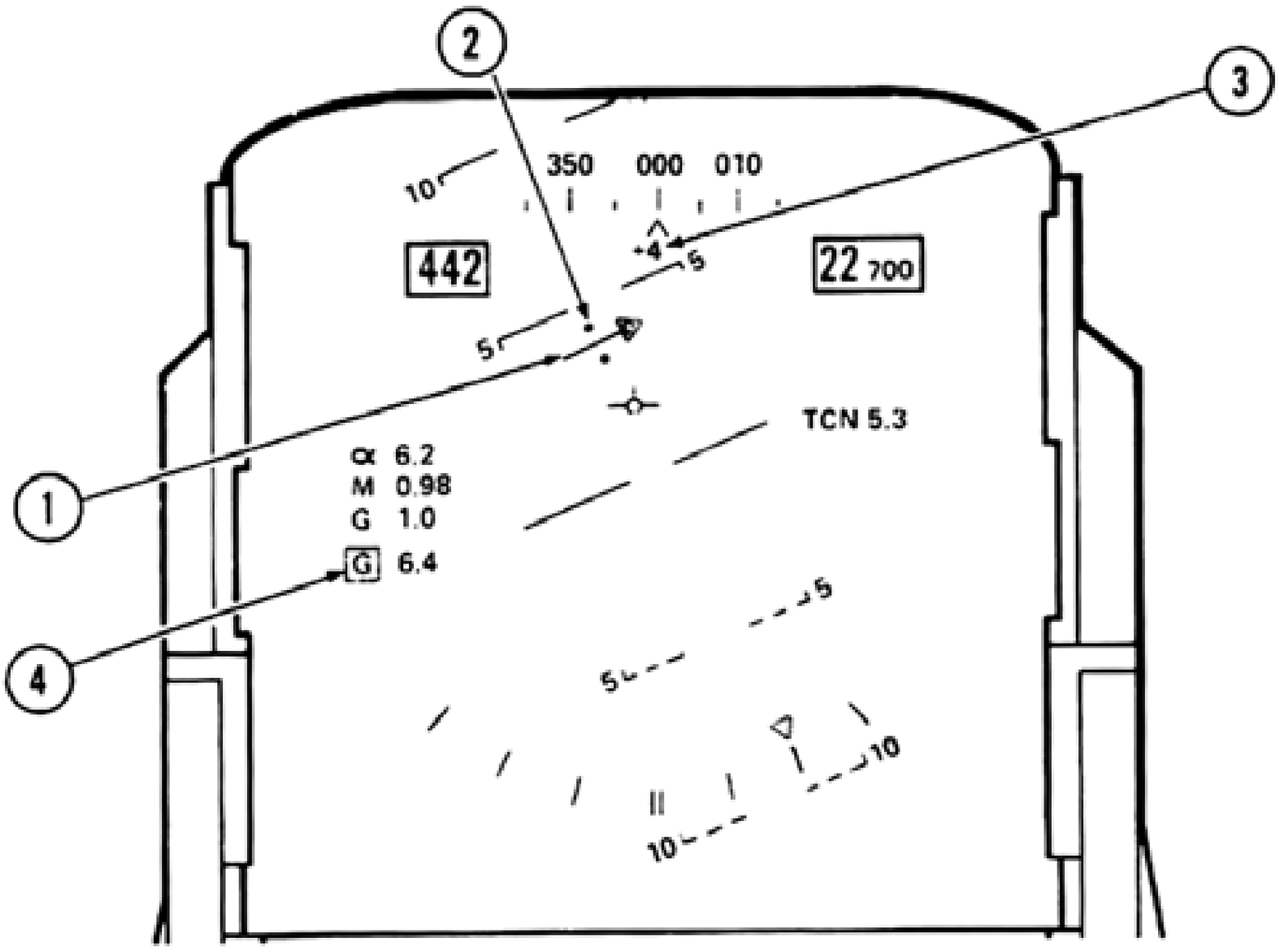
A typical gear up HUD in navigation direct steering mode, is shown in figure 1-30. The bank scale ⑥ has marks every ten degrees up to 30 degrees, to display bank angle when compared with bank pointer ⑤. On the left center of the HUD are indications of true angle-of-attack in degrees,

true Mach number, and aircraft load factor expressed in G. Above this group a boxed number ⑬ displays KCAS. The pitch scale ⑭ appears above and below the horizon bar ⑦ every five degrees. Pitch scale bars above the horizon are solid lines, and those below the horizon are dashed lines. Heading information is displayed by a heading scale ① with reference to the heading pointer ⑮. The command heading mark ② provides computed heading command when steering arrow ⑫ is less than 15 degrees from aircraft heading. On the right side of the HUD pressure altitude is displayed ③ in a rectangular box. Altimeter setting is manually set into the system on the AAU-34/A altimeter. A range indication is shown on the right side of the HUD, showing DME to the selected TACAN labeled TCN or range to waypoint labeled WPT. The steering arrow ⑫ gives steering to selected navigation point.

A typical gear up HUD in navigation course steering mode is shown in figure 1-31. The course steering arrow appears in TACAN course, INS waypoint-waypoint, and INS waypoint-course navigation modes. The arrow functions similar to a conventional horizontal situation indicator (HSI) course deviation indicator arrow. Two course deviation scale dots at 5 and 10 degrees deviation appear perpendicular to the arrow when the aircraft is more than 2-1/2 degrees off of the selected course. The HUD approach display (figure 1-32) automatically appears when the landing gear is down. This display adds an angle-of-attack bracket to provide AOA relative to optimum approach AOA. Vertical velocity in feet/minute is displayed above altitude. A positive number indicates a climb, a negative number indicates descent.

HUD NAVIGATION MODE (TYPICAL)

COURSE STEERING



1 COURSE STEERING ARROW
2 COURSE DEVIATION SCALE
3 SIDESLIP ANGLE (FLIGHT TEST)
4 MAXIMUM RECORDED G (FLIGHT TEST)

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Figure 1-31.

APPROACH DISPLAY (TYPICAL)

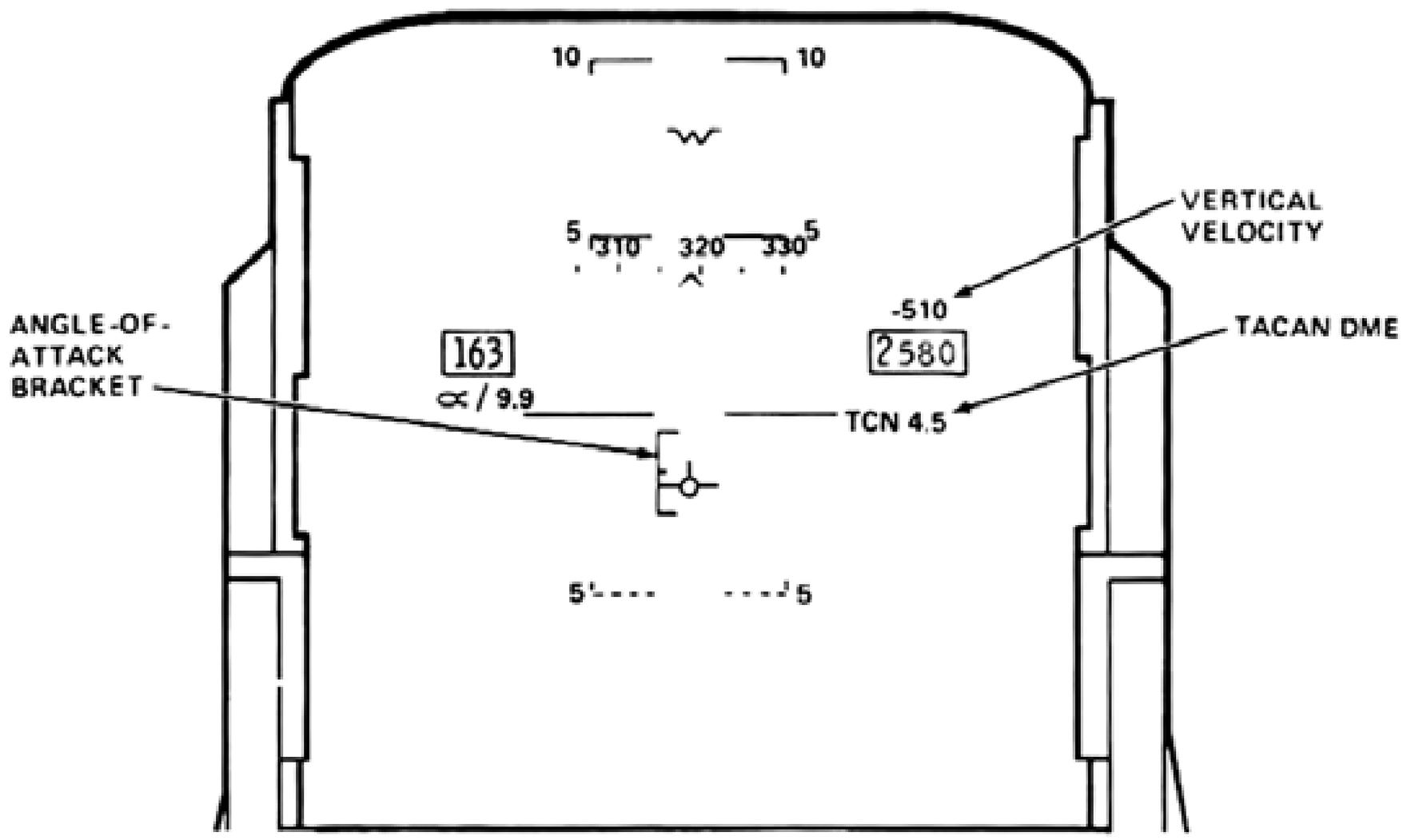


Figure 1-32.

DIGITAL DISPLAY INDICATORS

Two cathode ray tube (CRT) digital display indicators (figure 1-33) are on the instrument panel. All data available to the pilot can be displayed on either the right or left DDI. Both DDIs are identical and can present all displays: the left DDI is normally used for navigation, data entry, BIT status and stores management; the right DDI is normally used for radar display. There are twenty pushbuttons (PB-1 thru PB-20) and three control knobs on the faceplate of each DDI. The labels for pushbutton functions are part of the CRT display, and they may change for different displays. The following formatted displays are available on either DDI: index, HUD, HSD, radar, stores, BIT, CNI power, IFF, communications, INS inflight data, INS waypoint entry, and INS align.

Contrast Knob

The knob on each DDI, labeled CONT, controls video contrast.

Brightness Knob

The knob on each DDI, labeled BRT, controls video brightness.

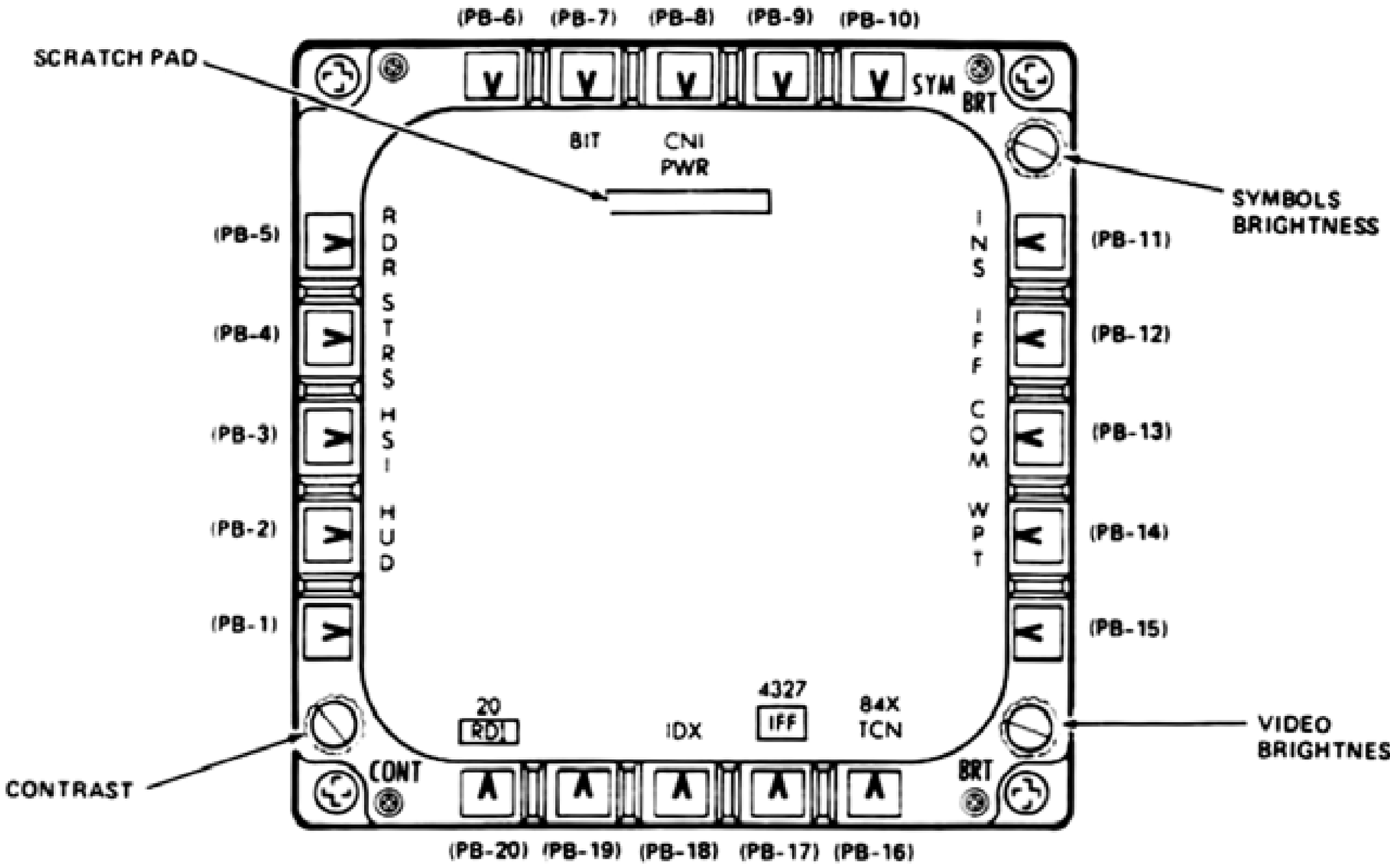
Symbology Brightness Knob

The knob on each DDI, labeled SYM BRT, controls symbology brightness on each DDI.

DDI Pushbuttons

The twenty pushbuttons on the faceplate of each DDI are controls for various systems and for selecting DDI displays. The label for each pushbutton appears on the display portion of the DDI and may be different for various displays. Buttons are referred to as PB-1 thru PB-20, (figure 1-33). PB-16 thru PB-20 have constant assigned functions on all displays except radar. On radar displays, pushbutton function activation can be made by slewing the acquisition (ACQ) cursor over a pushbutton label with the target designation control (TDC), and pressing and releasing the TDC. See Weapons Delivery System this section.

INDEX DISPLAY (TYPICAL)



PB-1	NO FUNCTION.
PB-2 HUD	SELECTS HUD FORMAT.
PB-3 HSI	SELECTS HSD FORMAT.
PB-4 STRS	SELECTS STORES DISPLAY.
PB-5	SELECTS RADAR DISPLAY.
PB-6	NO FUNCTION.
PB-7 BIT	SELECTS BIT DISPLAY.
PB-8 CNI PWR	SELECTS CNI POWER DISPLAY.
PB-9	NO FUNCTION.
PB-10	NO FUNCTION.
PB-11 INS	SELECTS INS DATA DISPLAY. WHEN INS ALIGNING, SELECTS INS ALIGN DISPLAY.
PB-12 IFF	SELECTS IFF MODE SELECT DISPLAY.
PB-13 COM	SELECTS COMMUNICATION DISPLAY, UHF PRESET FREQUENCIES.
PB-14 WPT	SELECTS WAYPOINT ENTRY DISPLAY.
PB-15	NO FUNCTION.
PB-16 TCN	TACAN CHANNEL SELECTOR.
PB-17 IFF	MODE 3 CODE SELECTOR.
PB-18 IDX	NO FUNCTION IN INDEX DISPLAY. IN ALL OTHER DISPLAYS, SELECTS INDEX DISPLAY.
PB-19	NO FUNCTION.
PB-20 RD 1	UHF RADIO NO. ONE GUARD RECEIVER AND CHANNEL/FREQUENCY SELECTOR.

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Figure 1-33.

INDEX DISPLAY

The index display (figure 1-33) may be called up from other displays by activating the PB-18 function, labeled IDX. Scratchpad entries are erased when IDX is selected.

BUILT-IN-TEST SYSTEM

As soon as systems are powered, a continuous BIT is initiated for INS, TACAN, MC, CNIIU, DP, DDIs, HUD, armament control panel (ACP), radar, MUX bus, wingtip interface units and pylon interface units. In addition, a one time IFF BIT check is accomplished. If the BIT detects a fault in these systems, the IDX label above PB-18 is boxed. To identify system fault, the BIT display (figure 1-34) is selected by PB-7 from the index display.

PB-7 BIT—Push	Selects BIT display.

Bit status is reported to the right of each tested system label with the following words.

NO RSPNS	System unpowered, missing, or not responding.
NO GO	System failed BIT.
IN TEST	System being tested (maintenance initiated BIT only).
DEGD	Partial failure of the system.
(BLANK)	System in a go or ready status.
NON-RED	DP is not redundant.
3D9FC060	Typical MUX BIT code.
1, 2 3, or 4	Radar antenna, processor, computer, or transmitter failed.

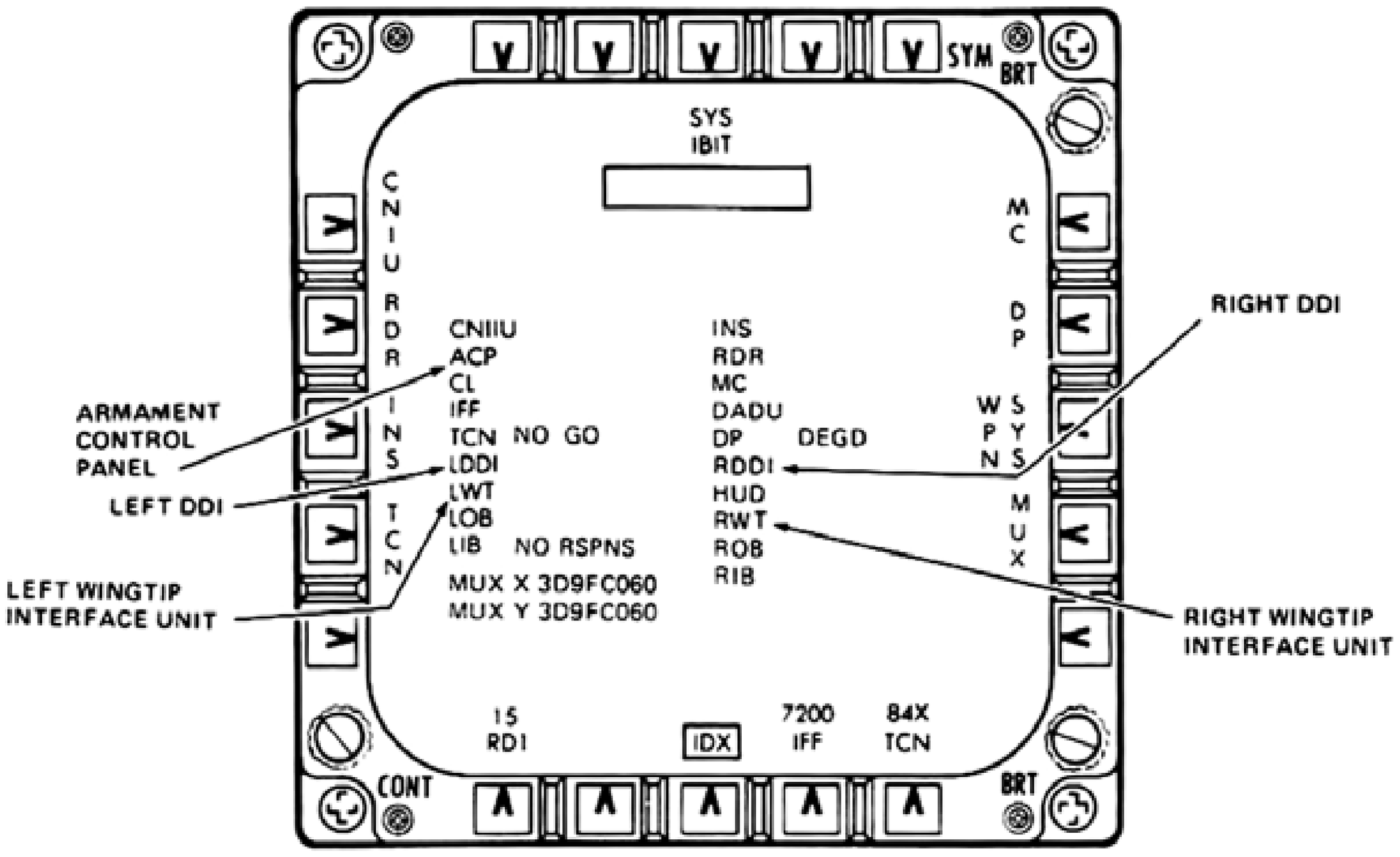
PB-18, 'abeled IDX, is pressed to exit the BIT display. Manually selected IFF BIT may be accomplished on ground or in flight by selecting the IFF mode select display. See figure 1-42.

INITIATED BIT

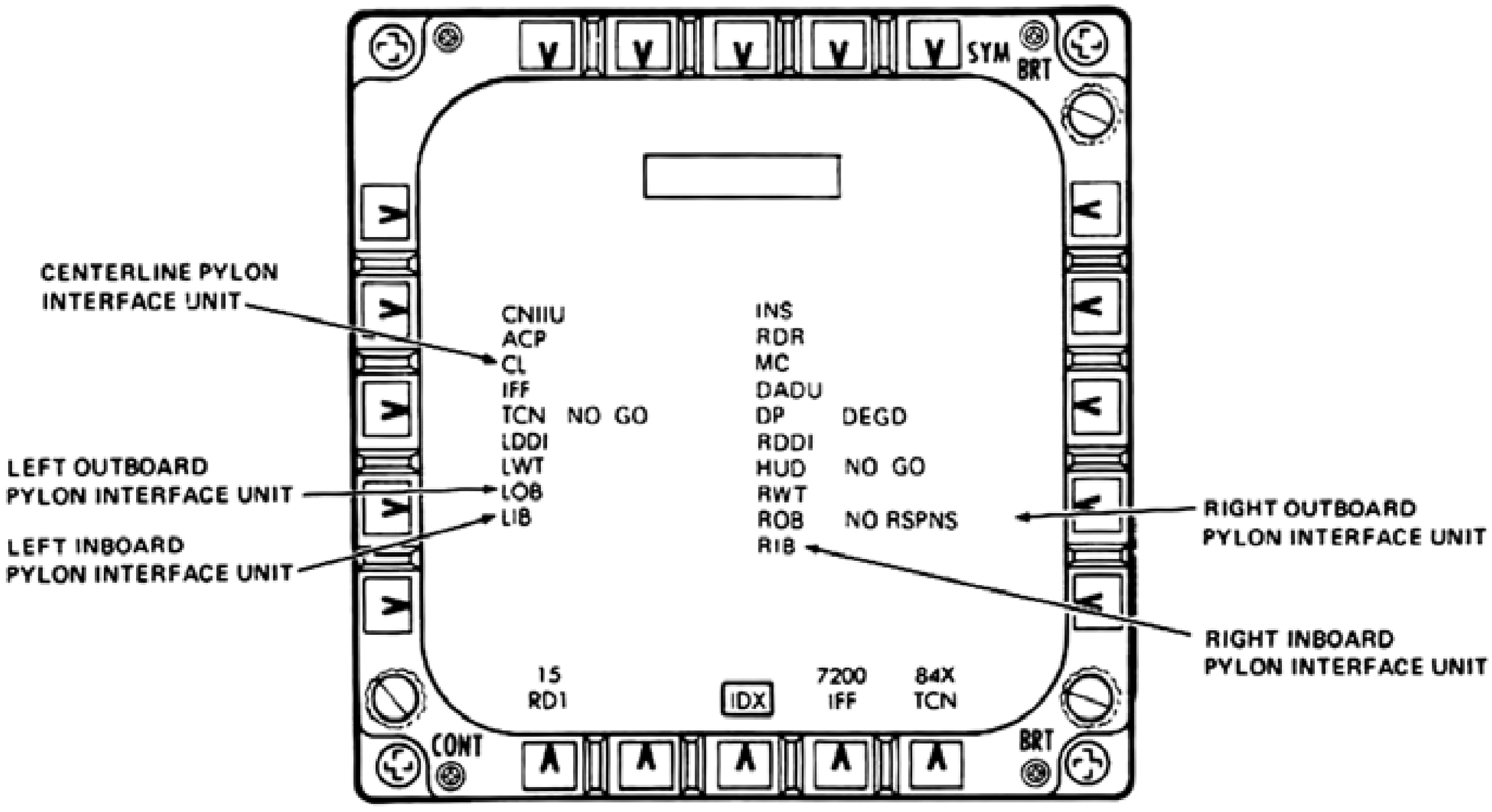
Initiated BIT is a more comprehensive maintenance test, and can be accomplished only on the ground. The BIT display labels pushbuttons to provide a means to initiate maintenance BIT checks. Systems in test are off-line during test. Initiated BIT may take up to 12 minutes to complete and cannot be cancelled or exited until completed. Initiated BIT for all systems simultaneously or for individual systems can be selected from the BIT display (figure 1-34). An electrical power interruption terminates all initiated BIT.

PB-2 TCN—Push	Initiated TACAN BIT.
PB-3 INS—Push	Initiated INS BIT.
PB-4 RDR—Push	Initiated radar BIT.
PB-5 CNIU—Push	Initiated CNIIU BIT.
PB-8 SYS IBIT—Push	Initiated BIT for INS, TACAN, MC, CNIIU, DP, DDIs, HUD and external stores interface units.
PB-11 MC—Push	Initiated MC BIT.
PB-12 DP—Push	Initiated BIT for DP left DDI (LDDI) right DDI (RDDI) and HUD.
PB-13 WPN SYS—Push	Initiated BIT for ACP, left wingtip interface unit (LWT), right wingtip interface unit (RWT), left outboard (LOB), right outboard (ROB), left inboard (LIB), right inboard (RIB), and centerline (CL) pylon interface units.
PB-14 MUX—Push.	Initiated MUX X and MUX Y BIT.

BUILT-IN-TEST DISPLAYS (TYPICAL)



BIT DISPLAY – GROUND



BIT DISPLAY – INFLIGHT

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Figure 1-34.

ATTITUDE REFERENCE SYSTEM

Attitude reference is provided by the INS to the HUD and to the alternate attitude indicator. INS attitude reference may also be provided on various DDI displays when selected. The standby attitude indicator provides a self contained backup attitude reference.

HUD ATTITUDE REFERENCE

The INS provides continuously stabilized pitch and roll attitude to the HUD throughout the flight envelope. The HUD displays basic attitude reference in the three master modes by the horizon bar, pitch scale and the velocity vector. In navigation mode a bank pointer and scale are provided (figure 1-30).

DDI ATTITUDE REFERENCE

The HUD format can be selected on either DDI. Attitude information is also available on radar displays unless declutter is selected.

ALTERNATE ATTITUDE INDICATOR

The ARU-20/A attitude indicator is stabilized thru a direct circuit by the INS to show pitch and roll attitude. The attitude sphere is continuously stabilized to maintain orientation during aircraft maneuvers. An off flag appears in the lower left indicator face if the attitude indicator is tumbled by power interruption or INS malfunction. The attitude indicator may erect to a false vertical after power is restored.

STANDBY ATTITUDE INDICATOR

The standby attitude indicator is a self-contained indicator that provides pitch and roll information. The indicator is caged and set following engine start, and left uncaged for flight. The instrument is powered by the essential DC bus. When power is interrupted to the instrument an off flag appears. Approximately 9 minutes of useful attitude information are available after power failure. The indicator is subject to basic gyro limitations such as precession during acceleration or deceleration and may tumble during maneuvering flight near the vertical.

HEADING REFERENCE SYSTEM

The INS normally provides heading reference to the HUD and to DDI displays. Backup heading reference to the HUD and DDI displays is provided by the directional gyro backup heading system. A standby magnetic compass is also provided.

HUD HEADING REFERENCE

Heading reference is displayed on the HUD by the heading scale and heading pointer (figure 1-30).

DDI HEADING REFERENCE

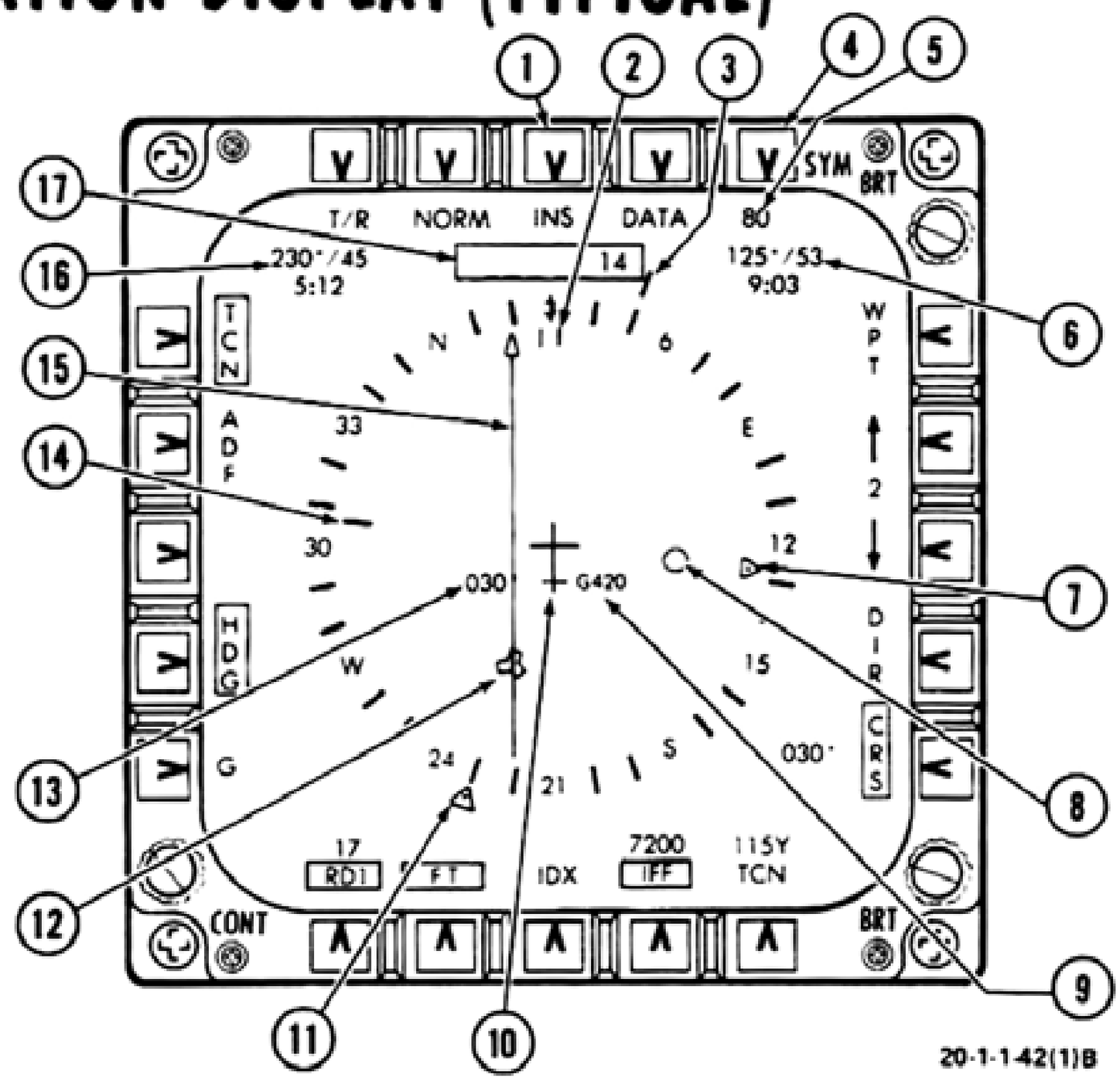
In the horizontal situation display (HSD), heading is provided to the digital electronic HSD in the form of compass card in a display similar to a conventional analog HSI (figure 1-35). The DDIs may display the symbology from the HUD. Heading reference is provided by the HUD heading reference scale unless HUD declutter two has been selected. Aircraft heading is displayed at the top center of each radar display.

HORIZONTAL SITUATION DISPLAY

The HSD is similar to a conventional analog HSI (figure 1-35). The steering arrow is either a course steering arrow when a course steering or a waypoint-waypoint steering mode is selected, or a direct steering arrow when a direct steering mode or ADF is selected. Bearing pointers show the bearing to a TACAN station and to an INS waypoint. Time, range and bearing to the TACAN station and the INS waypoint are also shown. TACAN and INS waypoint symbols are positioned on the HSD proportionately to the range scale selected. The selected range is from the center of the HSD to the inner edge of the compass rose. The scratchpad on the HSD is not shown unless there is a scratchpad entry. A heading marker is provided to mark a desired heading. Heading marker is positioned to heading entered in scratchpad.

PB-2 HDG—Push	Positions heading marker to heading in scratchpad. If scratchpad not shown, removes heading marker from display.

HORIZONTAL SITUATION DISPLAY (TYPICAL)



1 DG/INS SELECT
2 HEADING MARKER
3 TACAN BEARING POINTER (TAIL)
4 RANGE SCALE SELECT
5 RANGE SCALE INDICATION
6 INS WAYPOINT BEARING/ RANGE /TIME
7 INS WAYPOINT POINTER (HEAD)
8 INS WAYPOINT SYMBOL
9 GROUNDSPEED
10 AIRCRAFT SYMBOL
11 TACAN BEARING POINTER (HEAD)
12 TACAN SYMBOL
13 HEADING
14 INS WAYPOINT POINTER (TAIL)
15 STEERING ARROW
16 TACAN BEARING/DME/TIME
17 SCRATCH PAD

Figure 1-35.

The displayed range scale is selectable by PB-10, range scale selector.

PB-10 Push	Acts as a stepping switch, alternately selects range scale of 80, 40, 20, or 10 nm.

DIRECTIONAL GYRO BACKUP HEADING SYSTEM

The directional gyro (DG) backup system consists of a magnetic azimuth detector and a gyro to stabilize detected magnetic heading. Magnetic heading is sent to CNIIU for digital conversion, and then to the MUX BUS for use by other systems. If INS heading becomes unreliable DG mode is automatically selected. The DG heading reference can also be manually selected to replace INS heading reference. DG mode is selected from the HSD by PB-8 labeled INS.

PB-8 INS—Push	Selects DG heading reference mode and changes PB-8 label to DG. Labels PB-3, FS (fast slave).
PB-8 DG—Push	Selects INS heading reference mode and changes PB-8 label to INS. Deletes PB-3, FS label.

After selection of DG mode PB-3 becomes a DG fast slave button.

PB-3 FS—Push (Hold)	Fast slaves DG.

The DG system is monitored by the DG light on the caution light panel.

Directional Gyro Caution Light

The caution light labeled DIR GYRO illuminates when the DG system is inoperative or unreliable. When the DG caution light is on, the DG system should not be used.

MAGNETIC STANDBY COMPASS

The standby compass is provided to cross check primary and backup systems and for use if other systems fail. Compass correction cards are in the holders on the right interior trim panel of the cockpit (figure 1-2).

COMMUNICATIONS, NAVIGATION, AND IDENTIFICATION SYSTEMS

Communication, navigation, and identification (CNI) systems consist of UHF radios, TACAN, UHF ADF and IFF. These systems are normally controlled by DDI and DEP pushbuttons. TACAN, IFF, and No. one radio power are automatically turned on at initial aircraft power-up. Audio volume is controlled by separate controls on the volume control panel (figure 1-6). Backup control is provided by the controls on the auxiliary communication, navigation, identification control panel (AUX CNICP). CNI information is displayed on DDIs and HUD.

■ CNI POWER DISPLAY

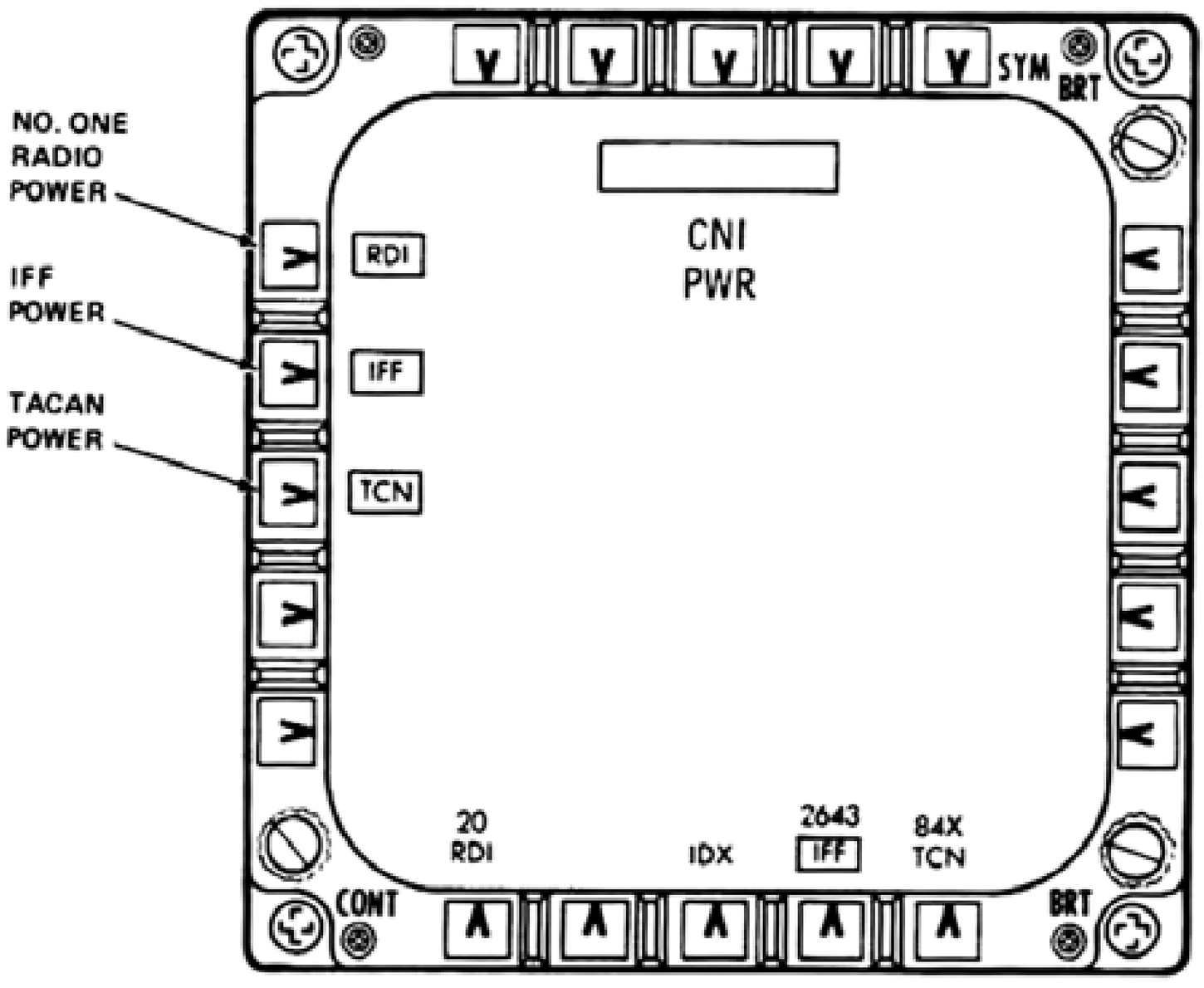
Power can be manually turned on and off from the CNI power display, (figure 1-36). The CNI power display is selected by pressing PB-8 labeled CNI, PWR, from the index display.

PB-8 CNI PWR—Push	Selects CNI power display.

On the CNI power display, PB-3 labeled TCN, PB-4 labeled IFF, and PB-5 labeled RD1, are the TACAN, IFF, and No. one radio power controls.

PB-3 TCN—Push	Alternately turns TACAN on or off. TCN label is boxed when system is on. Label TCN on PB-16 appears when power on.
PB-4 IFF—Push	Alternately turns on and off power to IFF system. Label IFF on PB-4, boxed when IFF power on. Label IFF on PB-17 appears when power on.

CNI POWER DISPLAY (TYPICAL)



20-1-1-43(1)A

Figure 1-36.

PB-5 RD1—Push	Alternately turns No. one radio power on and off. When power is on, RD1 label for PB-5 is boxed. Label RD1 on PB-20 appears when power on.

COMMUNICATIONS, NAVIGATION, IDENTIFICATION INTERFACE UNIT

The CNIIU acts as control interface between the MUX BUS and the UHF No. one radio, IFF, ADF, and TACAN. MUX BUS interface only is also provided for the directional gyro backup heading system. Pilot control is thru the DDI and DEP pushbuttons. Signal conversion from digital/analog-analog/digital for MUX BUS interface is provided, with data storage capability for last selected manual radio frequency, twenty-one preset radio channels, IFF modes/codes, last selected TACAN channel, and BIT status.

CNIIU BIT

The CNIIU continuous BIT checks internal functioning and interface to attached units. Initiated CNIIU BIT also checks attached units. BIT failure is indicated on the BIT display. After a BIT failure indication, CNI equipment should be checked for proper operation.

INTERCOMMUNICATIONS SYSTEM

The intercom system provides headset amplification for the UHF radios, the radio navigation systems, audio warning signals, AIM-9 missile tones, and cockpit-to-ground crew intercom.

Intercom Volume Control

The knob on the volume control panel (figure 1-6), labeled ICS, controls intercom volume only. Other audio signals are controlled by their separate volume controls.

UHF RADIO

The AN/ARC-164 UHF radio provides two-way voice or tone communications at line of sight range. Twenty-one frequencies may be preset and are selected by entering desired channel on the scratchpad and pushing PB-20. The system includes a main transceiver, guard receiver, antenna selector switch, a volume control on the volume control panel and backup controls on the AUX CNICP. A Flight Test No. two UHF radio, installed for additional flight test communication requirements, is not integral with the primary system.

UHF Radio Control

The UHF is normally controlled by DDI pushbuttons and the DEP. UHF radio power is automatically turned on at initial aircraft power-up. Power can be manually turned on and off from the CNI power display. The radio is keyed by sliding the throttle microphone switch forward to the position labeled 1, or by depressing the stick mounted nosewheel steering button in flight.

CAUTION

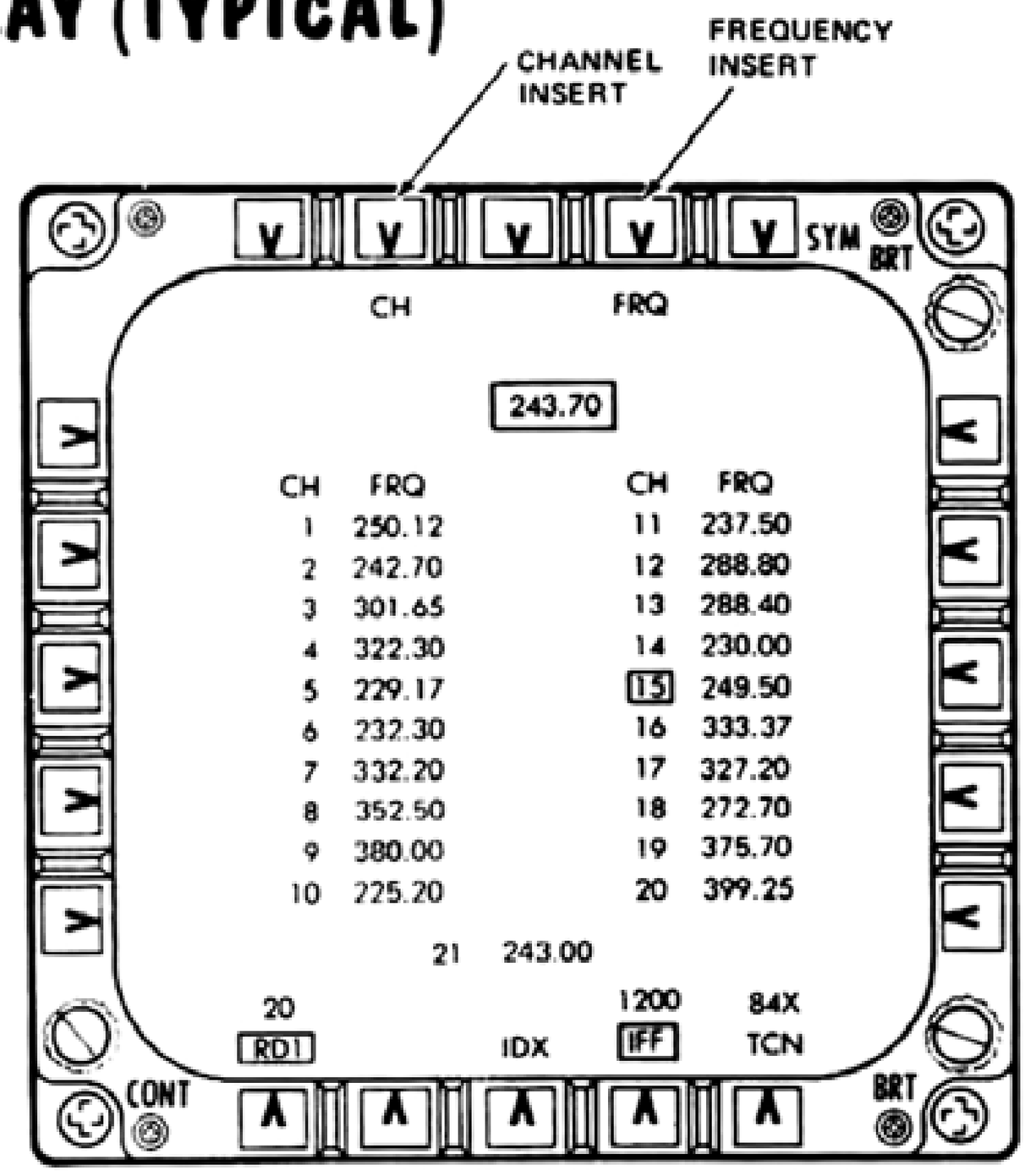
Do not key transmitter while changing frequencies, as damage to the transmitter results.

Label RD1 at PB-20 appears only when UHF power is on. This selection is available on all displays except radar. Selecting UHF frequencies, channels, and/or guard receiver is by PB-20 and the DEP, from any navigation master mode display.

PB-20 RD1—Push	With blank scratchpad, alternately turns guard receiver on or off. PB-20 label, RD1, is boxed when guard receiver is on. With numbers 1 thru 21 in scratchpad, selects preset channel. Channel selected is displayed above PB-20, RD1 label. With a UHF frequency in scratchpad, sets frequency. Frequency selected is displayed above PB-20, RD1 label.

When PB-20 is pressed with incorrect data in scratchpad, scratchpad numbers flash on and off.

COMM DISPLAY (TYPICAL)



20-1-1-44(1)A

Figure 1-37.

UHF Preset Channelization

The radio is channelized from the communication (COMM) display. The COMM display is selected from the index display by PB-13 labeled COM. COMM display PB-7 labeled CH, PB-9 labeled FRQ and the DEP are used for channelization. The channel is entered in the COMM display (figure 1-37) scratchpad and PB-7 pushed.

PB-7 CH—Push	Selects channel in scratchpad. Boxes selected channel.

Frequency to be channelized is entered in scratchpad and then PB-9 is pushed.

PB-9 FRQ—Push	Channelizes frequency to selected channel. Frequency appears next to channel number.

UHF Antenna Selector

The switch (③ figure 1-38) labeled COM ANT, is inoperative. The No. one UHF is connected to the upper UHF antenna, and the Flight Test No. two UHF is connected to the lower UHF antenna.

UHF Tone Button

The button on the AUX CNICP labeled TONE transmits a 1020 cps tone on the selected UHF No. one frequency.

UHF Squelch Switch

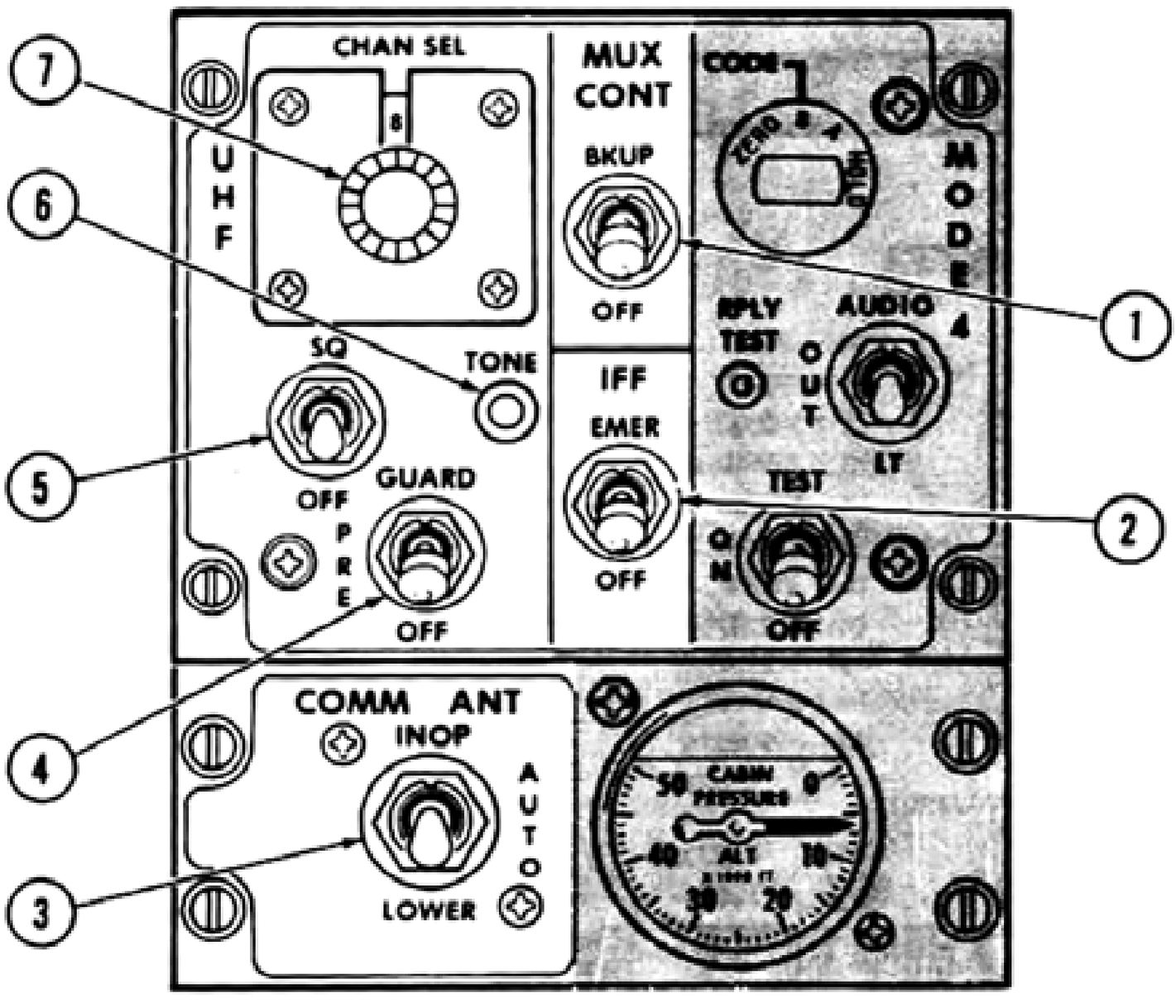
The switch on the AUX CNICP labeled SQ has two positions.

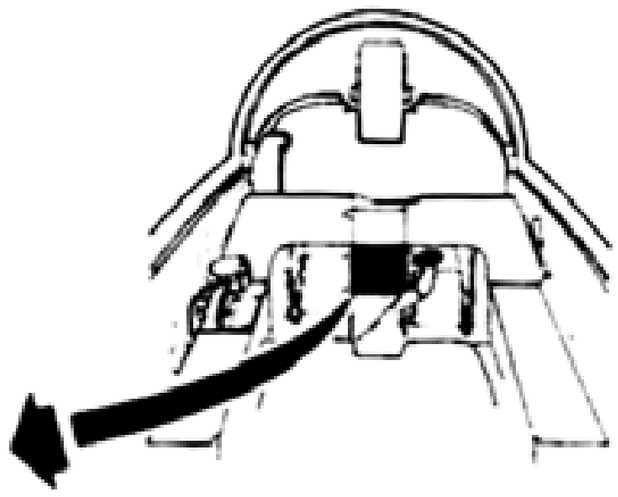
SQ	In the SQ position, squelch eliminates background noise in No. one UHF reception.
OFF	Disables squelch to permit reception of a weak UHF signal. Squelch is disabled during ADF operation.

UHF Radio Backup Controls

Backup control of the No. one UHF is provided by a channel selector and a guard/backup switch, figure 1-38.

AUXILIARY CNI CONTROLS





1 BUS CONTROL SWITCH
2 IFF EMERGENCY SWITCH
3 UHF ANTENNA SWITCH (INOP)
4 GUARD/BACKUP SWITCH
5 UHF SQUELCH SWITCH
6 UHF TONE BUTTON
7 UHF BACKUP CHANNEL SELECTOR

20-1-1-45(1)A

Figure 1-38.

Guard/Backup Switch

The three position lever lock switch (④ figure 1-38) selects guard channel or backup channel control.

GUARD	Transmitter and receiver tuned to channel 21. Guard frequency is selected only if 243.00 MHz is set into channel 21.
PRE	Enables backup channel selector.
OFF	Normal position for primary UHF operation.

Backup Channel Selector

The backup channel selector is used to manually select radio No. one preset channels when the Guard/Backup Switch is in PRE.

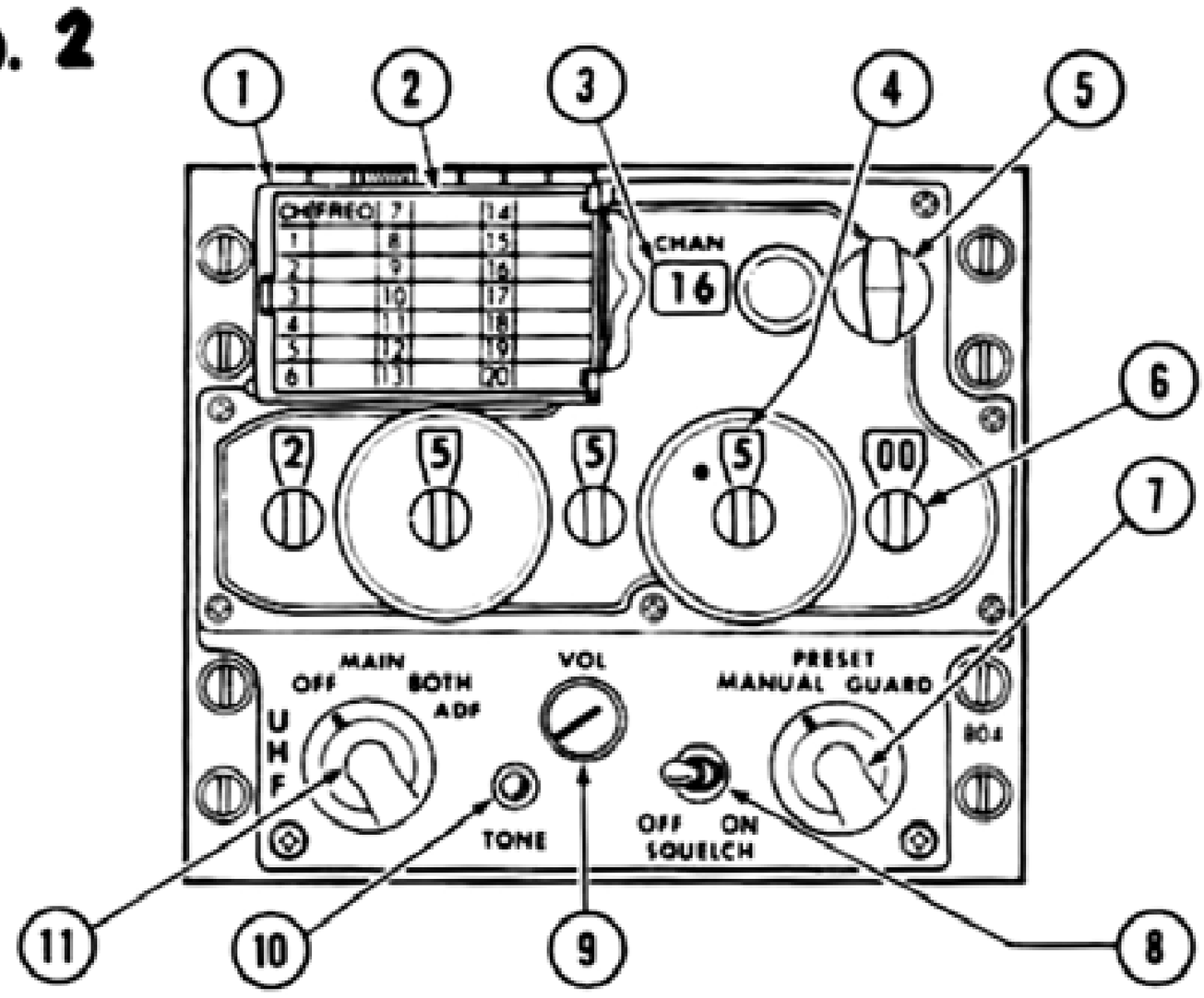
FLIGHT TEST NO. TWO UHF RADIO

A second AN/ARC-164 UHF radio (figure 1-39) is installed for flight test requirements. The radio control is located on the pilot's left console, and operates independently of the DDI and DEP controls.

Flight Test No. Two UHF Radio Control

The No. two UHF radio is turned on manually. Sliding the throttle microphone switch aft to the position labeled 2 keys the radio. The ADF function of the No. two radio is inoperative. The No. two radio system operates independently of the primary UHF radio system, and utilizes the standard AN/ARC-164 control head. Twenty preset channels are available. Refer to figure 1-39 for location of radio controls.

UHF RADIO No. 2



1 PRESET SET SWITCH ACCESS DOOR
2 PRESET CHANNEL CHART
3 PRESET CHANNEL INDICATOR
4 MANUAL FREQUENCY SELECTOR WINDOWS
5 PRESET CHANNEL SELECTOR KNOB
6 MANUAL FREQUENCY SELECTORS (5)
7 FREQUENCY SELECTOR MODE CONTROL
8 SQUELCH CONTROL SWITCH
9 VOLUME CONTROL
10 TONE TRANSMIT BUTTON
11 FUNCTION SELECTOR

20-1-1-83(1)

Figure 1-39.

TACAN SYSTEM

The UHF TACAN AN/ARN-118 system provides range, bearing, course and course deviation to a selected ground or airborne TACAN station. TACAN information can be displayed on the HUD and the DDIs. A total of 126 channels, each with an X or Y designation, can be selected, making 252 UHF channels (frequencies) available. The TACAN is controlled by DDI and DEP push-buttons.

Tacan Operation

Upon initial power-up, the TACAN is turned on. The system may be manually turned on from the CNI power display.

PB-3 TCN—Push	Alternately turns TACAN on or off. TCN label is boxed when system is on.

TACAN channel is selected by entering channel number on the scratchpad and then pushing PB-16 labeled TCN. This selection is available in all displays except RADAR.

PB-16 TCN—Push	With channel entered in scratchpad, selects and displays channel number above TCN label. With blank scratchpad, alternately selects X or Y band and displays X or Y after channel number.

TACAN mode selection is made by pushing the TACAN mode select button PB-6, on the HSD (③ figure 1-40). This button functions as a stepping switch alternately selecting receive (REC) transmit/receive (T/R), aircraft-to-aircraft transmit/receive (AA T/R), and aircraft-to-aircraft receive (AA REC).

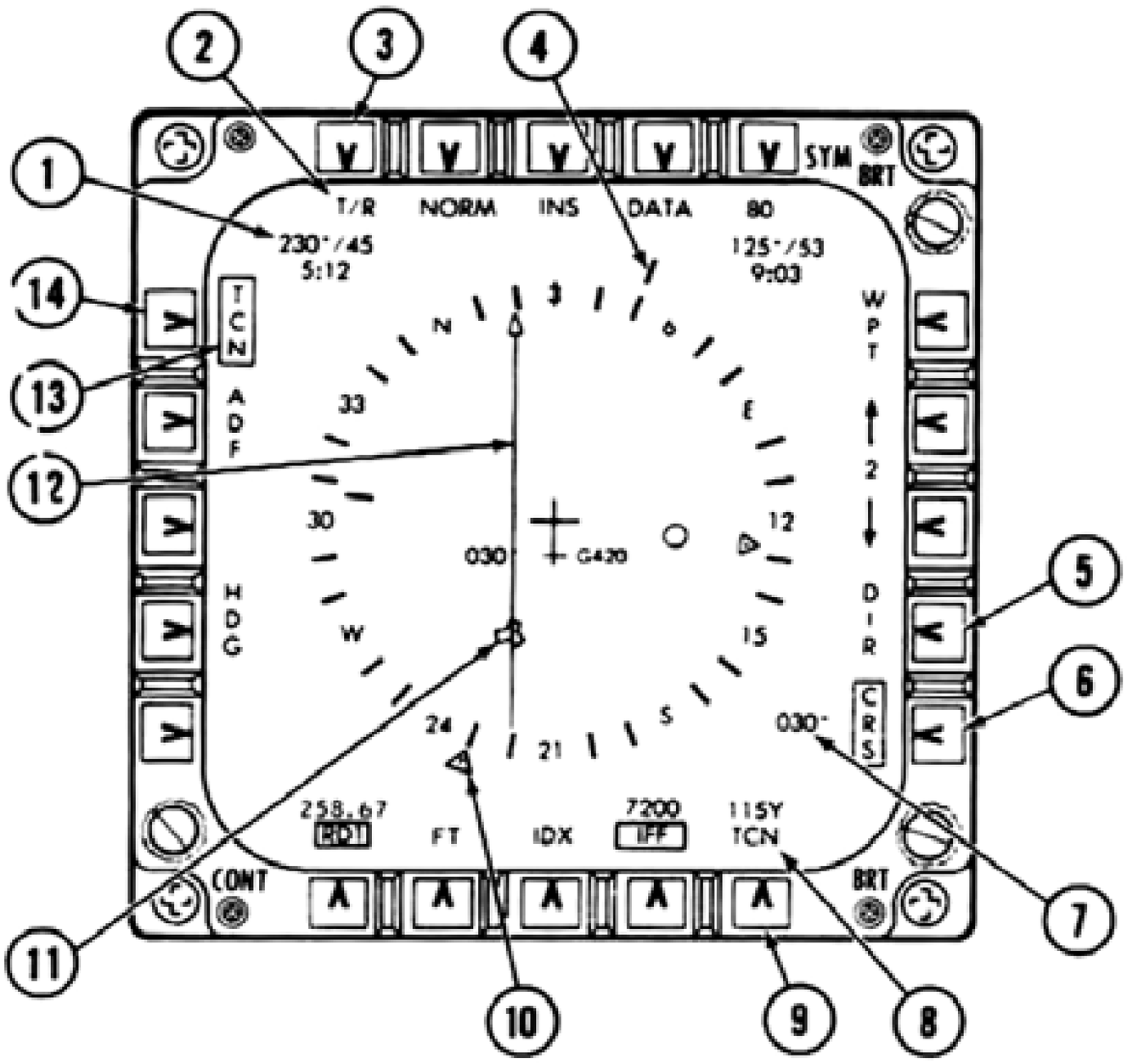
PB-6	Alternately selects REC, T/R, AA T/R and AA REC. Label displays mode selected.

Tacan Aircraft-To-Aircraft Mode

Aircraft-to-aircraft mode provides DME capability for tracking and rendezvous with similarly equipped aircraft out to 250nm. Cooperating aircraft must select channels spaced exactly 63 channels apart. Bearing can be available with specially equipped cooperating aircraft.

HORIZONTAL SITUATION DISPLAY (TYPICAL)

TACAN COURSE STEERING



1	TACAN BEARING/DME/TIME
2	TACAN MODE INDICATION
3	TACAN MODE SELECT
4	BEARING POINTER (TAIL)
5	DIRECT STEERING SELECT
6	COURSE STEERING SELECT
7	SELECTED COURSE
8	TACAN CHANNEL INDICATION
9	TACAN CHANNEL SELECT
10	BEARING POINTER (HEAD)
11	TACAN SYMBOL
12	STEERING ARROW
13	TACAN STEERING INDICATION
14	TACAN STEERING SELECT

20-1-1-46(1)B

Figure 1-40.

HSD - TACAN Steering

TACAN steering is selected from the HSD PB-5 labeled TCN (⑭ figure 1-40).

PB-5 TCN—Push	Selects TACAN steering TCN label, by PB-5, boxed when TACAN selected.

TACAN bearing, DME, and time to go are displayed under PB-6 TACAN mode label. The TACAN symbol is positioned on the HSD proportionately to its actual location from the aircraft based on the scale chosen. TACAN direct steering information on DDI and HUD may be selected by pushing PB-14. If no other steering mode has been selected TACAN navigation mode initializes in TACAN direct steering.

PB-14 DIR—Push	Selects direct steering to TACAN. Label DIR is boxed when selected.

TACAN course intercept steering is displayed by first entering desired course in scratchpad and then activating PB-15.

PB-15 CRS—Push	Provides steering display to intercept selected course. Selected course is displayed by PB-15, CRS label. Label CRS is boxed when selected.

HUD-TACAN Steering

In NAV mode TACAN bearing is presented on the HUD by the steering arrow and range is presented below altitude. In TACAN course steering, the steering arrow can displace from the flight path vector. When more than 2-1/2 degrees off course, five and ten degree deviation dots appear (figure 1-31).

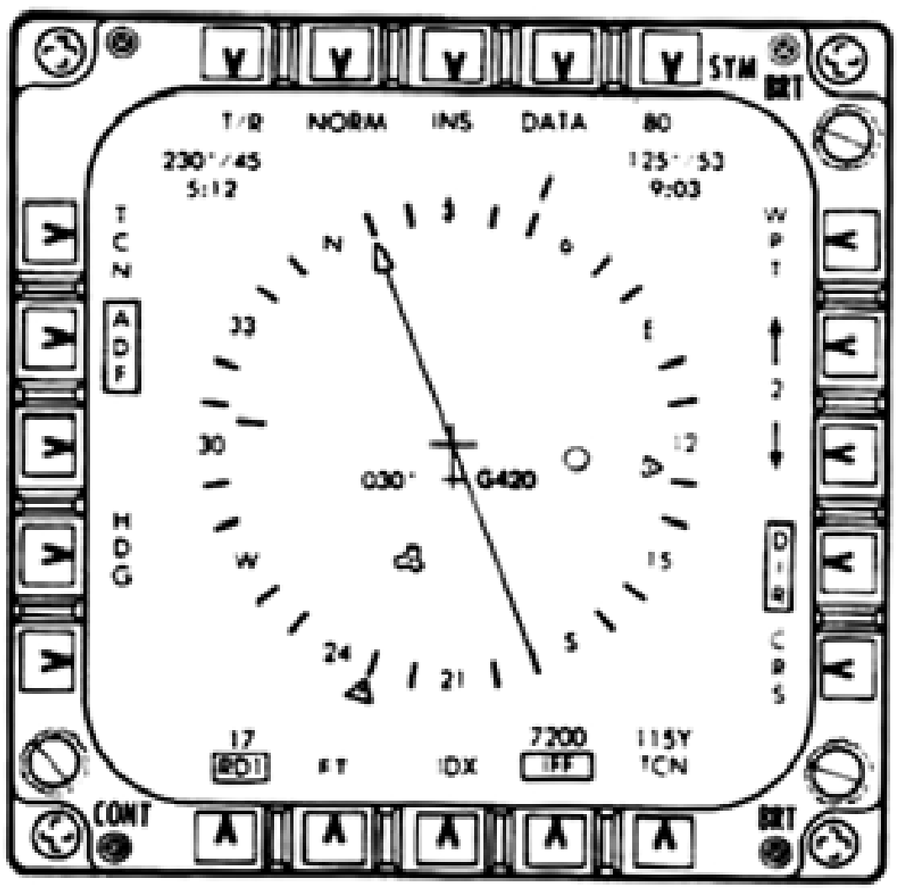
UHF AUTOMATIC DIRECTION FINDER (ADF)

The UHF ADF operates in conjunction with the number one radio to provide bearing indication to any ground or airborne UHF radio to which the radio is tuned. Any frequency in the standard UHF communications band may be used. ADF steering is displayed on the HSD (figure 1-41) by selecting PB-4 labeled ADF, from the HSD. The steering arrow points to the UHF station.

PB-4 ADF—Push	ADF bearing display selected. ADF and DIR labels boxed when ADF selected.

In ADF, the number one UHF radio squelch is disabled.

ADF STEERING (TYPICAL)



20-1-1-47(1)A

Figure 1-41.

IFF/SIF SYSTEM

The IFF/SIF system is an airborne pulse transponder that receives coded interrogations from surface or airborne radar (IFF) and automatically transmits coded selective identification (SIF). The system operates in five modes and is capable of I/P (identification of position) and emergency identification. The modes are 1—Security Identify; 2—Self Identify; 3—Air Traffic Identify; 4—Classified—Security Identity (not installed); and C—Altitude Reporting. The receiver responds only to interrogations in the selected mode and code. Mode 2 is preset on the ground only. IFF control is thru the DEP and DDI's and the AUX CNICP. Mode 4 controls on the right side of the AUX CNICP, as well as IFF volume control, are nonfunctional as mode 4 is not installed.

IFF/SIF Controls

The IFF power is turned on at initial power up. The system may also be turned on or off from the CNI power display.

IFF Mode Select Display

The IFF mode select display is selected from index display PB-12 labeled IFF. The IFF mode select display enables the entry of mode 1 and 3 codes. BIT and microphone selections are available (figure 1-42).

PB-3 MODE 3	With no code in scratchpad, alternately turns mode 3 on or off. When mode 3 on, label is boxed. With mode 3 numerical code in scratchpad, enters code as new mode 3 code and displays code beside PB-3, MODE 3, label. Also displays entered mode 3 code above PB-17 label, IFF.
PB-4 MODE 2	Alternately turns mode 2 on or off.
PB-5 MODE 1	With no code in scratchpad, alternately turns mode one, on or off. With mode one numerical code in scratchpad, enters new code in system and displays code beside PB-5 label, MODE 1.
PB-6 TEST	Initiates IFF BIT.
PB-10 MON	No function.
PB-11 MIC	Enables IFF microphone function, automatic identification reply signal to interrogations for 20 seconds after either microphone is keyed. Label MIC is boxed when function is selected.

IFF MODE SELECT DISPLAY

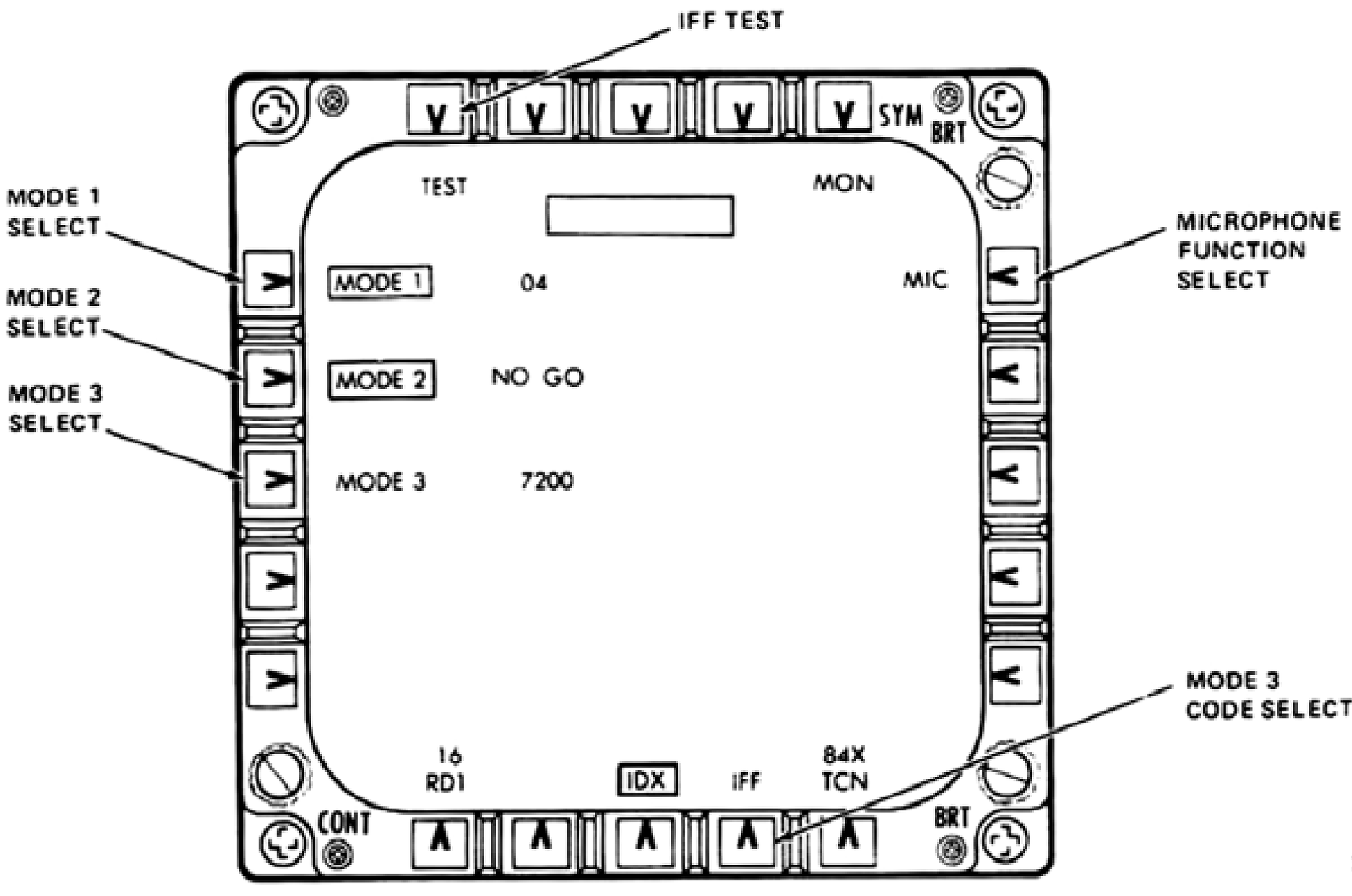


Figure 1-42.

IFF Bit

IFF BIT is initiated by pushing PB-6, labeled TEST on the IFF mode select display. BIT status is indicated beside each mode label. A blank indicates mode is in go status. Only modes selected on (boxed) will be tested. To test all modes simultaneously, first turn on mode one, mode two, and mode 3A and C. IFF BIT is a separate BIT system, and may be checked on-ground or in flight.

IFF Sensitivity (HSD Display)

IFF sensitivity options are selectable on the HSD by PB-7.

PB-7	Alternately selects IFF standby (STBY), normal (NORM) or low (LOW). Displays selection below PB-7.

IFF Mode 3 Select

IFF mode 3 numerical code and mode 3A and C are selected from any non-radar display by PB-17.

PB-17 IFF	No scratchpad entry, alternately selects mode 3A or mode 3A and C. Label IFF boxed when mode C selected. With mode 3 code numbers in scratchpad, enters new mode 3 code. Mode 3 code displayed over PB-17 labei IFF.

IFF IP Switch

The momentary pushbutton on the DEP, labeled I/P, provides 20 seconds of identification reply after being pressed.

IFF Emergency Switch

The two position lever lock switch on the AUX CNICP, labeled IFF, provides IFF emergency functions.

OFF (Normal)	IFF in normal operation as selected by other controls.
EMER	Transmits emergency reply signals to modes 1, 2, or 3A interrogations, regardless of mode control settings. Mode 3 (7700) transmitted automatically.

INERTIAL NAVIGATION SYSTEM

The laser inertial navigation system (INS) is a self contained, nonemitting navigation, attitude, and heading reference system. INS components are ring laser gyros, inertial accelerometers, a mode switch and ready light, and associated electronics. INS operation is accomplished by DDI and the DEP pushbuttons. The navigation unit is mounted so that each rotation axis has an associated laser gyro and accelerometer. Each laser gyro has two identical frequency laser beams aimed in opposite directions. Angular rotation in the plane of the beams causes a doppler frequency shift which is measured, electronically integrated with accelerometer data, and used for attitude, heading, and navigation data.

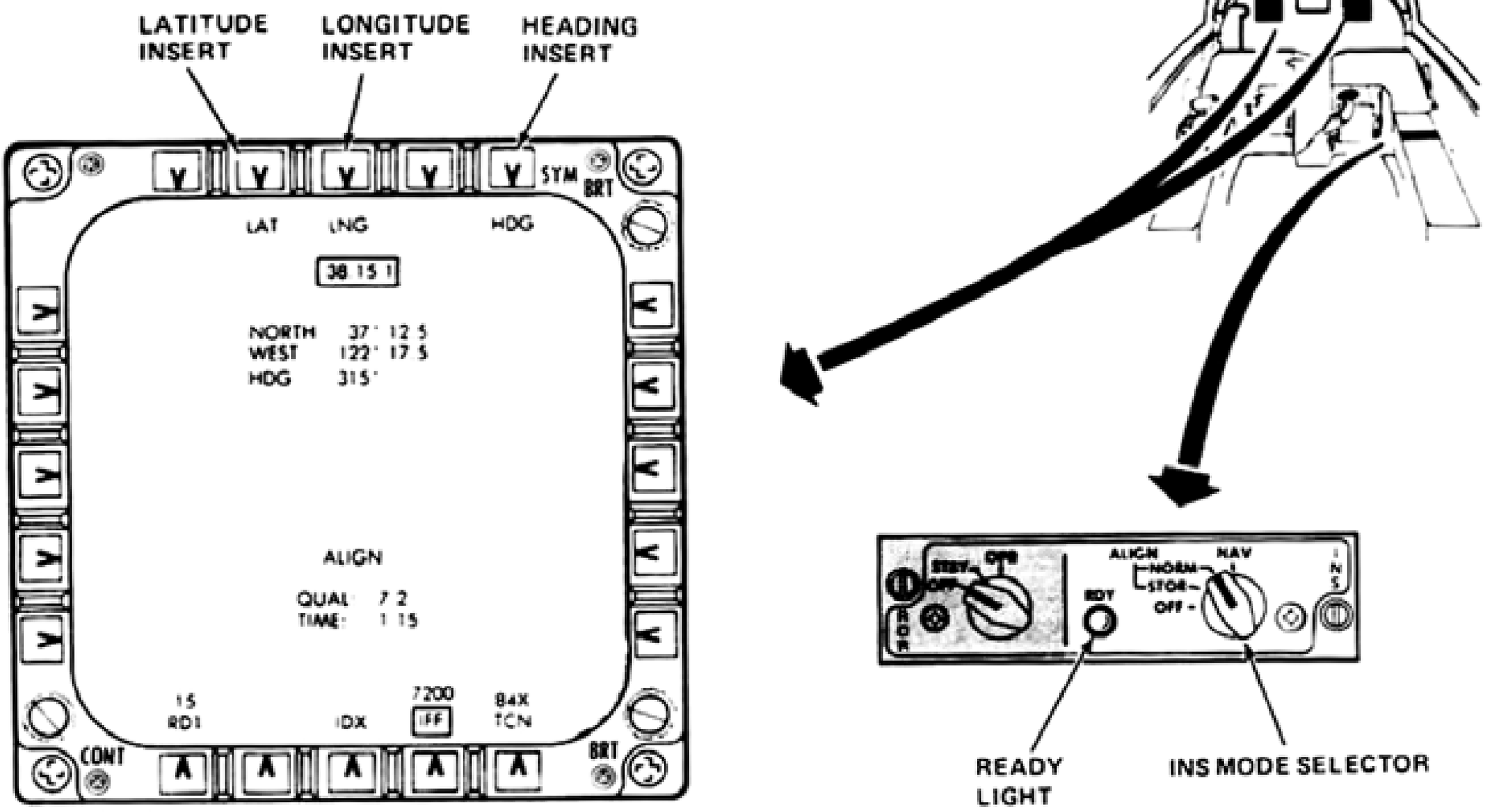
The INS provides present position, true and magnetic heading, magnetic variation, INS altitude, aircraft attitude, g, groundspeed, course deviation, wind direction and velocity, steering to waypoints, distance and time to waypoints or destination, and built-in-test information. INS attitude is provided directly to the alternate attitude indicator. INS information to other systems is provided through the MUX BUS and mission computer. In the event of MC failure, the INS performs the backup bus control function.

INS Mode Selector

INS power and alignment is controlled by the four position rotary switch (figure 1-43) labeled INS.

OFF	INS power off.
STOR-ALIGN	Powers INS to stored alignment mode after a 2 second BIT.
NORM-ALIGN	Powers INS to normal alignment mode after 2 second BIT.
NAV	After alignment, places INS into full operation.

INS ALIGN DISPLAY/CONTROLS (TYPICAL)



20-1-1-50(1)B

Figure 1-43.

INS Alignment

Two alignment modes are available, normal or stored. Both are initiated by the INS mode switch. As no warmup, spinup, or mechanical leveling is required for the ring laser gyro, attitude information is almost instantaneous. Attitude accuracy is 0.5 degree within one second. Full system accuracy can be attained in approximately four minutes in a normal alignment or in 22 seconds in a stored alignment. In both alignment modes the INS may be switched to NAV after the ready light illuminates if degraded navigation capat ility is acceptable.

INS Normal Alignment

After selecting normal alignment with the INS mode switch, present position should be entered as soon as possible to ensure a rapid alignment process. To enter present position, press PB-11, labeled INS, from the index display. In align mode PB-11 calls up the align display, figure 1-43.

Present position, to the nearest tenth of a minute, is entered on the scratchpad of the alignment display (degrees-decimal-minutes-decimal-tenths of minutes).

PB-7
LAT—Push

When latitude is on the scratchpad, enters latitude into system and displays entry on alignment display.

When scratchpad is blank, reverses north/south polarity.

PB-8
LNG—Push

When longitude is on the scratchpad, enters longitude into system and displays entry on alignment display.

When scratchpad is blank, reverses east/west polarity.

Alignment quality and elapsed time in alignment mode are displayed on the alignment display below the label ALIGN. The quality label indicates from 0.8 to 9.9. Minimum navigation accuracy is achieved within 30 seconds and full accuracy in four minutes.

INS Stored Alignment

INS stored alignment provides fast reaction time with full navigation accuracy. In this mode the INS

uses heading from previously aligned system. This heading is checked against sensed heading and accepted or rejected. If rejected, the system will go into a normal alignment mode after one minute. If the aircraft has been moved since last system shutdown, stored alignment may be used with a manually entered heading. Magnetic heading is entered into the system after selecting stored alignment and the alignment display. In the alignment display first enter aircraft magnetic heading in the scratchpad and then press PB-10 labeled HDG. Heading is entered into the system and displayed on the alignment display. Full system accuracy can be available in 22 seconds from the stored alignment mode.

INS DATA DISPLAY

After INS alignment when system is in NAV, INS data is presented on either the left or right DDI by pressing PB-11 from that index display, figure 1-44. Present position, wind velocity and direction, magnetic variation and groundspeed are displayed. Error information is displayed during an INS position update. The PB-9, labeled HSI selects an HSD.

INS Update

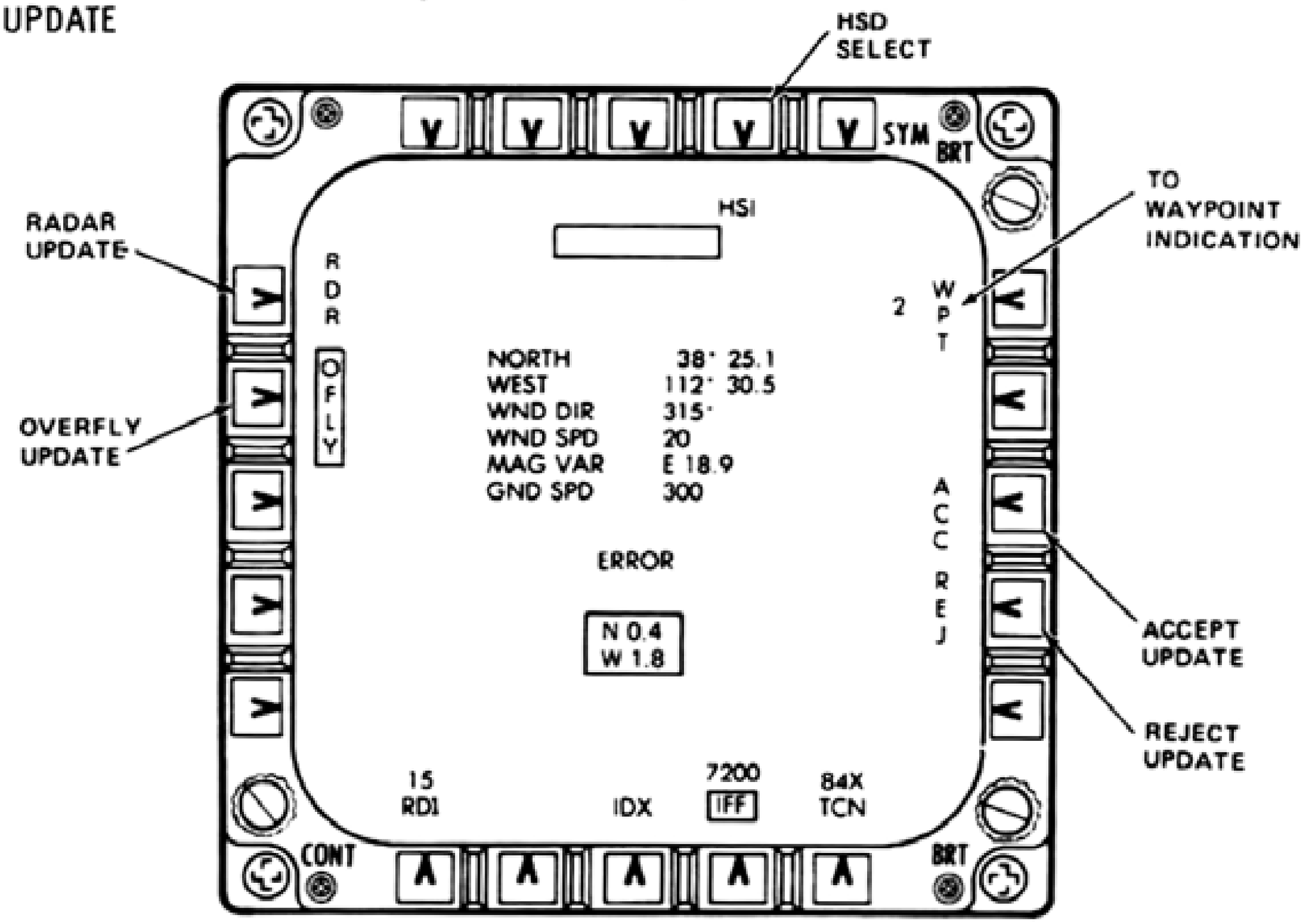
An overflight update is accomplished from the INS data display by selecting waypoint with PB-11, labeled WPT, and then pressing PB-4 labeled OFLY. When selected, OFLY is boxed. When aircraft is directly over selected waypoint the TDC on the throttle is pressed and released. A radar update is accomplished from the INS data display by selecting waypoint with PB-11 labeled WPT, and then pressing PB-5 labeled RDR. When selected, RDR is boxed. On a MAP or SEA display the cross hair cursor is placed over the waypoint radar return and the TDC is released. In either the radar or overflight update method, North (N)/South (S) and East (E)/West (W) error in nautical miles between computed and updated INS position are displayed below the ERROR label after the TDC is released. The update can be either accepted, PB-13, labeled ACC or rejected, PB-14, labeled REJ. In either case the error information disappears from the display.

INS WAYPOINT ENTRY DISPLAY

Up to ten navigation waypoints can be programmed into the system from the waypoint entry display. Waypoint entry display (figure 1-45) is selected by

INS DATA DISPLAY (TYPICAL)

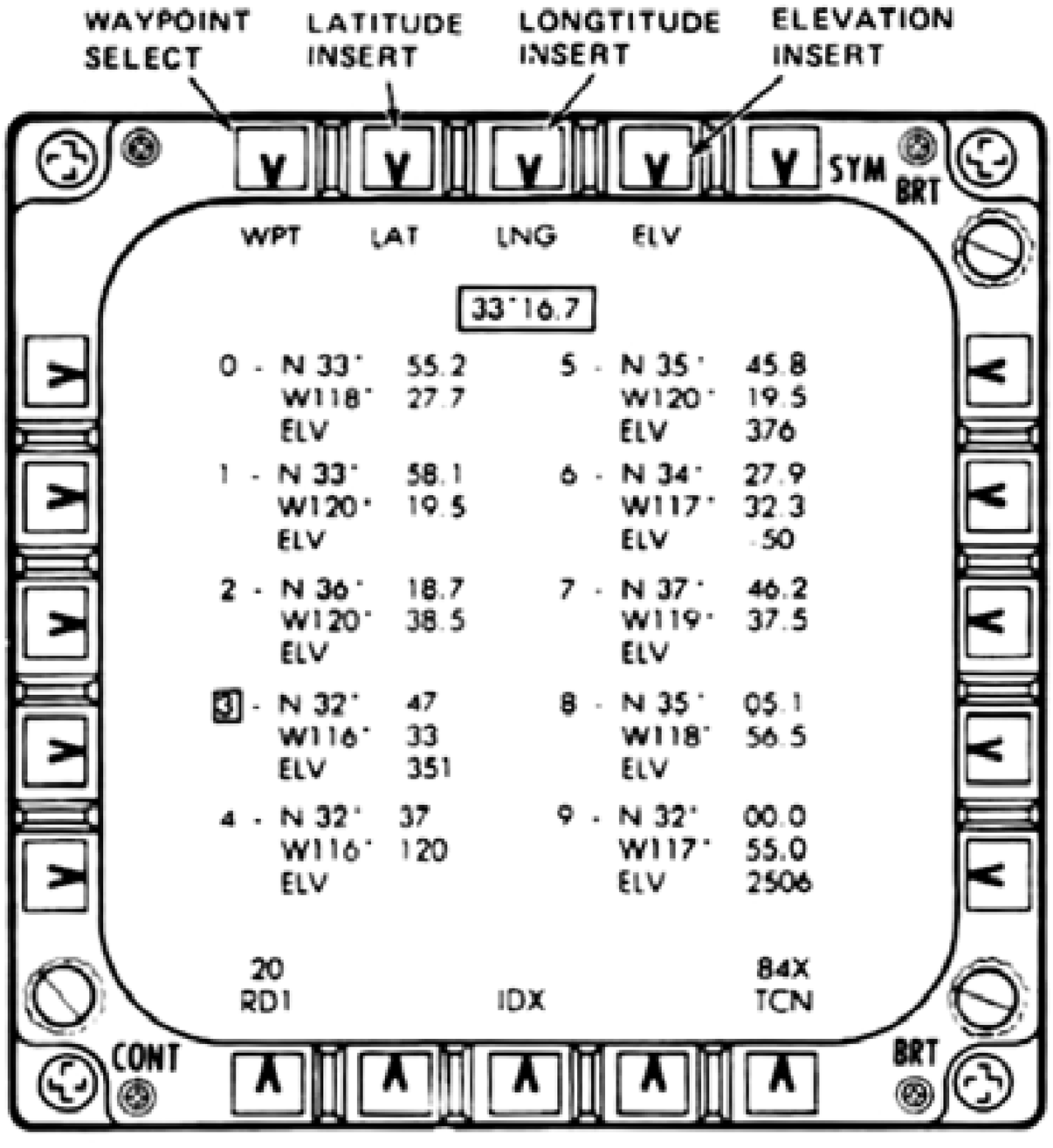
OVERFLY UPDATE



20-1-1-51(1)B

Figure 1-44.

WAYPOINT ENTRY DISPLAY (TYPICAL)



20-1-1-52(1)

Figure 1-45.

index display PB-14 labeled WPT. Waypoint entry is accomplished by entering data on scratchpad and selecting appropriate entry button.

PB-6 WPT—Push	Selects and boxes waypoint number in scratchpad. With blank scratchpad, steps to next numbered waypoint.
PB-7 LAT—Push	Transfers latitude in scratchpad to boxed waypoint. With blank scratchpad, reverses north/south polarity.
PB-8 LNG—Push	Transfers longitude in scratchpad to boxed waypoint. With blank scratchpad, reverses east/west polarity.
PB-9 ELV—Push	Transfers elevation in scratchpad to boxed waypoint. With blank scratchpad alternately changes selected waypoint elevation to below sea level (minus) or back to above sea level (no sign).

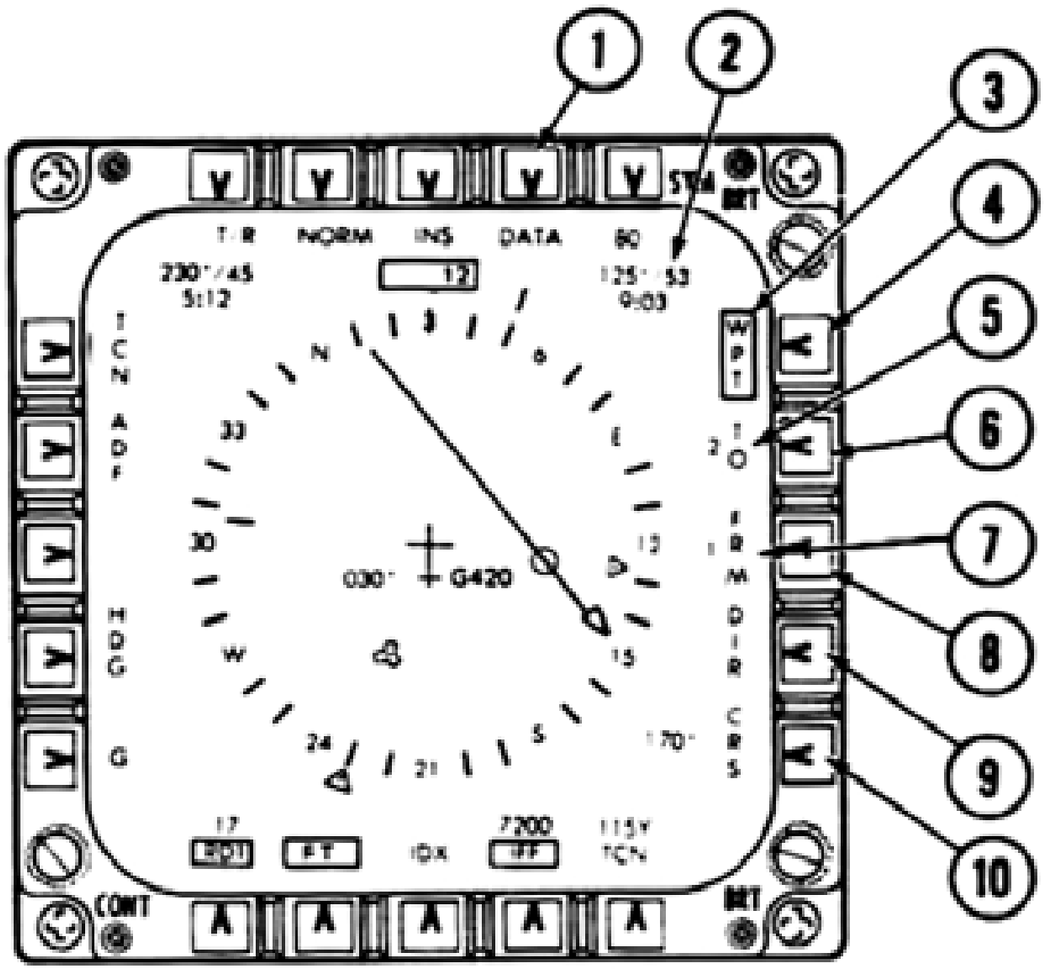
INS NAVIGATION

There are three INS waypoint steering options, waypoint-waypoint, waypoint-course, and waypoint direct, figure 1-46. Waypoint steering is selected by PB-11, labeled WPT, from the HSD. The PB-11 label WPT is boxed when in waypoint steering mode. Waypoint-waypoint steering display is initialized when waypoint steering is selected, unless course or direct steering is already selected.

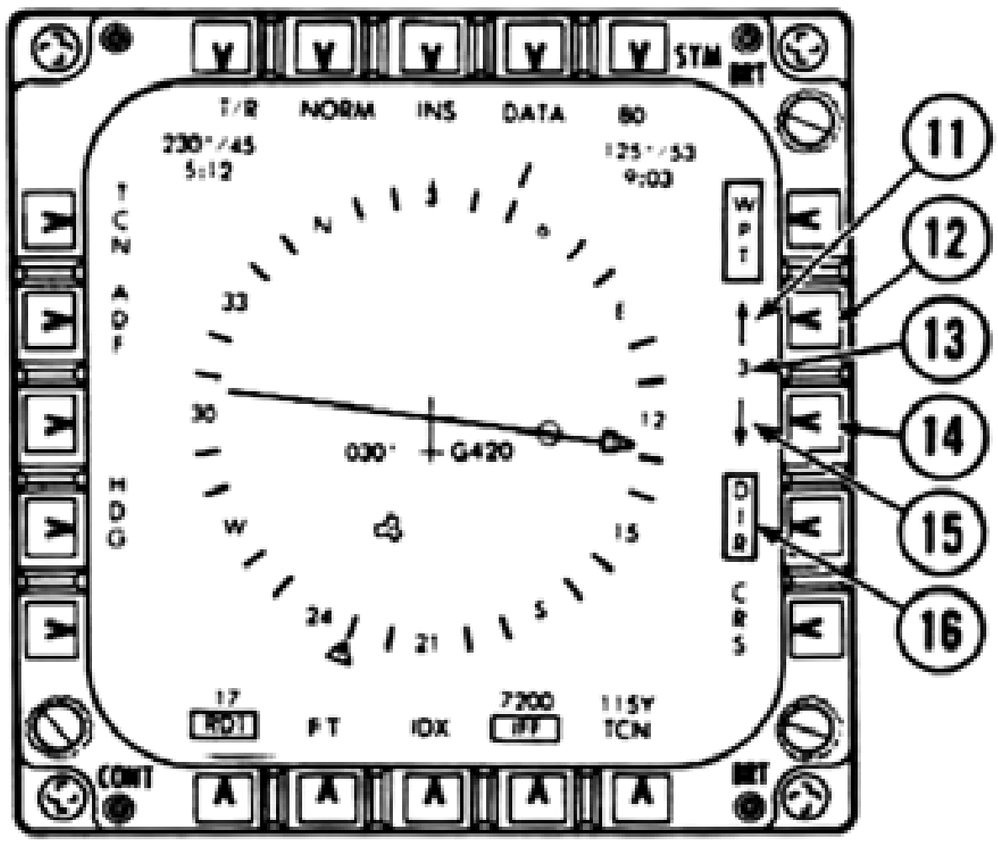
INS Waypoint-Waypoint Steering

Waypoint-waypoint steering is from a selected waypoint, to a selected waypoint. The number next to PB-12, labeled TO, is the waypoint being flown to and the number next to PB-13, labeled FRM is the waypoint being flown from. At power-up the TO and from numbers are initialized to 1 and 0 respectively. Waypoints are selected by PB-12 and PB-13 on the HSD.

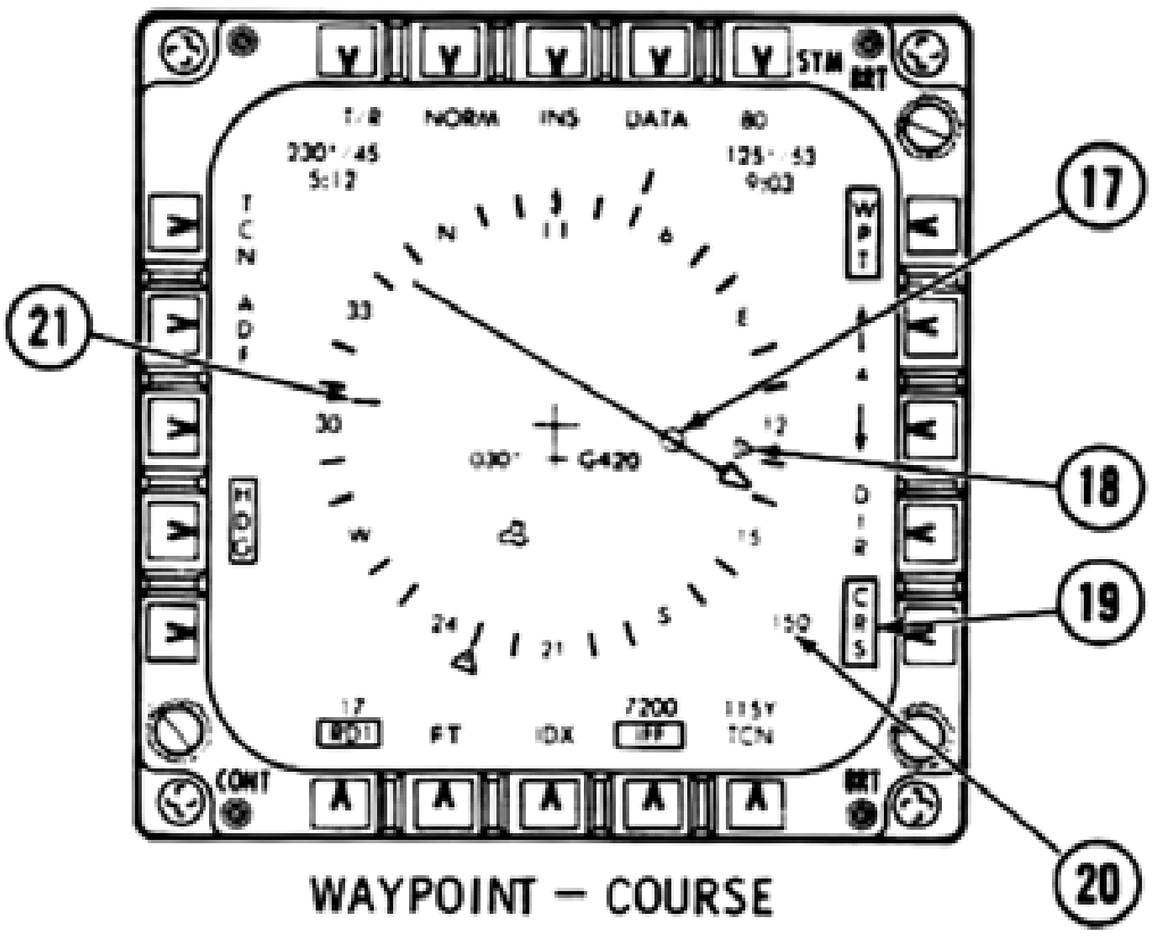
INS NAVIGATION DISPLAYS (TYPICAL)



WAYPOINT – WAY POINT



WAYPOINT – DIRECT



WAYPOINT – COURSE

1	INS DATA DISPLAY SELECT
2	WAYPOINT BEARING/RANGE/TIME
3	WAYPOINT STEERING INDICATION
4	WAYPOINT STEERING SELECT
5	TO WAYPOINT NUMBER
6	TO WAYPOINT SELECT
7	FROM WAYPOINT NUMBER
8	FROM WAYPOINT SELECT
9	DIRECT STEERING SELECT
10	COURSE STEERING SELECT
11	WAYPOINT INCREASE ARROW
12	WAYPOINT INCREASE SELECT
13	TO WAYPOINT NUMBER
14	WAYPOINT DECREASE SELECT
15	WAYPOINT DECREASE ARROW
16	DIRECT STEERING INDICATION
17	TO WAYPOINT SYMBOL
18	WAYPOINT BEARING POINTER (HEAD)
19	COURSE STEERING INDICATION
20	SELECTED COURSE
21	WAYPOINT BEARING POINTER (TAIL)

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Figure 1-46.

PB-12 TO—Push	With a waypoint number in scratchpad, enters new TO waypoint, and displays waypoint number next to PB-12 label, TO. With blank scratchpad increases TO waypoint number by one.
PB-13 FRM—Push	With a waypoint number in scratchpad enters new FROM waypoint and displays waypoint number next to PB-13 label FRM. With blank scratchpad increases FROM waypoint number by one.

The TO waypoint symbol (⑰ figure 1-46) is displayed in a position relative to the aircraft symbol both in range and bearing, range location depending on HSD selected display range, PB-10. The waypoint symbol is between the aircraft symbol and the waypoint bearing pointer (⑱ figure 1-46). Bearing, distance and time to the TO waypoint are displayed below range PB-10. The course arrow passes through the TO waypoint symbol on a course from the FROM waypoint. The course arrow is offset from the aircraft in the direction to fly to get on a direct course between the FROM and the TO waypoints. The course from the FROM waypoint to the TO waypoint is displayed next to PB-15 label CRS.

INS Waypoint-Direct Steering

Waypoint direct steering is selected by PB-14.

PB-14 DIR—Push	Selects waypoint direct steering, boxes PB-14 label DIR and de-selects waypoint course steering if previously selected.

Waypoint direct provides steering from present position to the TO waypoint.

INS Waypoint-Course Steering

When a waypoint is to be approached from a specific direction, a course may be set in the system with PB-15, labeled CRS.

PB-15 CRS—Push	Enters scratchpad course into system, selects waypoint-course steering, and boxes PB-15, CRS label. Selected course is displayed beside PB-15 label CRS.

The TO waypoint number is displayed between the PB-12 and PB-13 increase and decrease arrows.

PB-12 Push	Increases the TO waypoint by one.
PB-13 Push	Decreases the TO waypoint by one.

The course arrow passes through the TO waypoint symbol on the selected course and is offset from the aircraft symbol in the direction to fly to get on course.

HUD-INS Steering

In NAV mode with INS waypoint steering selected, bearing is presented on the HUD by the steering arrow and distance is below altitude. In waypoint-waypoint and waypoint-course steering the steering arrow can displace from the flight path vector to indicate off course. When more than 2-1/2 degrees off course five and ten degree deviation dots appear.

WARNING, CAUTION, AND INDICATOR LIGHTS

Warning, caution, and indicator lights warn of failures critical to flight, hazardous or potentially hazardous conditions, or of a change in system status requiring awareness and possible action. The lights consist of a red FIRE warning light, a yellow hot air leak light, a red gear unsafe warning light in the landing gear lever, a yellow master caution light, three green landing gear position indicator lights, and a caution light panel for individual aircraft systems.

A warning test switch on the lighting control panel (⑥ figure 1-47) permits testing the lights and fire warning/hot air leak circuits. Warning, caution, and indicator lights are powered by the essential dc bus in the bright mode and by the No. 2 main ac bus in the dim mode.

WARNING LIGHTS BRIGHT/DIM SWITCH

The momentary three-position switch (⑤ figure 1-47) labeled WARNING, is springloaded to a neutral center position.

BRT	Warning, caution, and indicator lights illuminate in bright mode.
DIM	Warning, caution, and indicator lights illuminate in dim mode when the flight instrument lights are on. With flight instrument lights off, or if ac power is lost, lights illuminate in bright mode.

WARNING TEST SWITCH

This two-position switch (⑥ figure 1-47) labeled WARNING, is springloaded to the OFF position.

TEST	Turns on all warning, caution, and indicator lights, and tests gear audible warning and fire warning/ hot air leak sensing loops.
OFF	No function.

The switch also closes the bleed air shutoff valve whenever the engine is running. As this stops precooler jet pump operation, the switch should be held for as short a time as necessary on the ground.

MASTER CAUTION LIGHT

The yellow master caution light (① figure 1-47) labeled MASTER CAUTION PUSH TO RESET, illuminates when a caution light capsule on the caution light panel comes on. Pushing the light resets and extinguishes the master caution light, but the caution light capsule, which caused the illumination, remains on.

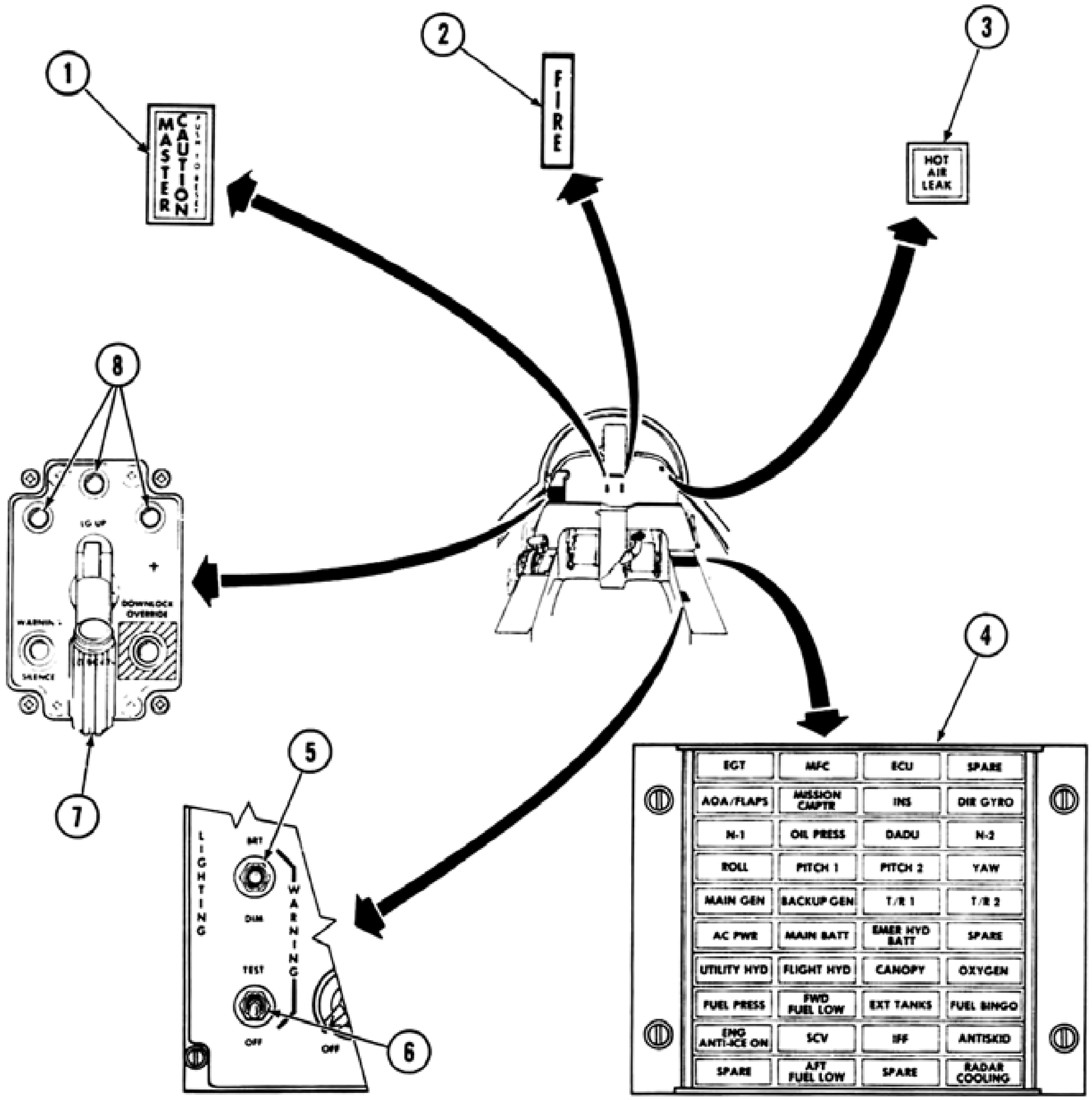
NOTE

The master caution light must be reset after each activation to provide warning of subsequent activation of caution lights.

CAUTION LIGHT PANEL

The caution light panel (④ figure 1-47) contains 40 individual system word capsules. Spare capsules illuminate only when the WARNING test switch is positioned to TEST. Each light when illuminated, remains on as long as the malfunction exists or the status is unchanged. The individual system caution light will not go out when the MASTER CAUTION light is reset to rearm the circuit. For functions of individual caution lights, see the appropriate system description.

WARNING, CAUTION, & INDICATOR LIGHTS



1 MASTER CAUTION LIGHT
2 FIRE WARNING LIGHT
3 HOT AIR LEAK LIGHT
4 CAUTION LIGHT PANEL
5 WARNING LIGHTS BRIGHT/DIM SWITCH
6 WARNING TEST SWITCH
7 GEAR LEVER WARNING LIGHT
8 GEAR POSITION INDICATOR LIGHTS

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Figure 1-47.

LIGHTING EQUIPMENT

The aircraft is equipped with exterior and interior lighting. Exterior lights consist of position (navigation) and fuselage lights, formation lights, and an anticollision beacon. Interior lights consist of flight and engine instrument lights, console and panel lights, cockpit floodlights, thunderstorm lights, and a utility light. See figure 1-48 for location of lighting controls and location of interior lights. See figure 1-1 for location of exterior lights.

EXTERIOR LIGHTS

Position and Fuselage Lights

Position lights are in outer wing panels (left-red, right-green). The tail position light is in the vertical stabilizer (white). Each position light has an inboard white segment which illuminates the aft fuselage and vertical stabilizer for night formation flying. Position lights are controlled by the NAV rheostat. Two white fuselage lights, on either side of the lower fuselage centerline come on steady-bright when the NAV control is placed in the FLASH position.

Formation Lights and Rotating Beacon

Formation lights, controlled by the FORMATION rheostat, consist of paired white dorsal lights and aft end-mounted missile launcher lights (left-red, right-green). A rotating anticollision beacon (red) in the vertical stabilizer is controlled by the BEACON switch.

INTERIOR LIGHTS

Flight and Engine Instrument Lights

Flight and engine instrument indicators on the instrument panel are white-lighted by internal lamps. These lights operate off the No. 1 ac bus and are controlled by FLT INSTR and ENG INSTR rheostats on the lighting control panel.

Armament Control Panel Lights

Armament control panel lights are controlled by the rheostat, labeled BRT-INC to the left of the backup nose tail switch. The lights operate off the No. 1 ac bus.

Console Lighting

Console lighting includes integral backlighting in the consoles, pedestal and vertical panels. Backlighting illuminates legends and markings on controls, control panels, and instruction plates. Console lighting is powered by the No. 1 ac bus and is controlled by the CONSOLE rheostat on lighting control panel.

Data Entry Panel Lighting

DEP lighting is controlled by the rheostat on the left vertical panel labeled DEP LIGHT.

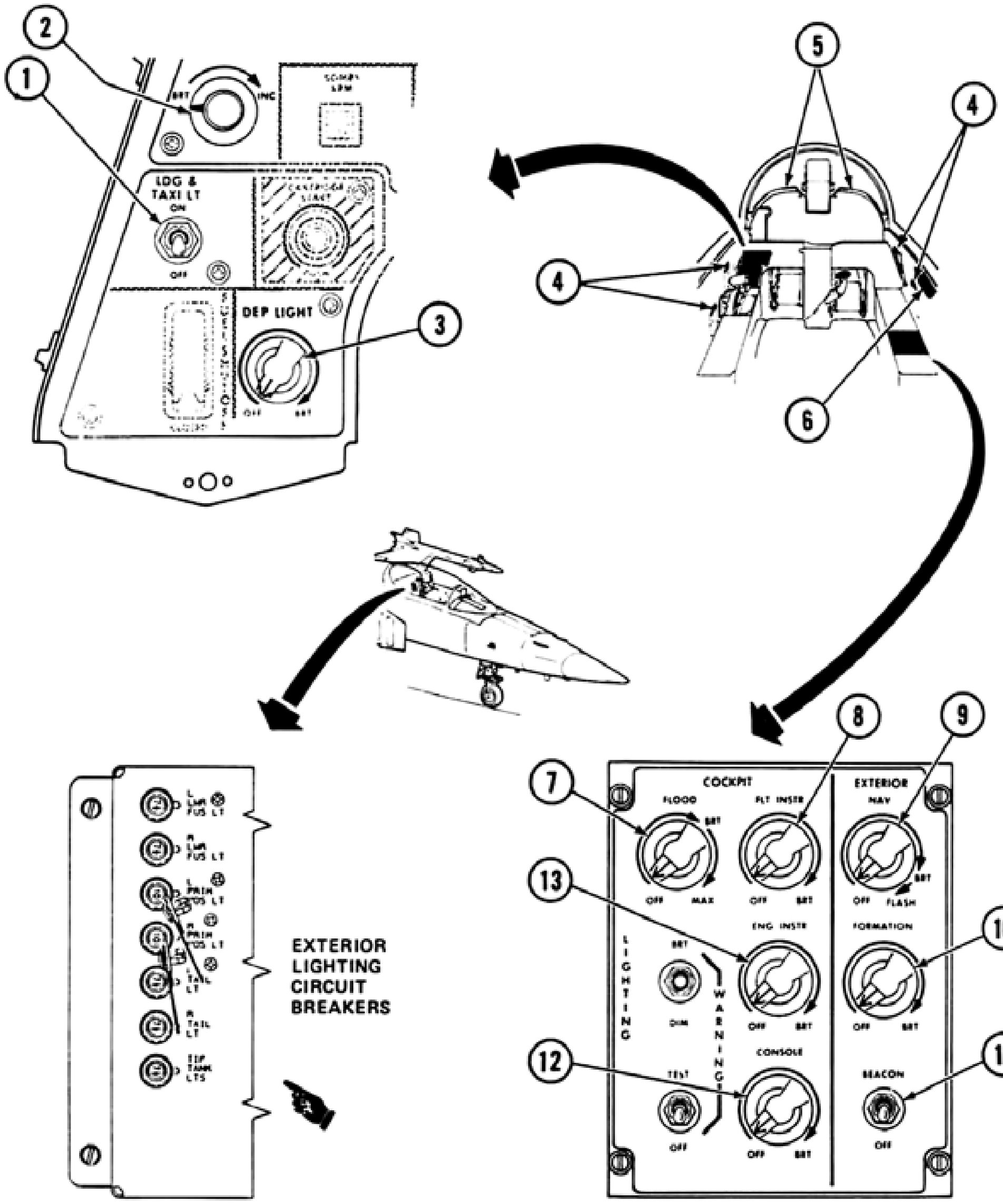
Floodlights

Floodlights in the cockpit provide white illumination of the instrument panel and each console panel. The floodlights are powered by the No. 2 ac bus and controlled by the FLOOD rheostat, from off to bright, on the right console (⑦ figure 1-48). Without ac power, the floodlights are emergency-powered bright by the dc bus thru the ENG INSTR rheostat on the right console (⑬ figure 1-48), bypassing the FLOOD rheostat. The ENG INSTR rheostat must be out of the OFF position for the floodlights to be available.

Utility Light

The utility light is on the right of the cockpit. The light is controlled by a self-contained rheostat switch which can be rotated to turn the lamp on and vary the lamp intensity. A lens cap provides selection of red or white spot or floodlighting. In an emergency, pressing the pushbutton on the light assembly provides full intensity of the lamp and permits use as a signal light when the pushbutton is intermittently pressed. The light, equipped with an extension cord, is hand portable and can be detached from its support to allow use anywhere in the cockpit. Auxiliary mounting support is provided for relocation of the light, if desired (lower right corner of the cockpit windshield frame).

LIGHTING EQUIPMENT



1 LANDING & TAXI LIGHT SWITCH (INOP)
2 ARMAMENT CONTROL PANEL LIGHTS
3 DEP LIGHT CONTROL
4 CONSOLE FLOODLIGHTS
5 INSTRUMENT PANEL FLOODLIGHTS
6 UTILITY LIGHT
7 FLOODLIGHT CONTROL KNOB
8 FLIGHT INSTRUMENTS LIGHTS KNOB
9 NAVIGATION LIGHTS KNOB
10 FORMATION LIGHTS KNOB
11 BEACON SWITCH
12 CONSOLE LIGHTS KNOB
13 ENGINE INSTRUMENTS LIGHTS KNOB

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Figure 1-48.

OXYGEN SYSTEM

A 5-liter liquid oxygen system supplies breathing oxygen. An oxygen regulator on the right console controls the flow and pressure of the oxygen and distributes it in the proper proportions to the mask. The oxygen regulator contains a gage, a blinker type flow indicator, emergency flow lever, oxygen diluter lever, and supply lever.

OXYGEN REGULATOR

A combination pressure breathing, diluter demand oxygen regulator (figure 1-49) is used in conjunction with the oxygen mask. The oxygen system is controlled by the supply, diluter, and emergency levers. An interlock between the supply lever and diluter lever causes the diluter lever to trip to 100% position when supply lever is at OFF, preventing any flow of air thru system. Gaseous oxygen is supplied to the regulator in the range of 65 to 110 psi. The regulator reduces the oxygen pressure, mixes oxygen with air in varying amounts, depending on altitude and demand, and delivers it thru a flexible hose to the oxygen mask. At high cockpit altitude, the regulator supplies positive pressure breathing. System operation is indicated by the flow indicator and oxygen pressure gage on the oxygen regulator panel. The emergency lever should remain at NORMAL unless an unscheduled pressure increase is required.

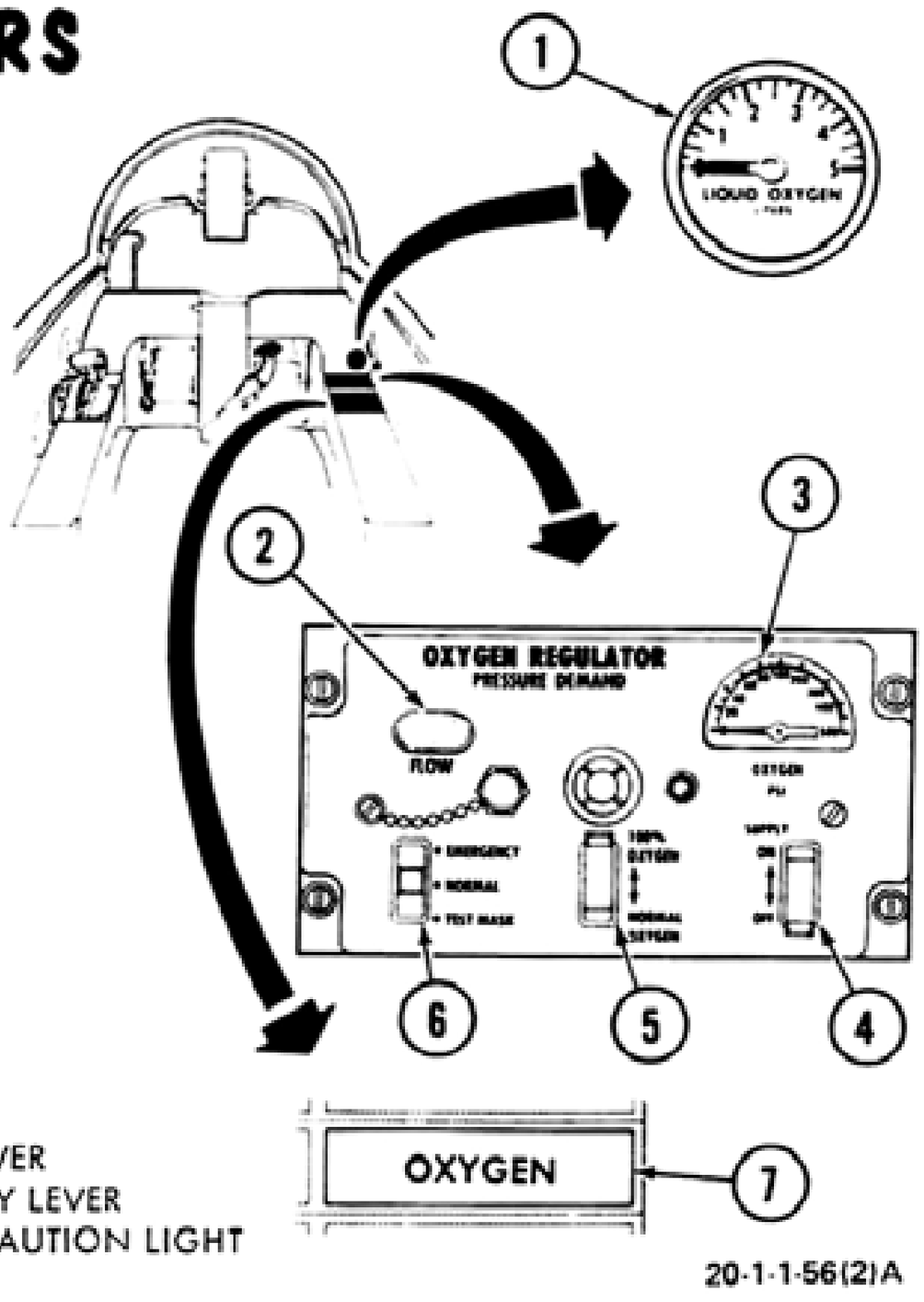
WARNING

When placing the emergency lever at EMERGENCY or TEST MASK, it is mandatory that the oxygen mask be fitted to the face and not removed. Continuous use of positive pressure with a leaking oxygen mask or the mask removed for extended periods will deplete the oxygen supply rapidly.

OXYGEN CONTROLS/INDICATORS

COCKPIT ALTITUDE — FEET	DURATION IN HOURS						
35,000 & ABOVE	31	25	19	12	6.2	3.1	EMERGENCY DESCEND TO ALTITUDE NOT REQUIRING OXYGEN.
	31	**25**	**19**	**12**	**6.2**	**3.1**	
30,000	23	18	14	9.1	4.5	2.3	
	23	**18**	**14**	**9.2**	**4.6**	**2.3**	
25,000	17	14	10	7.0	3.5	1.8	
	22	**17**	**13**	**8.7**	**4.3**	**2.2**	
20,000	13	11	7.9	5.3	2.6	1.3	
	24	**20**	**15**	**9.8**	**4.9**	**2.5**	
15,000	11	8.5	6.4	4.2	2.1	1.1	
	30	**24**	**18**	**12**	**6.0**	**3.0**	
10,000	8.5	6.8	5.1	3.4	1.7	0.9	
	30	**24**	**18**	**12**	**6.0**	**3.0**	
LIQUID CONTENTS — LITERS	5	4	3	2	1	1/2	BELOW: 1/2

● TOP FIGURES INDICATE DILUTER LEVER 100% OXYGEN.
● BOTTOM FIGURES INDICATE DILUTER LEVER NORMAL OXYGEN.



1 OXYGEN QUANTITY INDICATOR
2 FLOW INDICATOR
3 PRESSURE GAGE
4 SUPPLY LEVER
5 DILUTER LEVER
6 EMERGENCY LEVER
7 OXYGEN CAUTION LIGHT

Figure 1-49.

CANOPY

The cockpit is enclosed by a manually controlled one-piece clamshell type canopy. The canopy is counterbalanced throughout its travel limits. The canopy drive mechanism is protected against excessive loads by a hydraulic damper, which also restricts canopy opening and closing speeds. An inflatable seal in the canopy inflates only when the canopy is locked and engine is operating. Exterior and interior normal and jettison controls consist of locking handles and jettison handles and a canopy caution light. The exterior and interior locking handles must be used to lock and unlock the canopy. Raising and lowering the canopy must be done by hand pressure applied to the canopy frame.

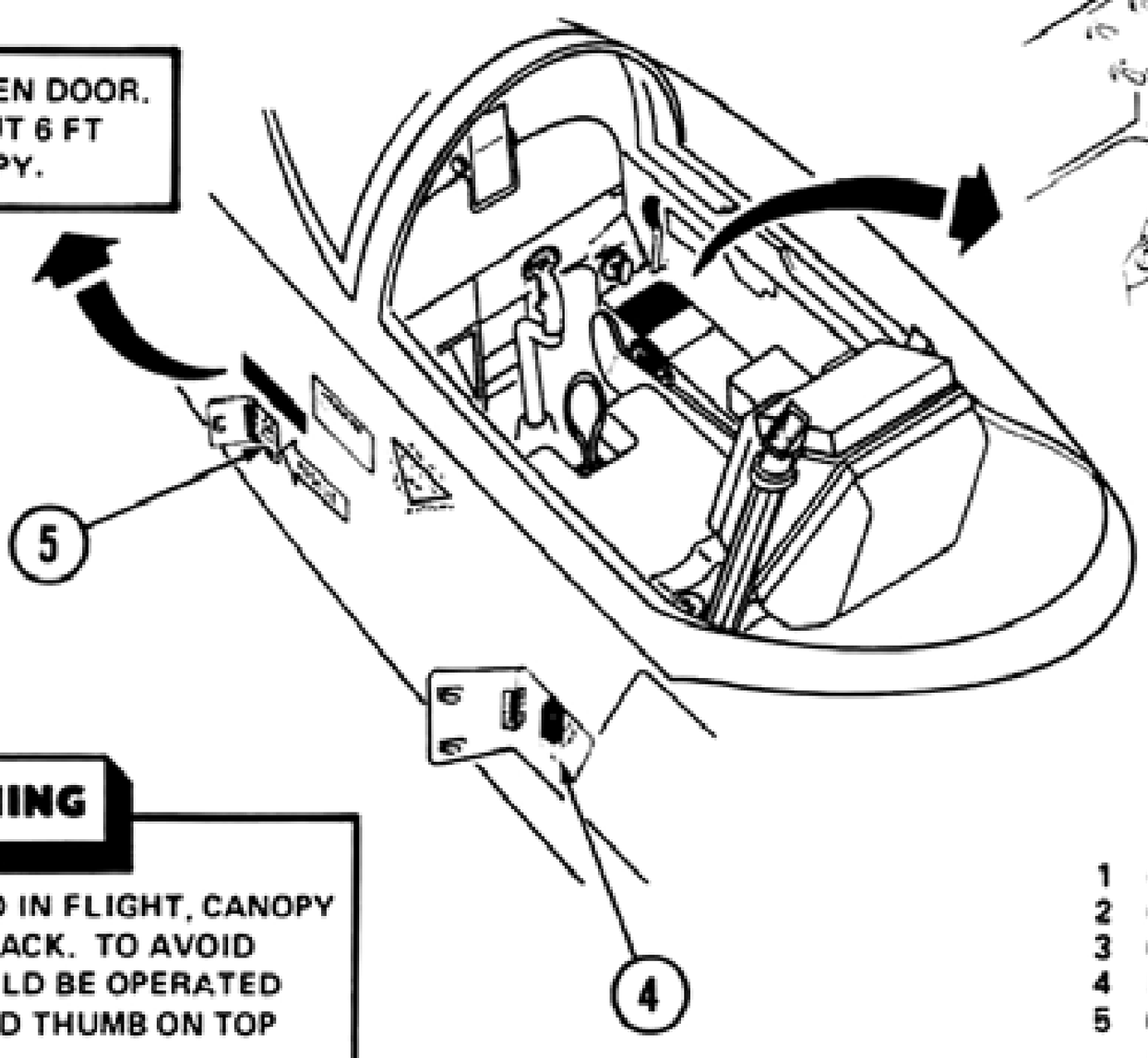
CAUTION

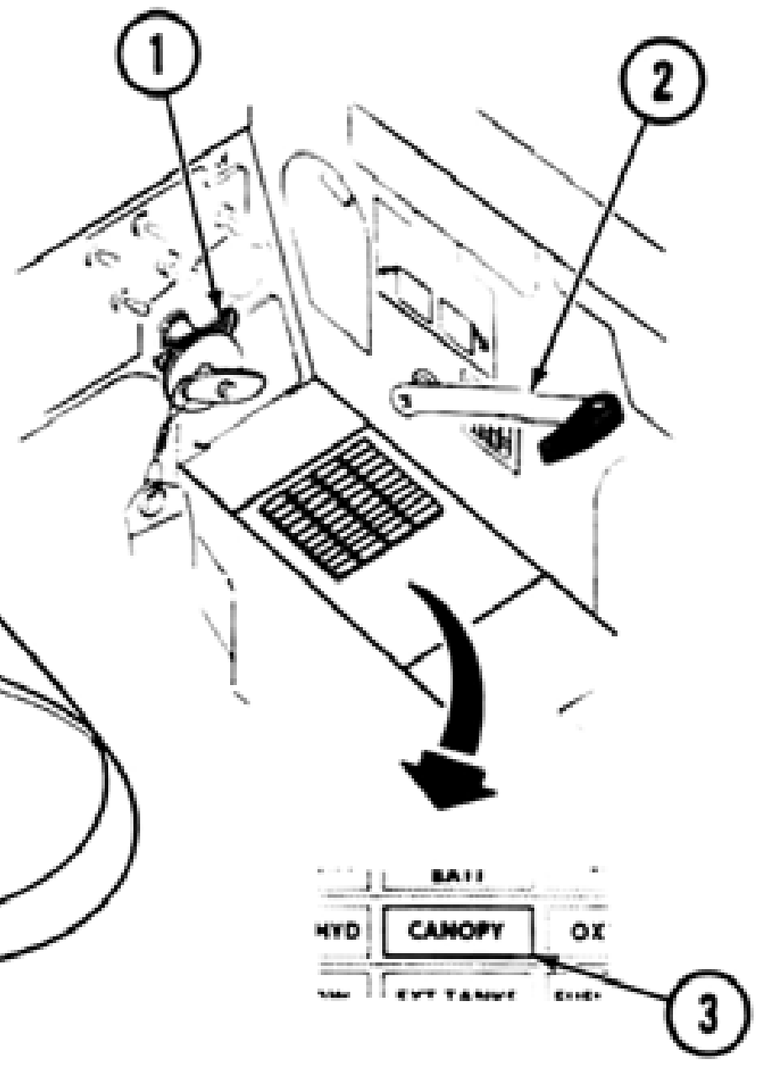
Damage to canopy drive mechanism may result if the locking handles are used to raise and lower the canopy.

The canopy jettison handle in the cockpit is safetied by a removable safety pin. After the pin is removed, a spring clip, which safeties the handle, must be overridden when the handle is pulled. See figure 1-50 for location of controls and caution light.

CANOPY CONTROLS/INDICATORS

1. PUSH LATCH TO OPEN DOOR.
2. PULL D HANDLE OUT 6 FT TO JETTISON CANOPY.





WARNING

IF CANOPY IS OPENED IN FLIGHT, CANOPY HANDLE WILL WHIP BACK. TO AVOID INJURY, LEVER SHOULD BE OPERATED WITH PALM DOWN AND THUMB ON TOP OF HANDLE.

1 CANOPY JETTISON T-HANDLE
2 CANOPY HANDLE (INTERIOR)
3 CANOPY CAUTION LIGHT
4 EXTERNAL CANOPY HANDLE
5 CANOPY JETTISON D-HANDLE (BOTH SIDES)

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Figure 1-50.

EJECTION SEAT

The Stencel SIIIS ejection seat (figure 1-51) provides the pilot with a safe escape capability from zero airspeed/zero altitude thru 600 knots and 50,000 feet. The seat incorporates redundant design features that ensure fail-safe seat ejection and pilot escape during critical flight regimes. Following pilot initiation of ejection, the sequence is automatic. The seat ejects thru the canopy if the canopy fails to jettison. The pilot's post ejection requirements are met by the seat pan survival kit and oxygen supply. The pilot is secured to the seat by a shoulder harness, survival kit straps, a safety belt, and leg restraints. Oxygen, G-suit hoses, and communication leads disconnect automatically upon ejection. The seat provides contoured support to the pilot during maneuvering flight and ejection. Back and seat cushions help absorb initial ejection forces transmitted to the pilot.

Canopy Piercer

Projecting upward above the headrest, and integral with the drogue parachute container assembly, is the twin-prong canopy piercing device. In the event the canopy fails to jettison before ejection, the canopy is shattered by the canopy piercing device.

Seat Adjust Switch

The seat is vertically adjustable thru a range of 6 inches. Movement is controlled by the seat adjust switch, that actuates a DC motor. To prevent motor overheating, seat adjust operation is limited to 30 seconds on—1 minute off.

Inertia Reel Lock

An inertia reel lock, consisting of a gas-driven power reel and cable attachment, provides mechanical locking and unlocking of the shoulder harness controlled by an inertia reel lock lever. With the harness locked (LOCK position) any slack remaining in the harness can be reduced by sitting back in the seat. The slack is then reeled in to assume a new locked position. When unlocked (AUTO position) the harness is free to reel in or out. The inertia reel automatically locks whenever the shoulder harness reels out at a rate in excess of 3g. The inertia reel remains locked until the inertia reel lock lever is cycled. When ejection is initiated, the power-reel actuates, causing the shoulder harness to be forcibly retracted and locked regardless of the position of the lock lever.

Safety Belt

A two-piece safety belt restrains the pilot's lower body during all flight maneuvers, and ejection.

Anti-G Suit Hose

Bleed air for the pilot's anti-G suit is supplied via the anti-G suit hose. Upon ejection, the G-suit hose connection automatically disconnects at the personal services equipment block.

Ejection Handle

The ejection handle initiates the ejection sequence when pulled upward approximately 4 inches. A firm grip on the handle, with both hands, should be maintained until man/seat separation, to minimize injury by windblast.

Ground Safety Lever

The ground safety lever arms or safes the ejection seat. The armed position is down and aft (vertical) against the seat. The safe position is up and forward (horizontal) from the seat. To actuate the lever, the release knob must be pulled out. After the pilot is strapped in with the canopy closed, the ground safety lever may be placed in the armed position.

WARNING

The seat should not be armed unless the canopy is closed and locked. Ejection seat/pilot collision with the canopy bow is probable during ejection with the canopy open.

EJECTION SEAT

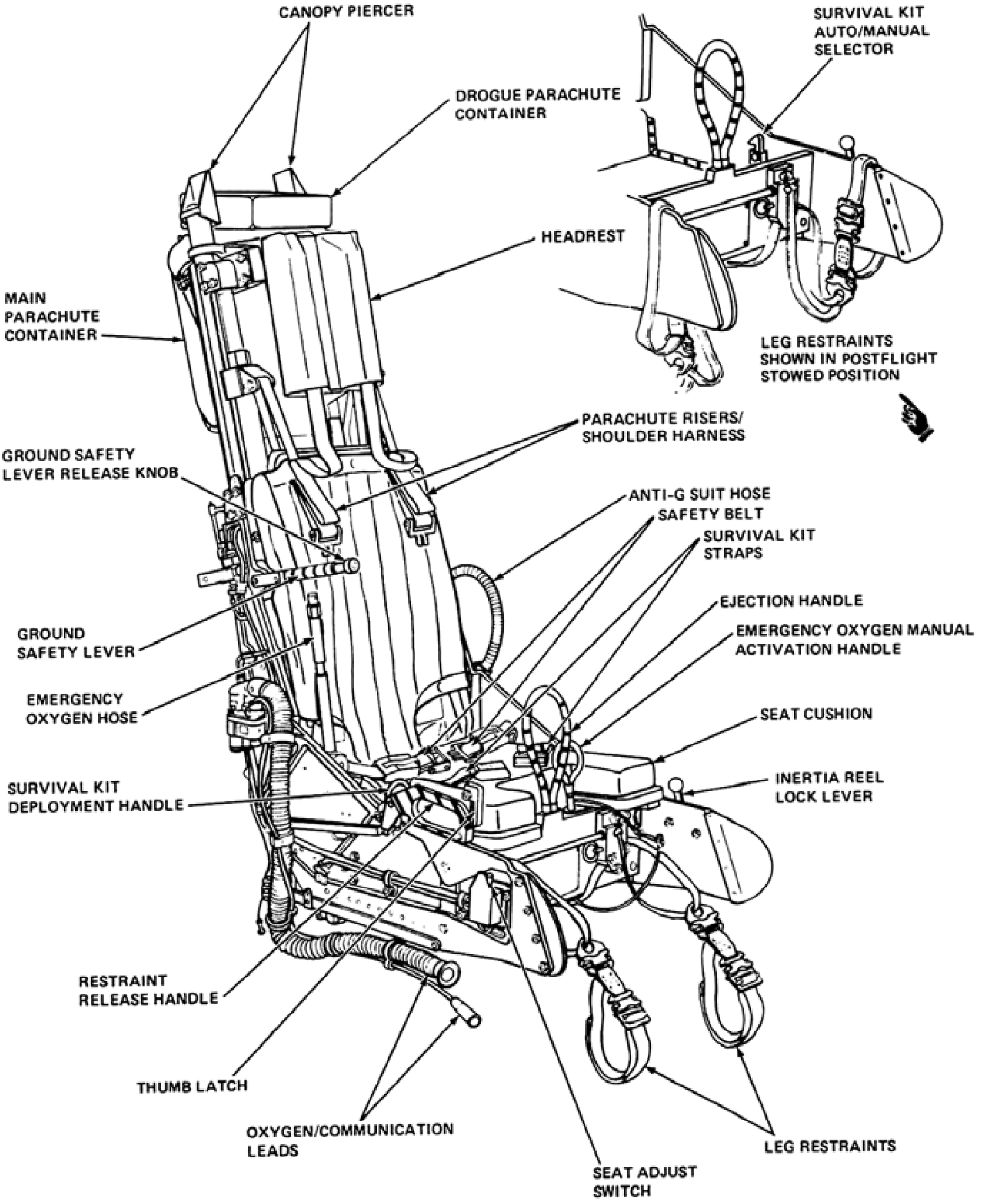
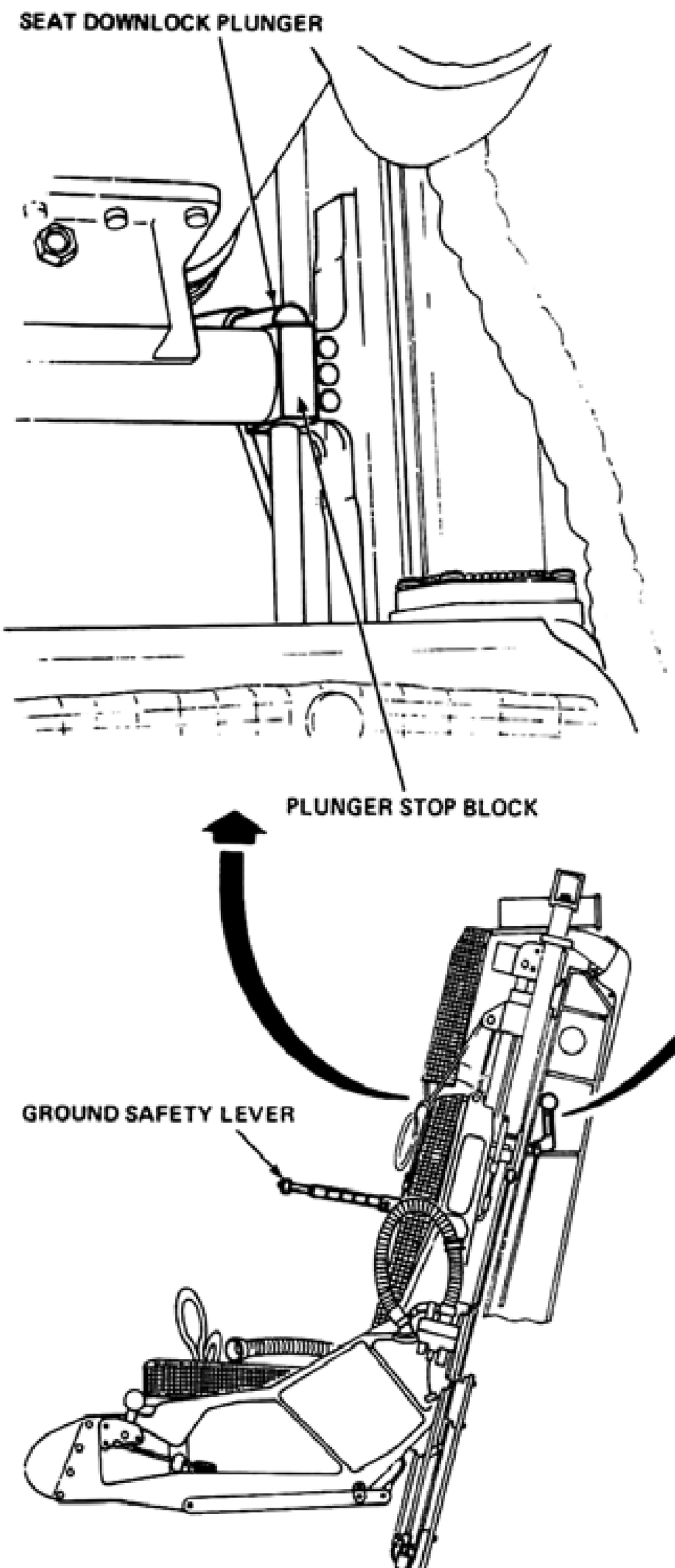
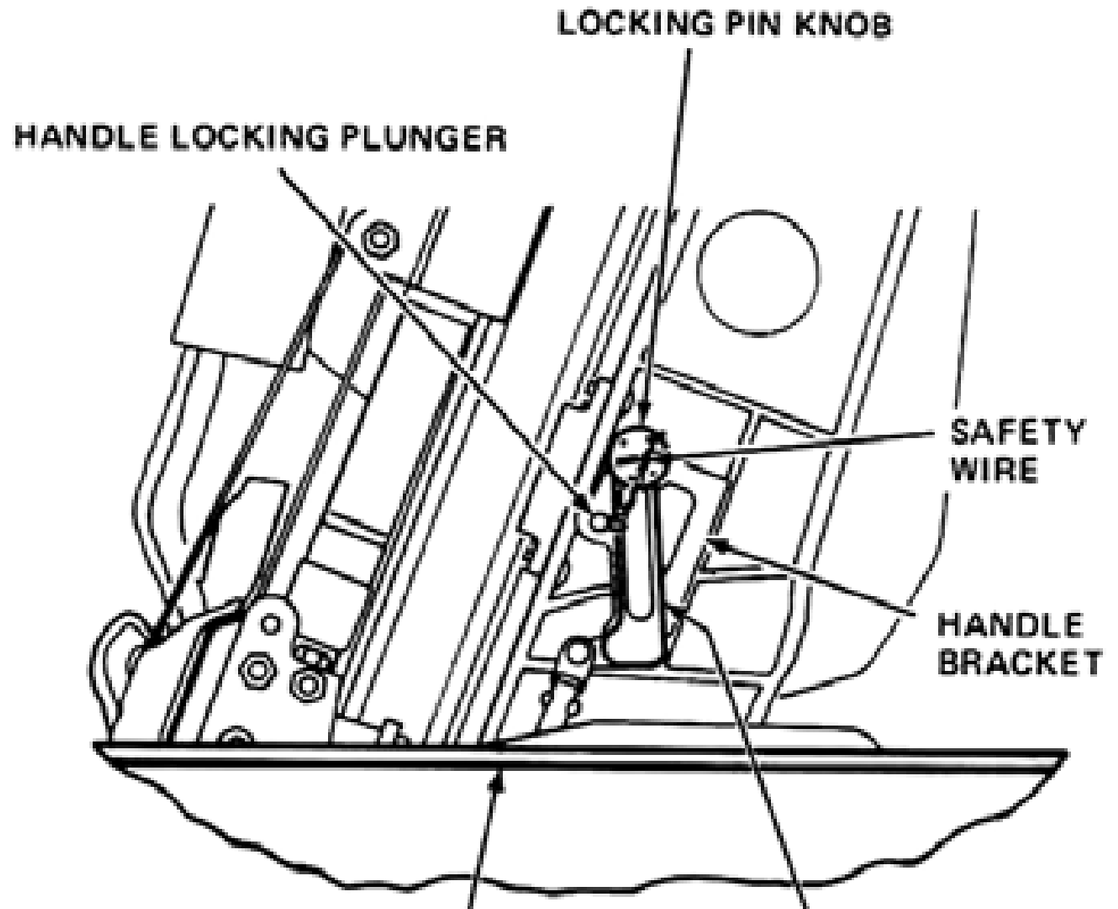


Figure 1-51.

EJECTION SEAT PREFLIGHT





ENSURE THE FOLLOWING ITEMS ARE CHECKED DURING BEFORE EXTERIOR INSPECTION:

1. GROUND SAFETY LEVER-CHECK UP (HORIZONTAL).
2. SEAT DOWNLOCK HANDLE-CHECK POSITIONED FORWARD WITH HANDLE LOCKING PLUNGER ENGAGED AND WITH LOCKING PIN KNOB IN HANDLE RECESS AND SAFETY WIRED TO HANDLE BRACKET.
3. SEAT DOWNLOCK PLUNGER-CHECK THAT CUTOUT AREA ON PLUNGER EXTENDS FORWARD OVER PLUNGER STOP BLOCK.

WARNING

IF PLUNGER DOES NOT EXTEND ACROSS TOP OF STOP BLOCK EJECTION SEAT IS NOT SECURED TO AIRCRAFT.

4. SEAT GROUND MAINTENANCE SAFETY PINS-REMOVED.

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Figure 1-52.

SEAT PROPULSION

The seat is initially propelled by a catapult charge and then by two solid propellant rockets. The catapult charge provides initial seat movement that is required for rocket actuation. The rockets then accelerate the seat out of the cockpit area and clear of the vertical stabilizer.

LEG RESTRAINT SYSTEM

The leg restraint system prevents flailing injuries to the pilot during high speed ejections. The restraints are disconnected automatically during man/seat separation after ejection, or when the emergency restraint release handle is pulled. During ejection, the leg restraints are retracted by the upward motion of the ejection seat, forcing the pilot's legs against the seat pan front. The leg restraints must be worn at all times the ejection seat is armed. Install leg restraints on upper calf above maximum calf diameter to preclude slippage and possible restriction to leg movement.

RESTRAINT RELEASE HANDLE

The restraint release handle disconnects most of the man/seat attach points for emergency ground egress, and all attach points for manual man/seat separation following ejection. The handle is actuated by pulling the thumb latch aft, squeezing the handle, and pulling the entire handle up and aft. When the emergency restraint release handle is activated with ground safety lever in safe (up) position, the following occurs.

Pull (up and aft)	Leg restraints, safety belt and survival kit straps released. Shoulder harness fittings must be manually released.

When restraint release handle is activated with ground safety lever in armed (down) position the following occurs.

Pull (up and aft)	Safety interlock prevents inadvertent ejection during egress. Leg restraints, safety belt and survival kit straps are released. The guillotine severs the inertia reel straps, but the shoulder harness fittings must be manually released.

WARNING

The emergency restraint release handle must not be pulled before or during flight, prior to ejection. Pulling the handle removes pilot's ejection capability, and restraint for flight maneuvering and emergency situations.

AIRSPEED/ALTITUDE SENSOR

In flight, the airspeed/altitude sensor monitors the aircraft pitot and static pressure for ejection operating mode selection. During ejection, ballistic gas arms the airspeed/altitude sensor, which preselects the ejection operating mode for the seat during the post ejection sequence. The sensor selects either the high speed or low speed mode of seat operation, below 7,000 feet MSL depending on airspeed relative to 225 ±20 knots.

The airspeed/altitude sensor is connected to the aircraft pitot-static system. If a failure causes an erroneous indication below 225 knots and 7000 feet MSL, the seat operates in the low speed mode, regardless of actual airspeed. If the low speed mode is erroneously selected above 225 KCAS, severe damage to the parachute can occur. With known or suspected pitot-static malfunctions the pilot should attempt zooming to slow the aircraft to a speed estimated less than 225 knots prior to initiating ejection.

PARACHUTE SYSTEM

Parachute Drogue Chute

The drogue chute stabilizes and decelerates the man/seat during high-speed ejections, and assists in main parachute deployment.

Main Parachute

The main parachute system includes a parachute withdrawal line, risers with snubbing lanyards that initiate the spreading gun and man/seat separation, a spring-loaded pilot parachute, the main canopy, and a ballistic canopy spreading gun.

Parachute Deployment Rocket

The parachute deployment rocket provides for positive main parachute extraction by pulling it to full line stretch in the airstream, to decrease parachute deployment time in low-speed/low-altitude ejections. The rocket is attached to the rear of the seat until firing, and functions automatically. The rocket is integral with the drogue parachute-to-main parachute line. Normal parachute deployment occurs with slight delay if the parachute deployment rocket misfires.

Parachute Riser/Shoulder Harness

The parachute riser/shoulder harness connects the pilot to the inertia reel and parachute risers. Each riser/harness (left and right shoulders) consists of two separate straps connected to a fitting, which attaches to the respective fitting on the pilot's PCU-15 torso harness. The risers are routed upward through the headrest pad to the parachute container. The shoulder harness is routed over the backpad into the inertia reel.

Four Line Release

The four line release system is incorporated into the suspension lines to reduce parachute oscillation, and to provide parachute maneuverability during descent. The system has a line release lanyard assembly on each riser. When pulled, the lanyards release 4 rear suspension lines. This gives the pilot positive forward motion for improved landing site selection. The four-line release should not be activated at night or any time the probable landing area cannot be seen by the pilot.

SURVIVAL KIT

The seat pan survival kit, (figure 1-53) provides survival equipment storage for post ejection survival, and serves as a mount for the emergency oxygen cylinder. The survival kit is connected to the pilot by survival kit straps with quick release fittings. Following man/seat separation a 4.0-second time delay initiator provides automatic survival kit deployment, or it may be deployed manually. The automatic/manual lever is under the

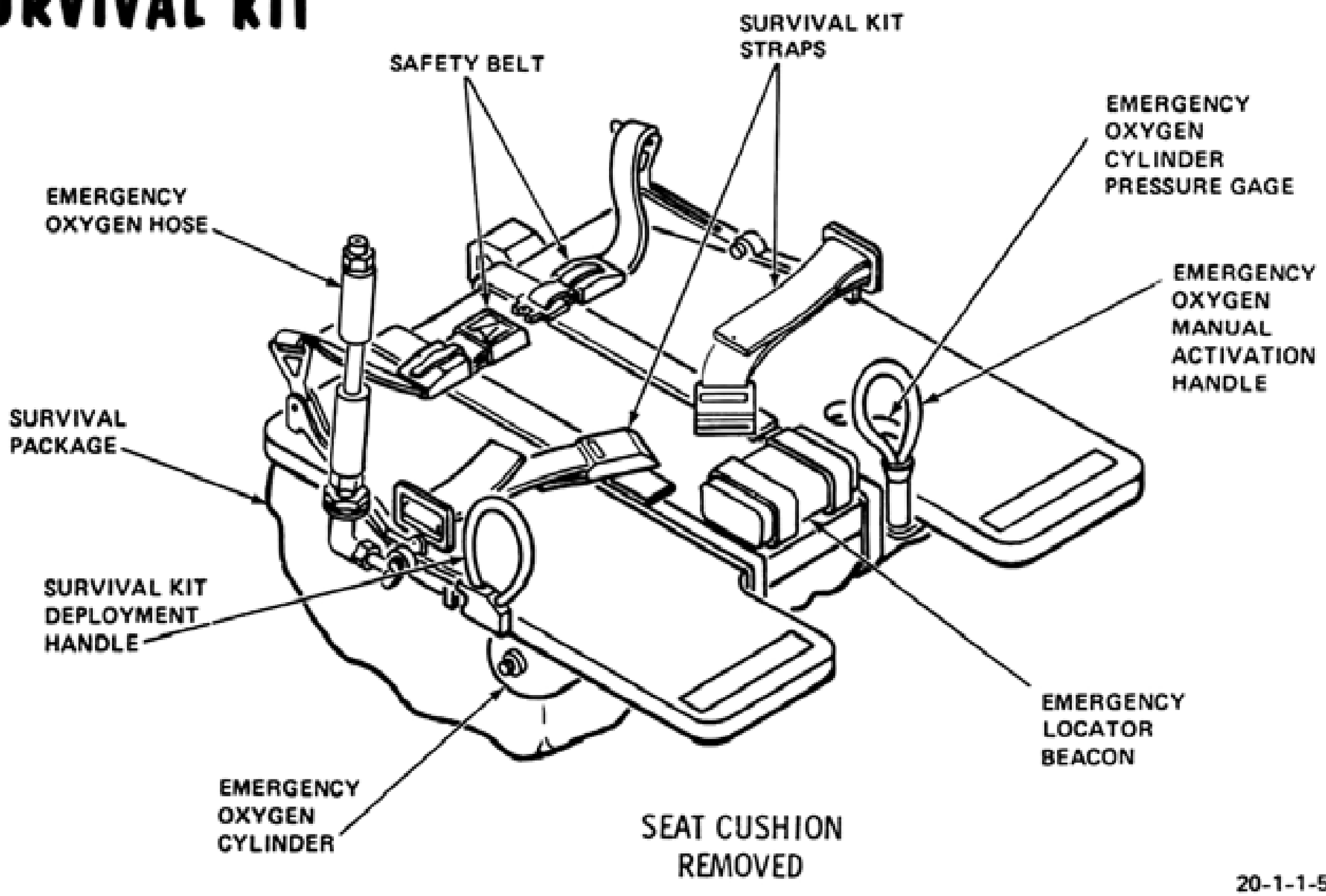

Figure 1-53.

seat cushion left side. The selected position is visible to the pilot by the word MANUAL or AUTO inscribed on either side of the lever. The manual position (forward) maintains survival kit integrity following man/seat separation until the pilot pulls the survival kit deployment handle. The automatic position (aft) allows for automatic deployment of the survival kit and life raft 4.0 seconds following man/seat separation. A removable emergency locator beacon is attached to the upper forward seat pan and is activated automatically upon ejection.

Emergency Oxygen Cylinder

The emergency oxygen cylinder, (figure 1-53) provides an approximate 10-minute backup supply of oxygen. The cylinder is mounted to the seat pan and stays with the pilot during the post ejection sequence. Oxygen flow is activated manually by pulling upward on the green actuator ring, or automatically during seat ejection. Supply pressure is checked on pre-flight by sighting the pressure gauge located beneath the forward, left side of the seat cushion. Pressure must be 1800 psi minimum.

Survival Kit Straps

The survival kit straps connect the left and right sides of the survival kit to the pilot's harness (PCU-15), with quick release fittings.

EJECTION SEQUENCE

Ejection is initiated by pulling the ejection handle. This jettisons the canopy, retracts and locks the shoulder harness, arms the airspeed/altitude sensor, and fires the seat catapult cartridge after a 0.3 sec delay. The seat begins upward movement, which activates the emergency locater beacon and emergency oxygen cylinder. The solid propellant rockets fire, accelerating the seat well clear of the aircraft.

The leg restraint system pulls the pilot's legs against the seat pan front and between the seat side panel extensions, minimizing leg movement to decrease flailing injuries by windblast. The leg restraint straps are automatically released during man/seat separation. Post ejection seat stabilization is provided by the seat stabilization system. The stabilization system is automatically deactivated when the seat is well clear of the cockpit.

The parachute deployment rocket aligns itself before firing, opposite the direction of seat travel, and fires as determined by seat operating mode. The mode of operation is automatically selected by the airspeed/altitude sensor and barostats. In modes 1, 2, and 3, the main parachute deploys almost immediately after ejection (figure 1-54). In mode 4 the man/seat is suspended under the drogue chute until descending to 14,000 feet MSL. This allows for man/seat deceleration and stabilization during free fall to 14,000 feet MSL, when the main parachute deploys.

The parachute deployment rocket ignites and pulls the main parachute into the relative airstream. Upon main parachute inflation the man/seat separation lanyards are actuated, causing the shoulder harness guillotine to fire, the leg restraints to release, and the seat to rotate away from the pilot on a separate trajectory. The survival kit and life raft are released and deployed 4.0 seconds after man/seat separation if the pilot has selected the auto position for deployment on the auto/manual selector.

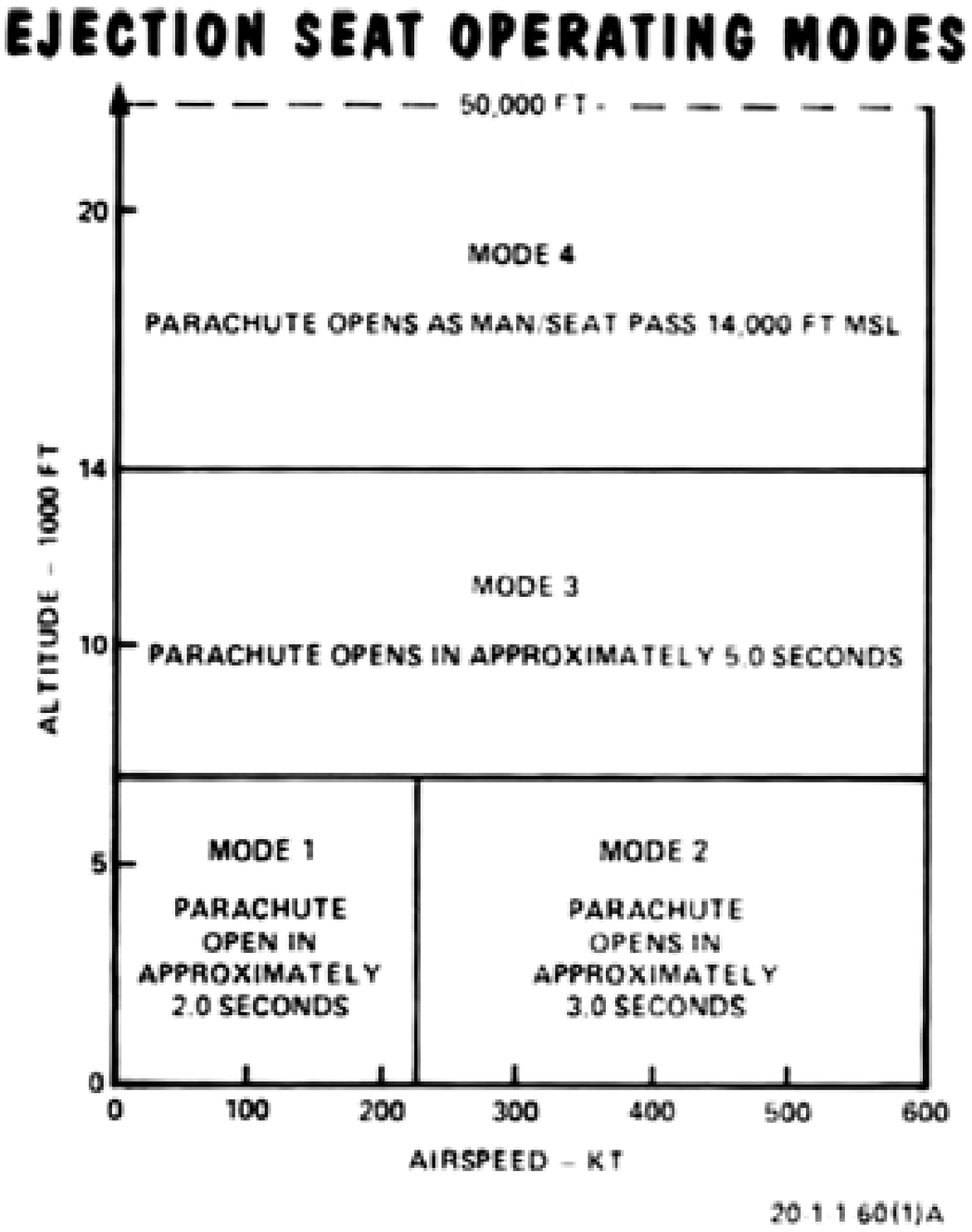

Figure 1-54.

ENVIRONMENTAL CONTROL SYSTEM

The environmental control system (ECS) (figure 1-55) consists of the following: air conditioning, pressurization, canopy and windshield defog, and air distribution systems. All systems except anti-g suit, canopy and windshield seal system, hydraulic reservoirs, external fuel tank(s), radar cooling, and radar waveguide pressurization are controlled by controls located on the right vertical panel. Air from the seventh stage of the compressor section of the engine is used to perform cooling, heating, conditioning, and pressurization functions.

AIR CONDITIONING AND PRESSURIZATION SYSTEMS

Air is routed thru a heat exchanger, cooling turbine, and water separator before entering the cockpit area. Cockpit temperature is automatically or manually selected by a temperature switch. In the automatic mode a temperature control valve automatically maintains the temperature level selected by the temperature knob. In manual mode, the temperature controller is inactive. Temperature is controlled by manual operation of the temperature switch until desired temperature is achieved. Manual mode should be used only if a malfunction occurs in automatic mode. A pressure regulator automatically maintains a cockpit pressure differential (see figure 1-56). Cockpit pressure altitude is indicated by the cabin pressure altimeter on the instrument panel. Static pressure ports on each side of the fuselage below the windshield area provide a static source reference for the regulator and safety valve. A pressure safety valve incorporated in the system automatically protects the cockpit from excessive high or low pressure and depressurizes the cockpit when the cockpit pressurization switch, placarded CABIN PRESS is in RAM DUMP position. Pressurizing air is supplied to the external tank system, anti-g suit system, canopy and windshield seal system and hydraulic reservoirs.

CANOPY AND WINDSHIELD DEFOGGING

The canopy and windshield are defogged by a mixture of bleed air and partially cooled package heat exchanger air that is directed thru ducting to the canopy and windshield surfaces. Defogging air temperature is independent of the temperature selected by the cockpit temperature knob, but is maintained within temperature limits by the defog temperature control valve and the defog temperature sensor.

AIR DISTRIBUTION

The cockpit air distribution subsystem provides distribution of air conditioning and pressurization airflow and routes cooling air to the torso outlet in the right vertical panel (figure 1-4) and the two torso outlets on the left forward canopy frame. Airflow volume of the outlets can be adjusted or shut off by turning the outer opening and can also be adjusted directionally by tilting the outlet left-right or up-down. Two outlets in the lower rear bulkhead of the cockpit provide conditioned air to the floor area and are stationary and nonadjustable. In an emergency, the pilot can shut down the cabin conditioning and pressurization system by selecting the RAM DUMP position of the cockpit pressurization switch. The RAM DUMP position fully opens the pressure safety valve, opens a ram air valve to provide ambient airflow from an opening behind the left engine air inlet duct, and closes the air conditioning shutoff valve.

ELECTRICAL/ELECTRONIC EQUIPMENT CONDITIONING

On the ground, two ac-powered blowers circulate ambient air within the forward avionics bay when electrical power is on. When the canopy is closed, conditioned air from the cockpit area is discharged thru the cabin pressure regulator to the forward avionics bay. This conditioning maintains temperature limits in flight. The aft electrical bay is cooled by circulating conditioned air.

RADAR COOLING (WHEN INSTALLED)

Conditioned air is used for radar cooling. Turning the radar power selector to STBY or OPR initiates radar cooling. Radar temperature control is automatic. Turning the radar off or selecting cockpit pressurization RAM DUMP or DEFOG ONLY shuts down radar cooling.

ENVIRONMENTAL CONTROL SYSTEM

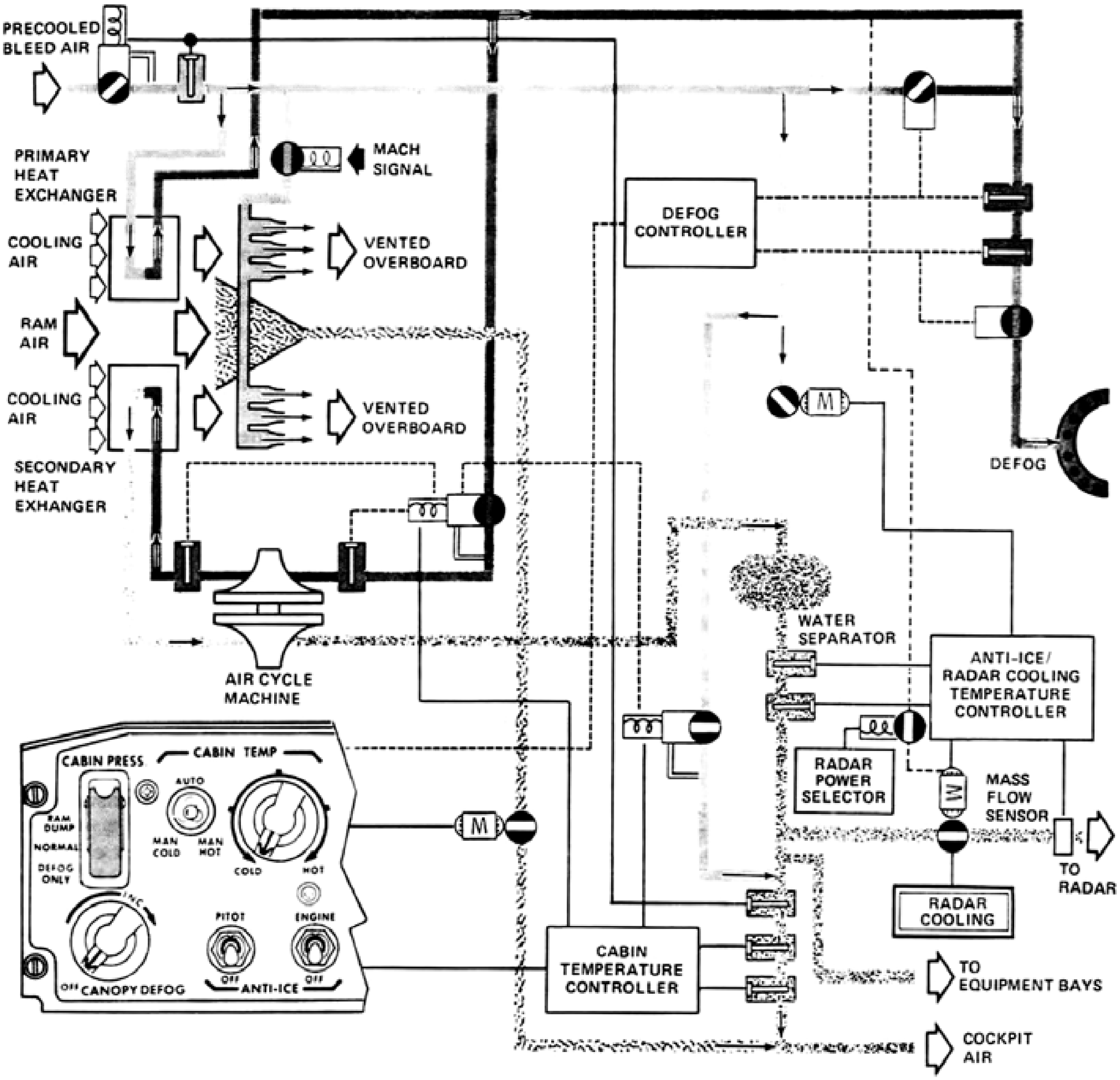

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Figure 1-55.

COCKPIT PRESSURIZATION SCHEDULE

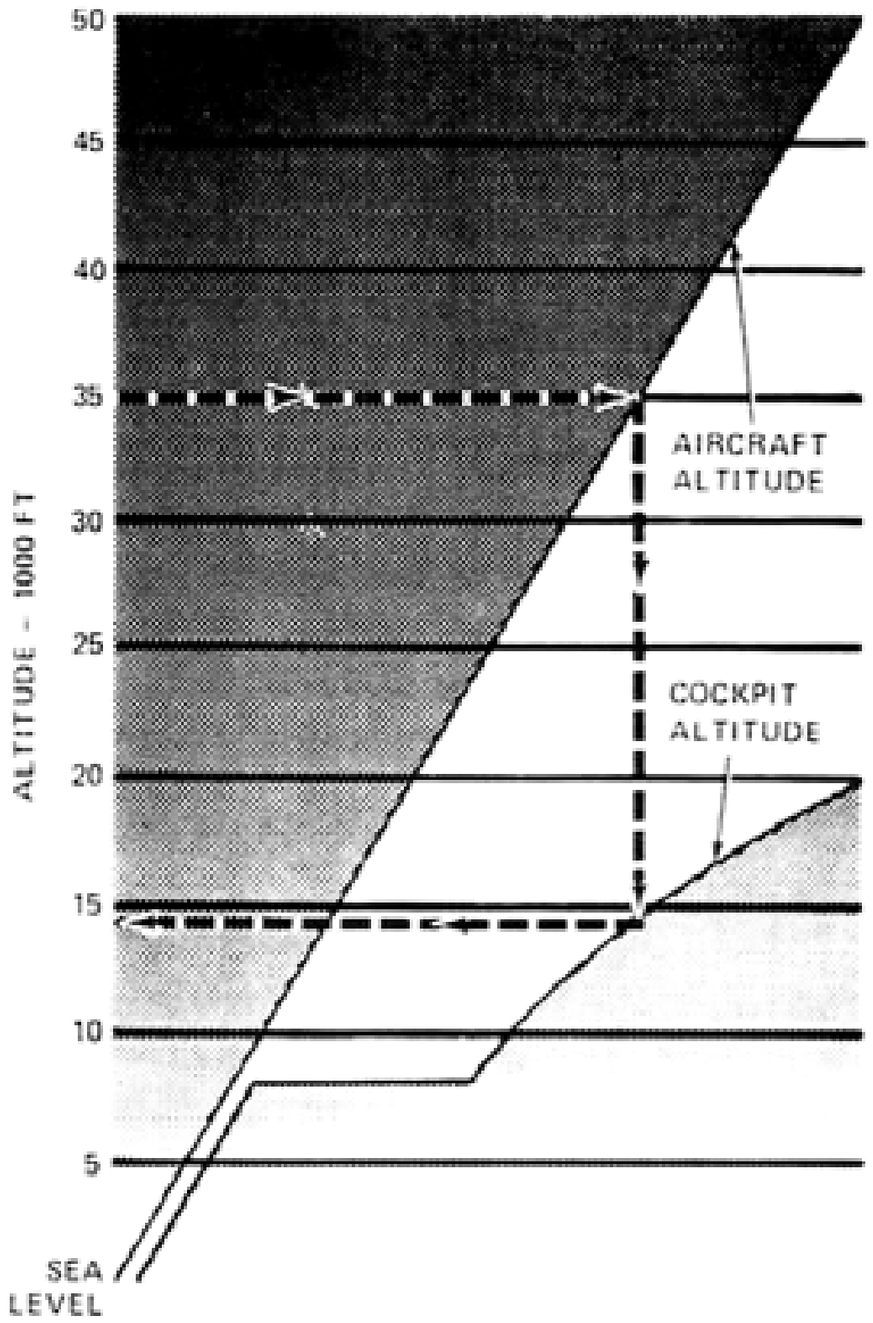

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Figure 1-56.

ANTI-ICING SYSTEM

The Pitot booms, total temperature probe, and AOA vane contain electric heating elements for anti-icing. Positioning the two-position pitot heat switch on the right vertical panel to PITOT activates all heating elements. For engine anti-icing see Engine, this section.

MAJOR CHANGE

WEAPONS DELIVERY SYSTEM

WEAPONS DELIVERY SYSTEM

The weapons delivery system provides A/A and A/G weapons normal or backup delivery capability. The mission computer (MC), RADAR, multiplex bus (MUX BUS), HUD, DDIs, armament control panel (ACP), stick and throttle switches/controls, INS, missile interface units (MIU), pylon interface units (PIU), gun control unit, rounds remaining counters, data entry panel (DEP), and display processor interface to provide weapons delivery and the fire control function (figure 1-57). The weapons delivery system is initialized to the normal weapons delivery mode. The system responds to pre-programmed weapons delivery options to automatically provide weapons delivery displays, weapons selections, and status. The master arm switch on the ACP is used for all weapons deliveries. When the system is armed the pilot has control of weapons delivery with controls located on the stick and throttle. This allows the pilot to maneuver the aircraft and select and deliver weapons without removing hands from stick or throttle. The ACP is used for backup weapons delivery mode or stores jettison.

WEAPONS DELIVERY CONTROLS

The weapons delivery controls are located on the stick and throttle. Various display features and radar modes are selected using DDI pushbuttons, or the target designator control and the DDI radar display.

THROTTLE CONTROLS

Throttle mounted controls include the A/G mode select switch, target designator control, missile cage/uncage switch, undesignate button, and radar antenna elevation control (figure 1-58).

WEAPONS CONTROL

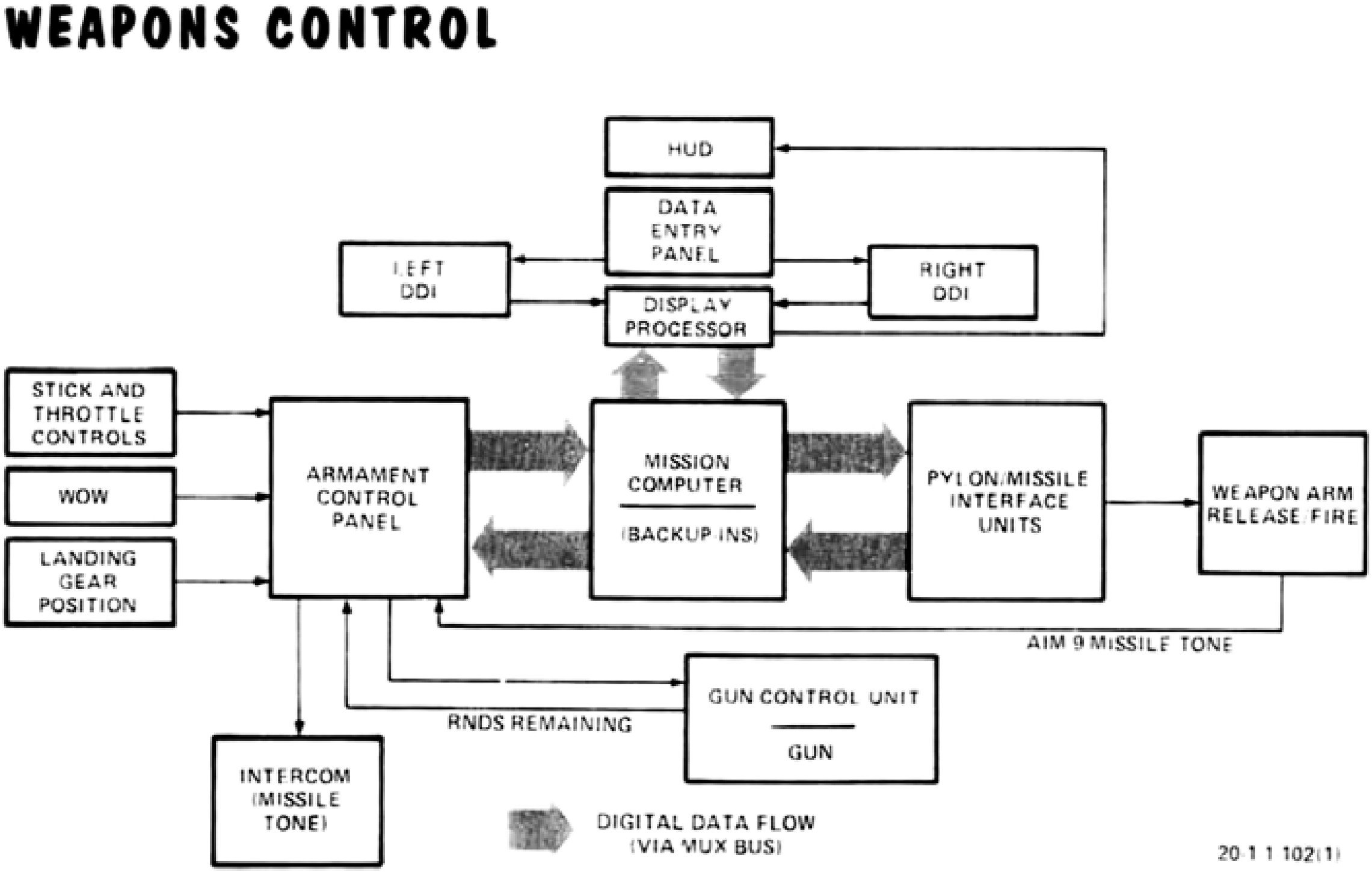


Figure 1-57.

STICK AND THROTTLE CONTROLS

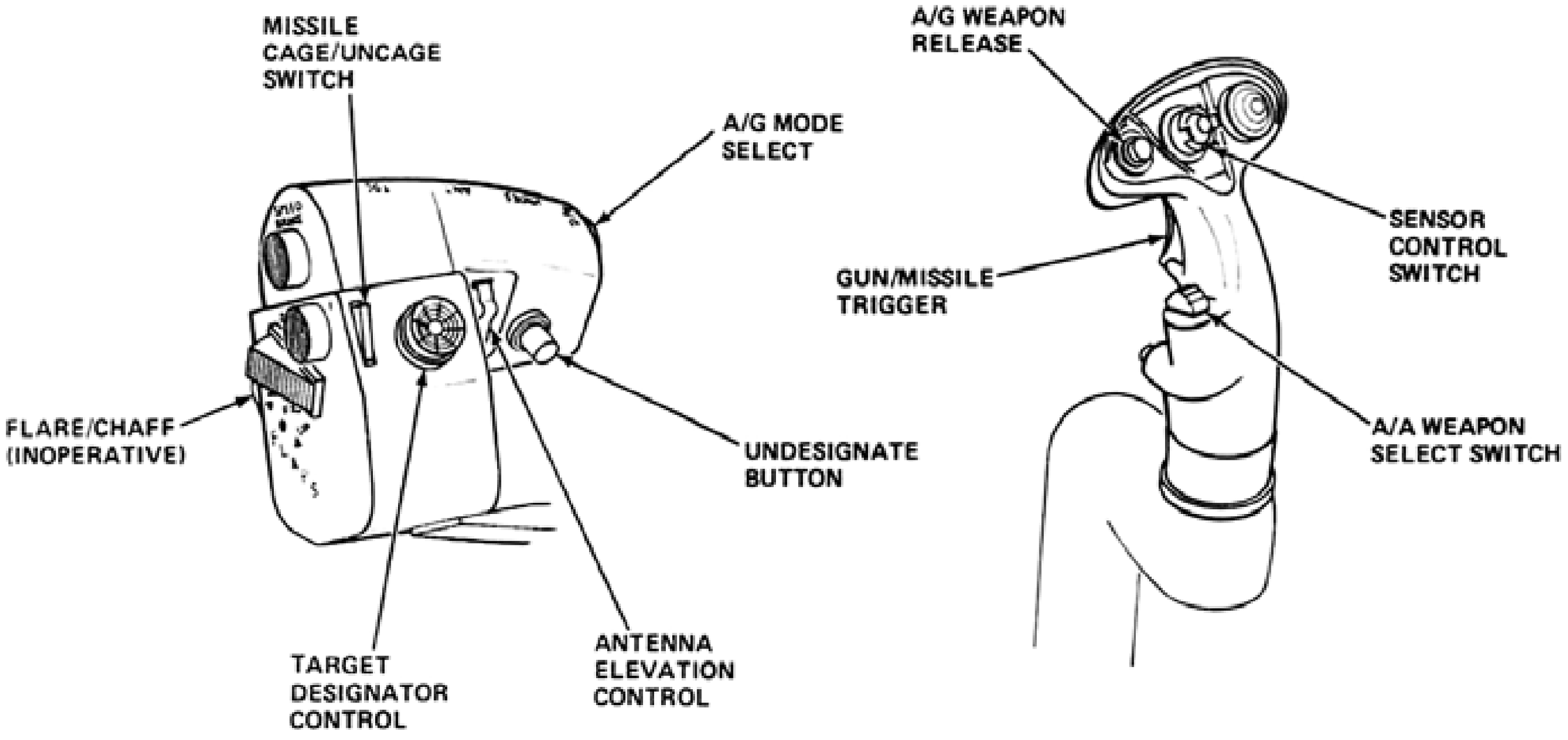


Figure 1-58.

A/G Mode Select Switch

Pressing the momentary A/G mode select switch places the system into the A/G master mode and automatically selects program 1 for the first priority weapon and commands the appropriate HUD, DDI stores, and DDI radar displays. If the system is already in the A/G mode, pressing the A/G mode select switch steps to the next station with the same weapon model designation.

Target Designator Control

The target designator control (TDC) moves the acquisition (A/A), designator (A/G), or the cross hair cursor on the radar display to acquire/designate targets; the target designator diamond on the HUD to designate A/G targets; or to actuate DDI pushbutton options (see Radar Option Select — TDC). When the TDC is pressed and held the acquisition cursor on the radar display changes to a designator cursor cross hair for more accurate placement. When moved to the edge of the display and held, the cursor maintains its position on the display edge until TDC movement in the opposite direction returns cursor to within the display area.

TDC—A/A

When the cursor cross hair is over a target to be acquired and the TDC released, the radar acquires the target and the system tracks the selected target.

TDC—A/G

When the cursor cross hair is over a target to be designated, releasing the TDC designates the selected target, the cross hair changes to an inertially stabilized target marker to mark the target location, and the cursor is stowed in the upper left of the radar display. Target position can be updated by designating the target again. When the target designator is assigned to the HUD by the sensor control switch, the target designator diamond appears in the circle of the flight path vector and the radar enters air-to-ground ranging. The target designator diamond can be moved to any position in the HUD field of view by the TDC. Placing the target designator diamond on the target, either by maneuvering the aircraft or by the TDC if the target is in the HUD field of view, and then pressing and releasing the TDC designates the target. The TDC, without pressing, is used to refine target designator diamond placement over the target if a target update is desired.

Missile Cage/Uncage Switch

The missile cage/uncage switch is a momentary switch for control of the selected AIM-9 seeker head. AIM-9 seeker heads are initialized caged in boresight position. Pressing and releasing the switch uncages the seeker head of a selected missile and allows the seeker head to track a heat source. Pressing and releasing the switch again, cages the seeker head.

Undesignate Button – A/A

The undesignate button when pressed and released, breaks radar lock-on or rejects automatic acquisition (AUTO ACQ) and places the system into the previous search mode (RWS, TWS, or VS).

Undesignate Button – A/G

The undesignate button when pressed and released, undesignates the radar or HUD designated target, or rejects moving target track (MTT) and places the radar system into the previous A/G mode (GMTI or SEA2).

Antenna Elevation Control

The antenna elevation control provides vertical adjustments of ± 60 degrees elevation of the radar antenna. Rotating the control up/aft tilts the antenna upward until the control is released or the antenna reaches the upper limit. Rotating the control forward/down tilts the antenna downward until the control is released or the antenna reaches the lower limit. The antenna elevation caret on the left side of the radar display indicates the vertical look angle. In A/A, the radar beam coverage upper and lower altitude is displayed above and below the acquisition cursor.

STICK CONTROLS

Stick mounted controls include the A/A weapon select switch, A/G weapon release button, gun/missile trigger and the sensor control switch (figure 1-58).

A/A Weapon Select Switch

The weapon select switch selects an A/A weapon and places the weapons delivery system into the A/A master mode. The three-position momentary switch selects guided missile or guns.

Aft	-Selects guns and A/A master mode. -A/A guns display on DDI and HUD. -Radar to AUTO ACQ super search, or to gun parameters in single target track (STT) if a target locked-on.
Down	-Selects missile and A/A master mode. -AIM-9 display on DDI and HUD. -Radar to range while search (RWS) 20 NM range, or to AIM-9 parameters in STT if target locked-on.
Forward	-Selects missile and A/A master mode. -AIM-9 display on DDI and HUD. -Radar to RWS 40 NM range, or to AIM-9 parameters in STT if target locked-on.

A/G Weapon Release Button

The weapon release button is a momentary pushbutton that activates the pylon interface unit firing or release signals of the selected pylons, and runs the HUD camera, if installed. In continuously computed impact point or manual weapon delivery, the weapon is released when the button is pressed. In automatic delivery, the button is pressed and held until weapon release is commanded by the MC. A ripple release weapons delivery program is interrupted if the weapon release button is released before the program is completed.

Trigger

Squeezing the trigger to the first detent starts the HUD camera running, if installed. Squeezing thru to the second detent fires guns, if installed, or launches missiles.

Sensor Control Switch – A/A

The sensor control switch selects AUTO ACQ submodes, see Automatic Acquisition.

Sensor Control Switch — A/G or NAV

The sensor control switch assigns the target designator and TDC to the HUD or to the DDI with the radar display. The target designator is automatically assigned to the right DDI radar display when A/G is selected.

Forward	-Assigns the target designator to the HUD.
Left	-Assigns the target designator to the left DDI radar display.
Right	-Returns the target designator to the right DDI radar display.
Aft	-No function.

ARMAMENT CONTROL PANEL

The armament control panel (ACP) (figure 1-59) consists of an armament control processor, master arm switch, armament panel lighting control, backup weapons delivery controls, and selective or emergency jettison controls. The ACP functions are interface between the stick/throttle controls and the MUX BUS for normal weapons delivery, jettison control (refer to Jettison System), master arm control, and the primary control for backup weapons delivery. Upon selection of A/A or A/G master modes, the MC automatically selects weapon(s) and station priority based on data entered in the weapons program prior to flight. The ACP initiates continuous BIT upon power up. The BIT status is displayed to the right of the ACP label on the BIT display.

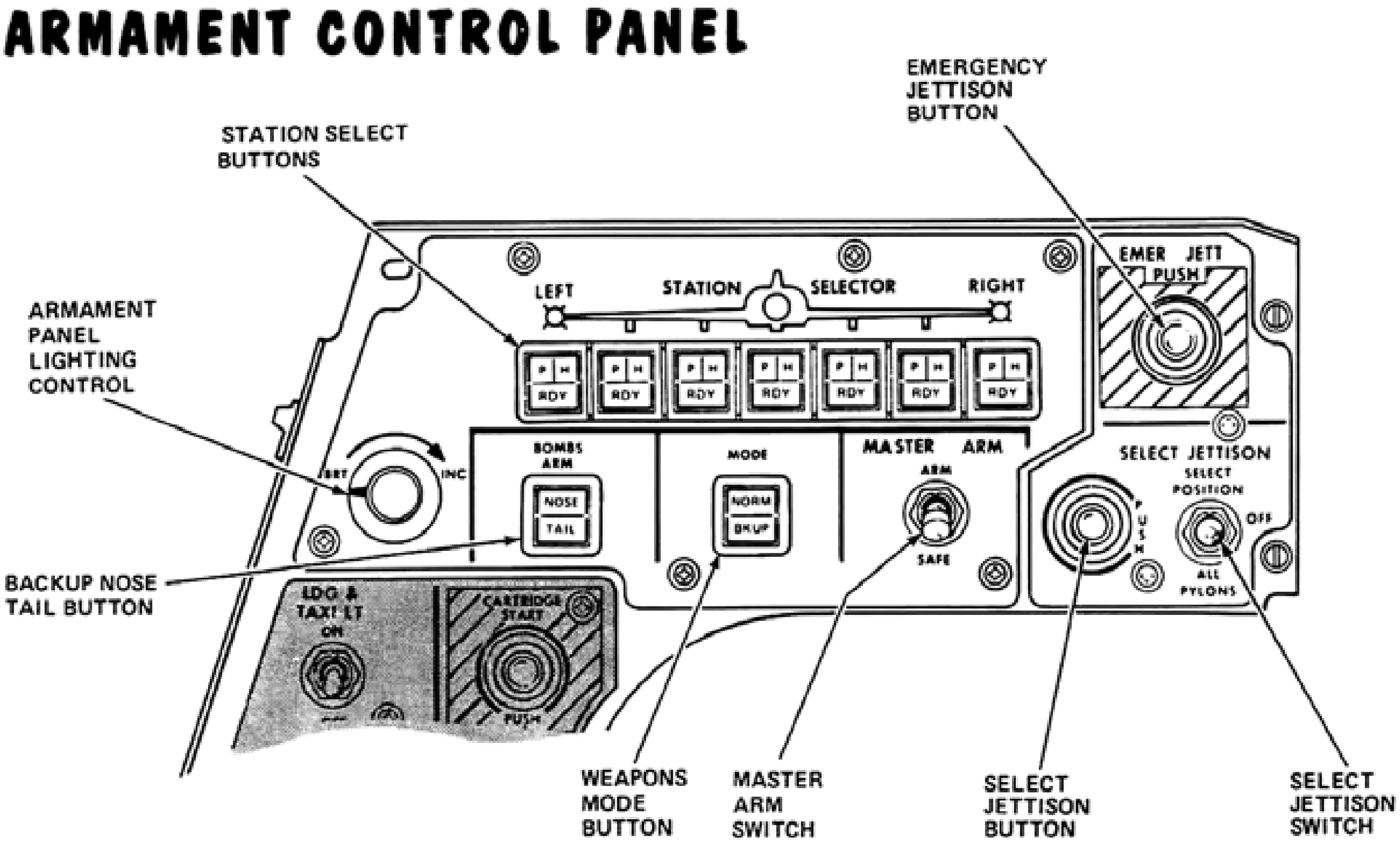


Figure 1-59.

MASTER ARM SWITCH

The master arm switch, labeled MASTER ARM is a lever lock toggle switch that arms or safes the weapon release circuits for normal or backup weapons delivery. The two positions are labeled SAFE and ARM.

SAFE	-Disables normal or backup weapon(s) release. The word SAFE appears on the HUD and in the center of the stores display. A cross appears across the displayed weapon symbol on the DDI and the HUD.
ARM	-(Pull out and up) Enables weapon(s) release. In navigation mode the word ARM appears in the center of the HUD. ARM appears on the stores display.

BACKUP WEAPONS DELIVERY CONTROL

Backup weapons delivery controls include the master arm switch; weapons release button; trigger; the ACP weapons mode button, seven station selector buttons, and backup nose tail button; DEP standby reticle switch; and the pedestal bus control switch.

Station Select Buttons

The seven station select buttons, labeled STATION SELECTOR, provide station selection and weapons status for backup weapons delivery or for selective jettison. For selective jettison, see Jettison System this section. Each station select button is divided into three station status lights labeled P (present), RDY (ready), and H (hung). A status light indicates one of four store status advisory conditions in backup or jettison modes.

Not illuminated.	-No store on station.
P (white)	-Store on station.
RDY (green)	-Store ready for backup release or jettison.
H (amber)	-Store failed to release/ jettison/launch.

Nose Tail Button

The backup nose tail button labeled BOMBS ARM provides selection of fuze arming for bomb release in backup weapons delivery. The button is a momentary press stepping switch containing two separate status lights labeled NOSE (green) and TAIL (white).

Button— Press (no lights)	-NOSE light comes on. Only nose fuze is armed at bomb release.
NOSE — Press	-NOSE light goes out, TAIL light comes on. Only tail fuze is armed at bomb release.
TAIL — Press	-TAIL light remains on, NOSE light comes on. Nose and tail fuzes are armed at bomb release.
NOSE/TAIL — Press	-NOSE and TAIL go out. Neither fuze is armed at bomb release.

Weapons Mode Button

The weapons mode button labeled MODE provides selection of backup weapons delivery if the BUS control switch on the pedestal is at BKUP. The button is a momentary press stepping switch with two separate status lights labeled NORM (green) and BKUP (yellow).

NORM — Press	The NORM goes out, BKUP comes on. The system is in backup weapons delivery mode. Enables station select buttons and nose tail button.
BKUP — Press	BKUP goes out, NORM comes on. Returns system to normal weapons delivery.

Standby Reticle Switch

The standby reticle switch selects the HUD standby reticle (figure 1-60). In the ON position, the standby reticle appears and all other HUD symbology is blanked. When the switch is turned off, normal HUD symbols reappear in approximately 22 seconds.

STORES MANAGEMENT SYSTEM

Stores management consists of entering, displaying, and managing the stores and the weapons delivery programs. Stores management uses the DDI stores display. The MC interfaces with the DEP, DDIs, pylon and missile interface units, gun control unit and rounds remaining counter, and stick and throttle controls to provide normal weapons management. Stores status appears on the stores display. DEP and DDI pushbuttons are used to enter weapons configuration into the system. The MC displays a stored weapons delivery program on the HUD/DDI when a weapon is selected. DEP and DDI pushbuttons are used to enter up to three A/G weapons delivery programs into the MC for each weapon model designation A/G weapon on the aircraft. Backup stores management is through the ACP.

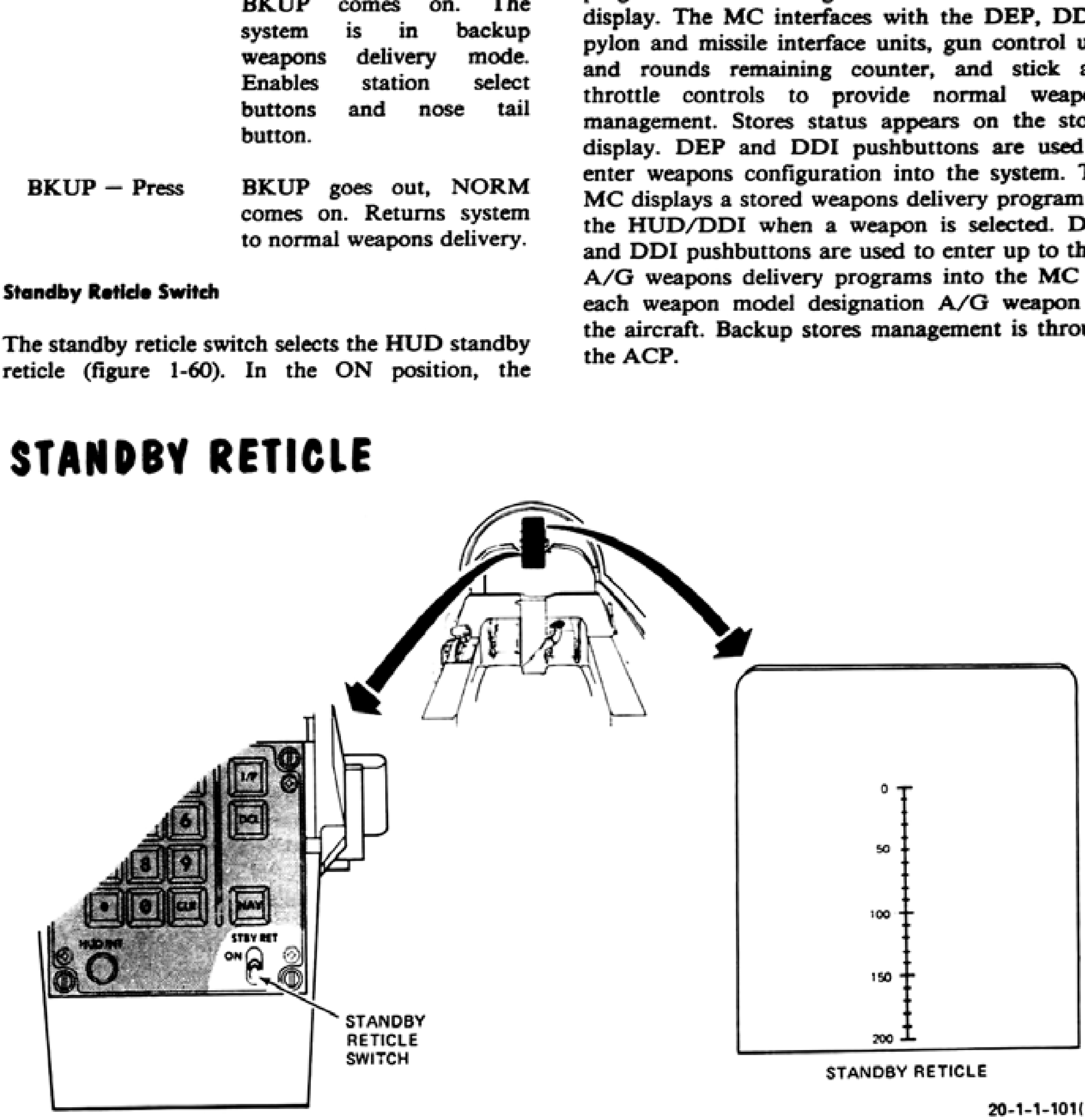


Figure 1-60.

STORES DISPLAY

The stores display appears when PB-4 labeled STRS is selected from the index display. The stores display appears automatically on the left DDI after an A/A or A/G mode is selected, a weapon is released, the gun/missile trigger is squeezed to the second detent, or the missile cage/uncage button is pressed in A/G mode. The stores display depicts the weapon(s) selected and status, aircraft stores loading, the A/A or A/G mode, and the A/G weapons delivery program, as applicable. The HSD replaces the automatic appearing stores display 5 seconds after the last switch actuation/weapons release.

WEAPONS/CONFIGURATIONS

Weapons data codes are entered into the mission computer using the DEP and the DDI stores display while the aircraft is on the ground. Prior to flight, the pilot shall verify the stores display weapons/stores configuration exactly matches the stores loaded on the aircraft. The pilot shall also verify that the A/G weapons priority conforms to inflight carriage and sequencing limitations. The stores display is selected from the index display by PB-4 labeled STRS (figure 1-61).

WEAPONS PRIORITY – A/G

Weapons priority is established when the stores codes are entered into the MC. Priority one, two, and three weapon labels appear at PB-6, PB-7, and PB-8 respectively on the stores display. When the master arm switch is at ARM and A/G mode is selected, the priority one weapon is automatically enabled for delivery. The guns or priority two or three weapons are manually selected if priority one weapons have not been expended.

WEAPONS DELIVERY PROGRAM

A weapons delivery program is a set of delivery data. The MC stores up to three weapons delivery programs for gun and for each model designation A/G weapon on the aircraft. Delivery data are normally entered prior to flight. Delivery data can be entered or changed either on the ground or in flight. The DDI stores display and DEP are used to enter the delivery data into the weapons delivery program of the MC.

ENTERING DELIVERY DATA

Delivery data includes weapon type, mode of weapons delivery, fuze arming, total number of weapons to be delivered, and may include depressed reticle, number of weapons to be released simultaneously, and distance between weapons impacts (figure 1-62, sheets 1 and 2). Weapon type is selected by the boxed weapon label entered at PB-6, PB-7, PB-8, or PB-10. Programmable modes of delivery are continuously computed impact point (CCIP) and manual (MAN). Nose, tail, or nose and tail are bomb fuze arming options. The manual mode of delivery uses a depressed reticle. Quantity of bombs, multiple releases, and intervals between releases are used when more than one release for each delivery is desired.

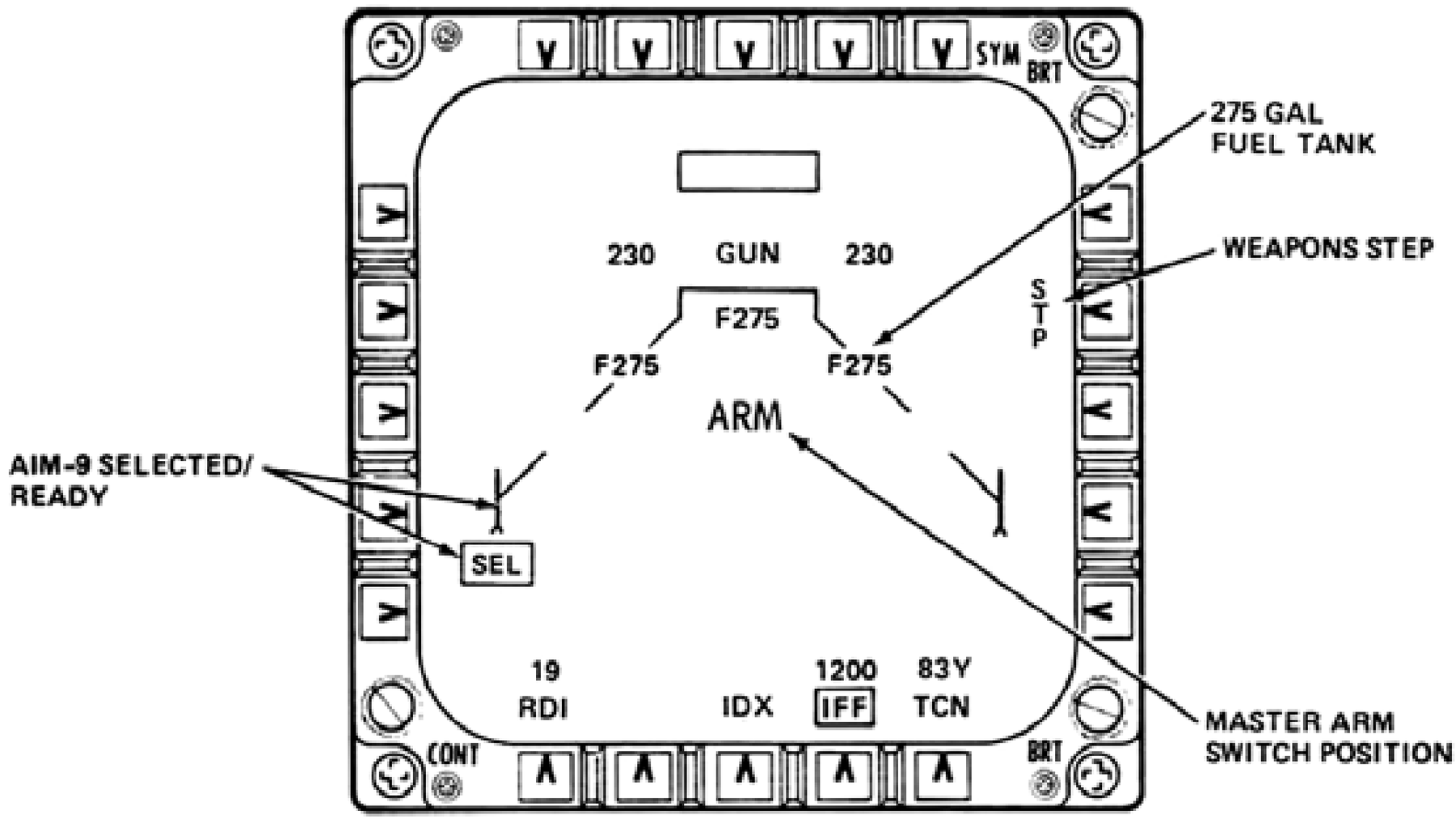
Program

One of three programs is selectable from the stores display using PB-11 labeled PGM. The number (1, 2, or 3) next to the PGM label is the program number for that delivery data.

PB-11 PGM—Push	-Steps to next program for entering delivery data. -Program number appears next to PGM. -Delivery data for program appears on the stores display.
PB-6, PB-7 or PB-8 Weapon label —Push	-Enables program entry for selected weapon. Boxes weapon label. -Weapon label appears next to WPN in the delivery data.
PB-10 GUN—Push	-Enables program entry for the gun. Boxes GUN label. -GUN appears next to WPN in the delivery data.

STORES DISPLAY (TYPICAL)

A/A



A/G

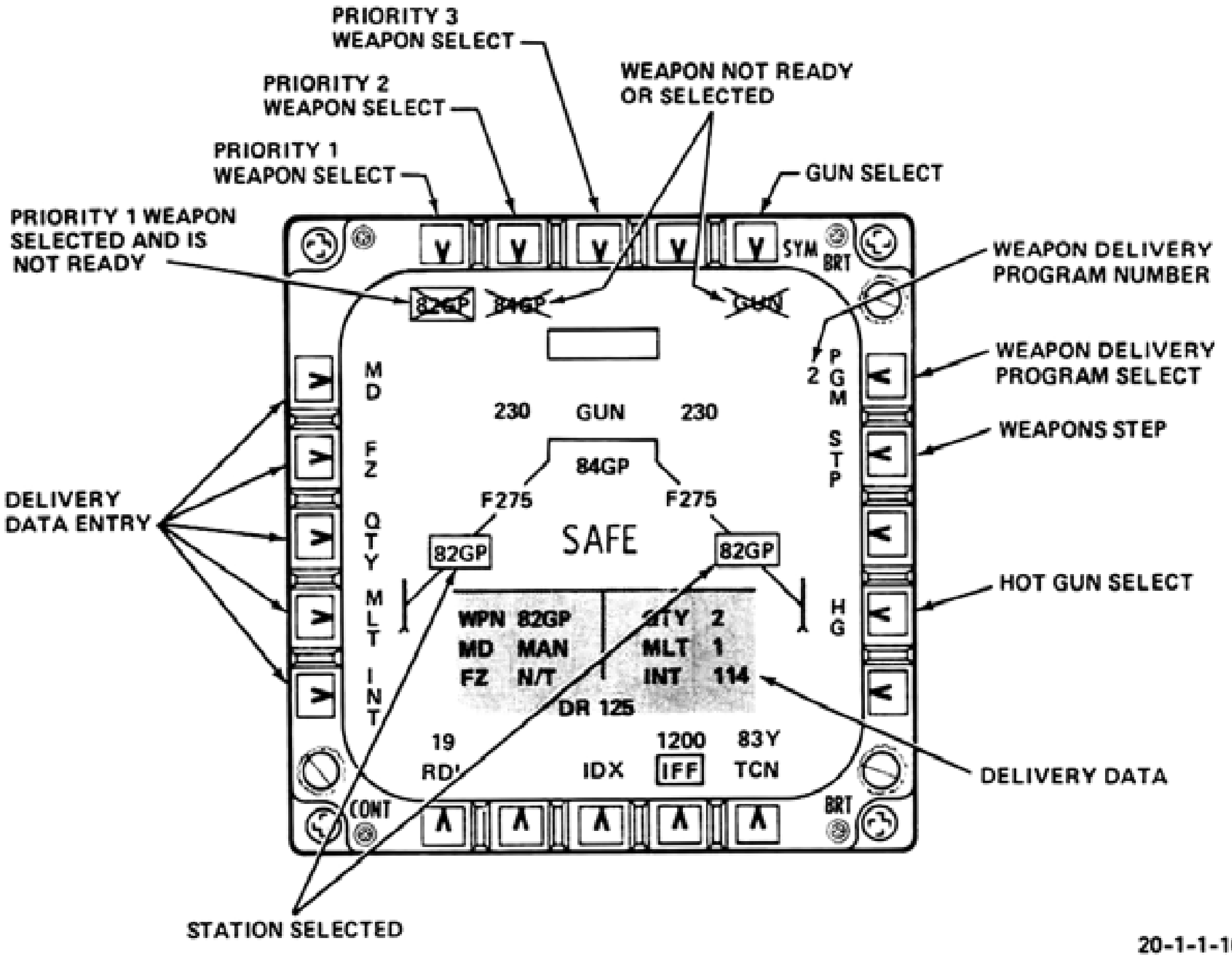


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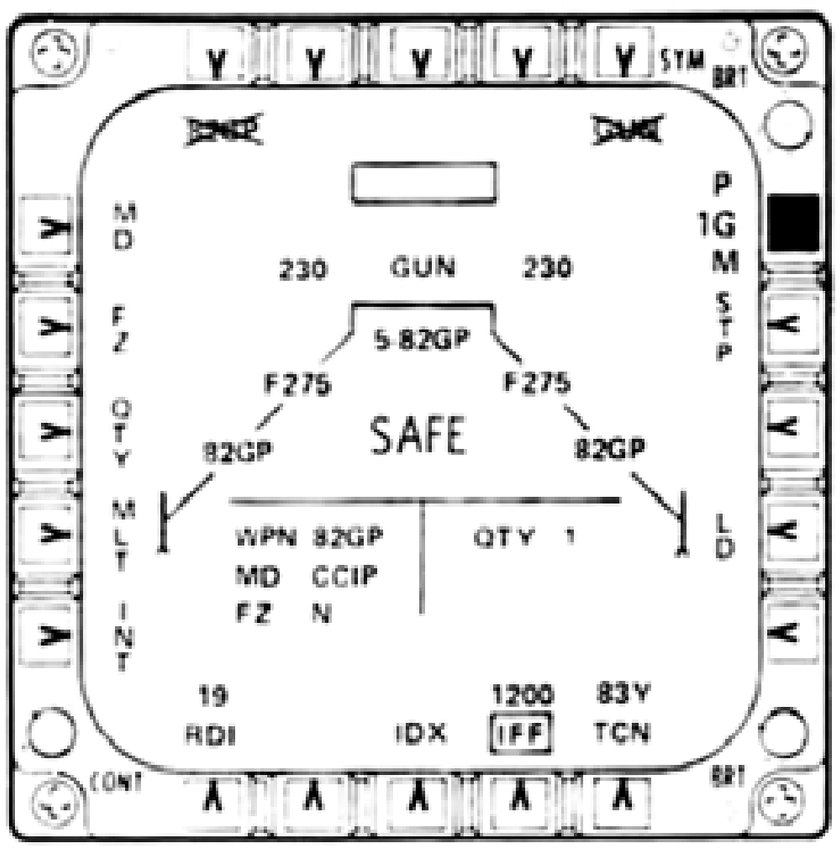
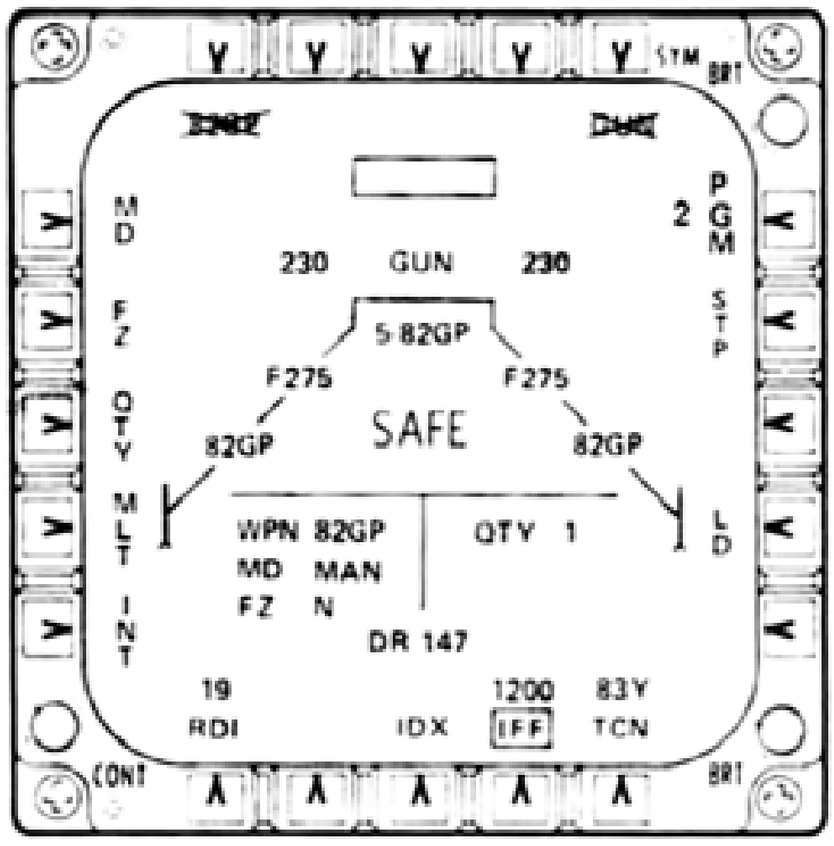
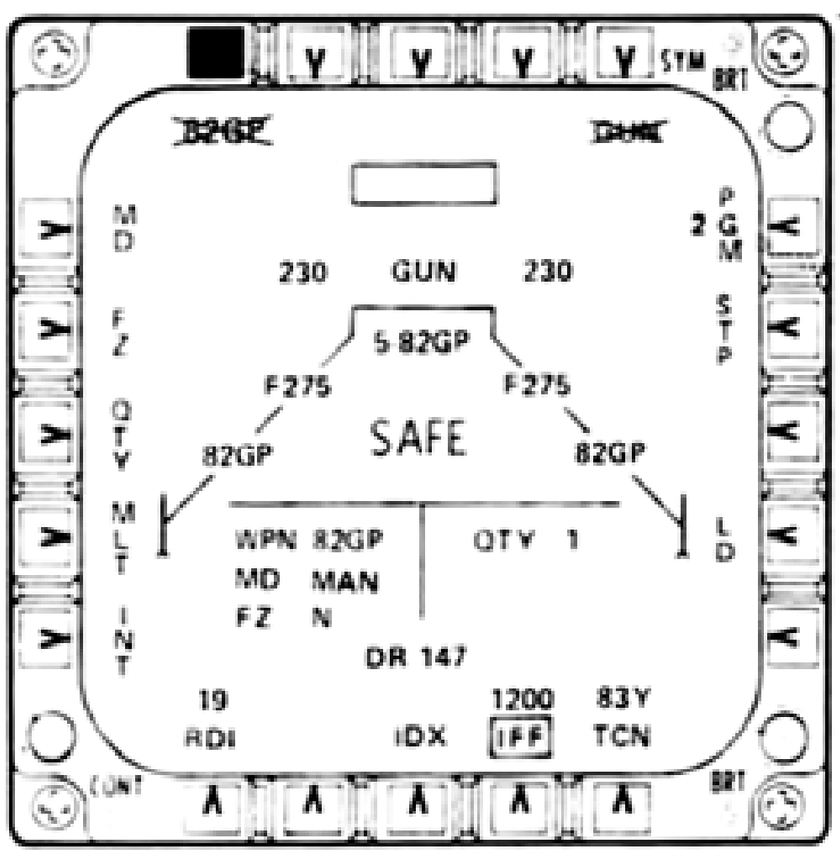
Figure 1-61.

ENTERING DELIVERY DATA (TYPICAL)

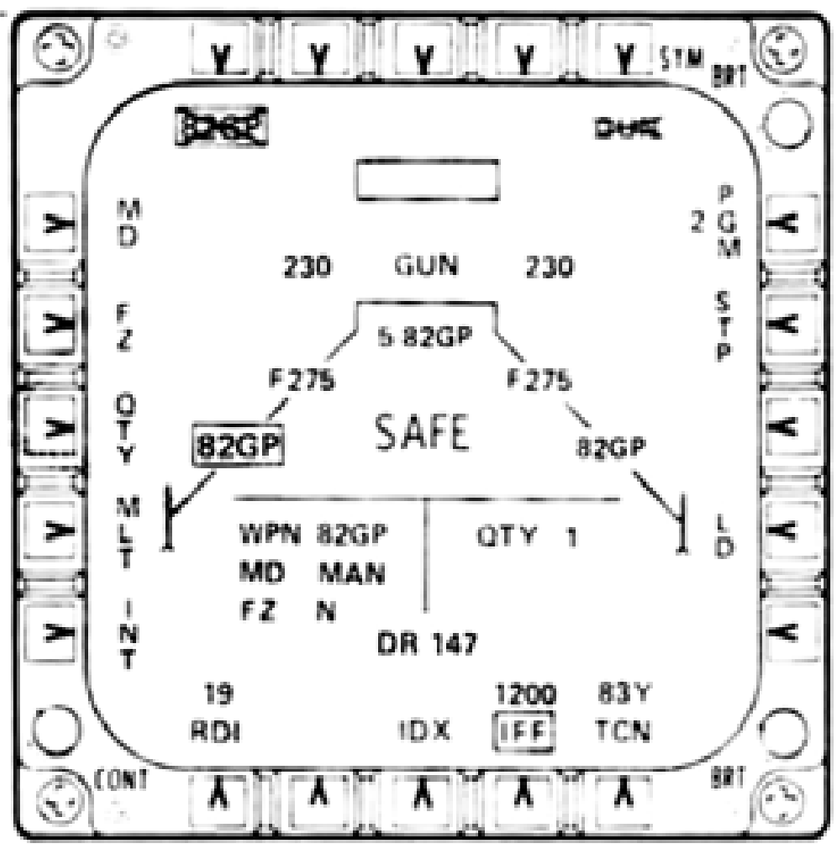


1. INDEX DISPLAY PB-4 SELECTS STORES DISPLAY.
2. PB-11 STEPS TO NEW PROGRAM.



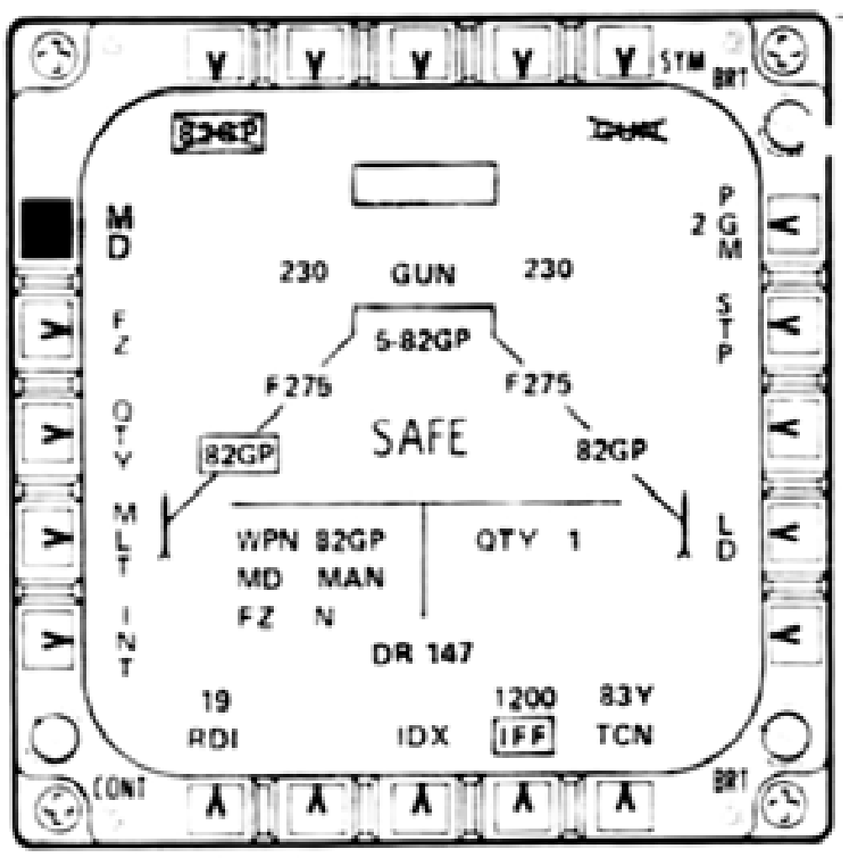


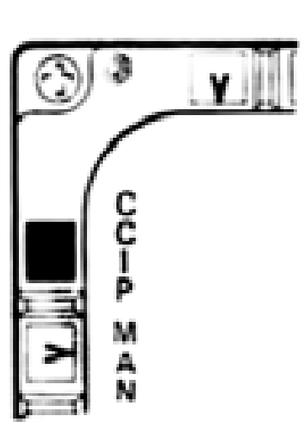
3. PB-6, PB-7, PB-8 OR PB-10 SELECTS WEAPON FOR DELIVERY DATA ENTRY.



DELIVERY MODE OPTION

4. PB-5 SELECTS DELIVERY MODE OPTIONS.





5. DELIVERY MODE OPTION PB-5 SELECTS CCIP MODE.

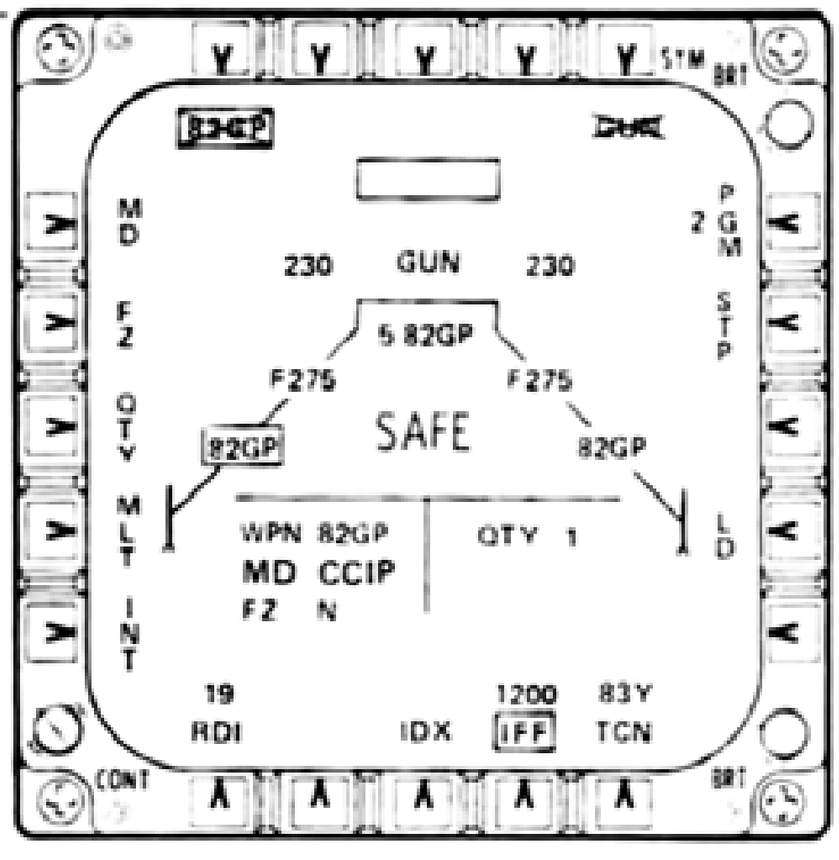


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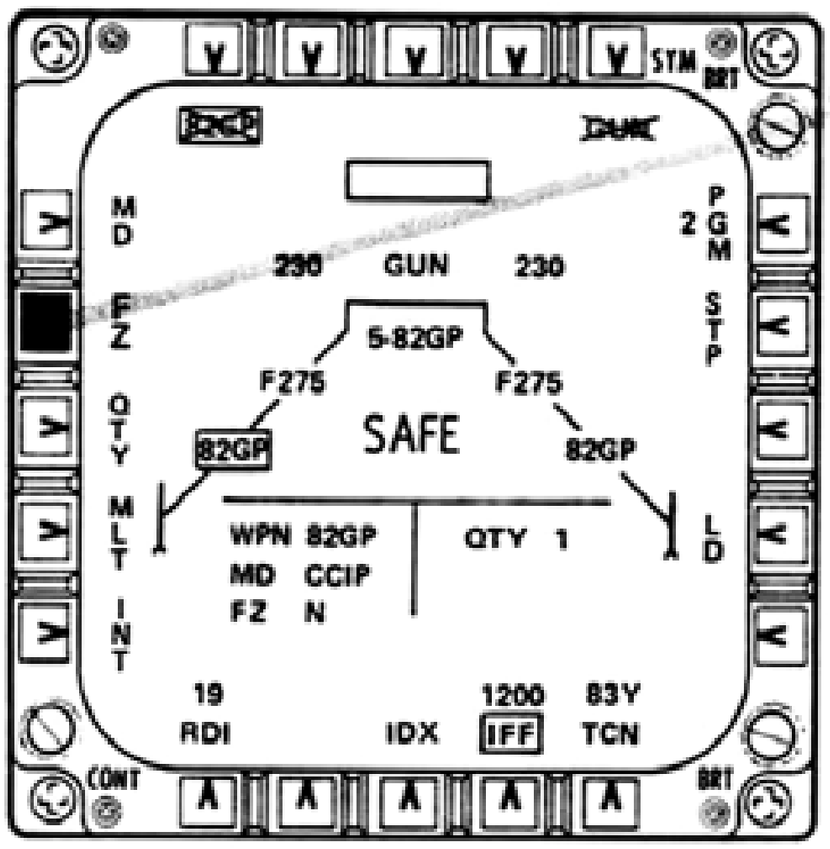
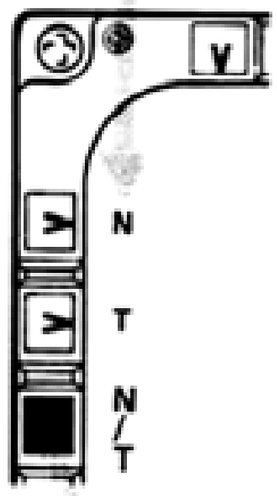
Figure 1-62 (Sheet 1).

ENTERING DELIVERY DATA (CONTINUED)

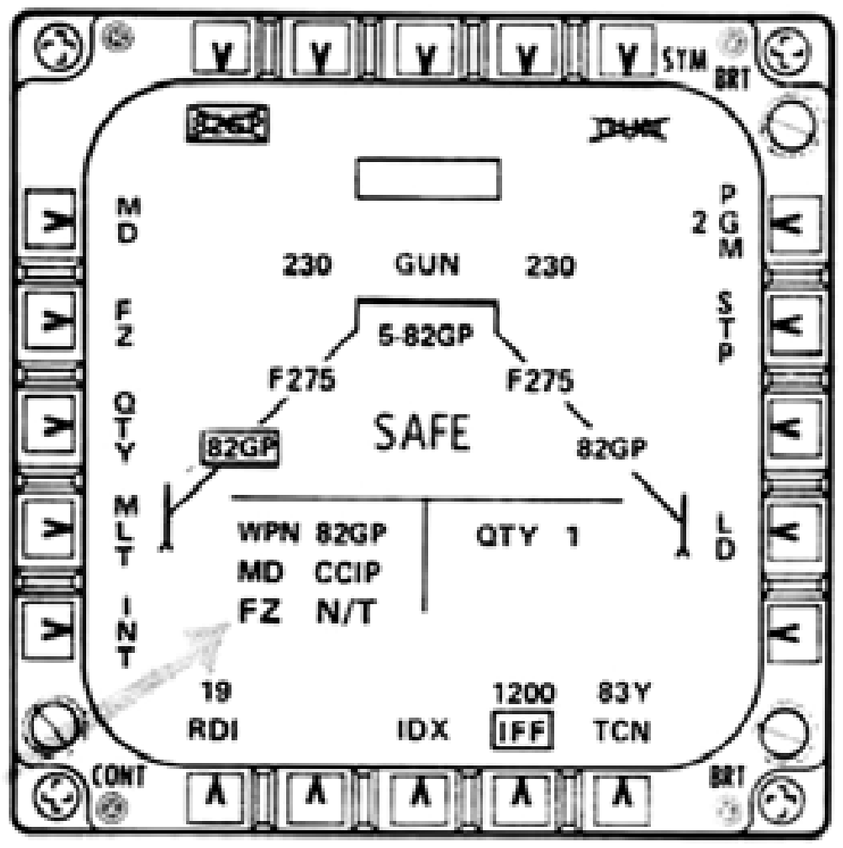


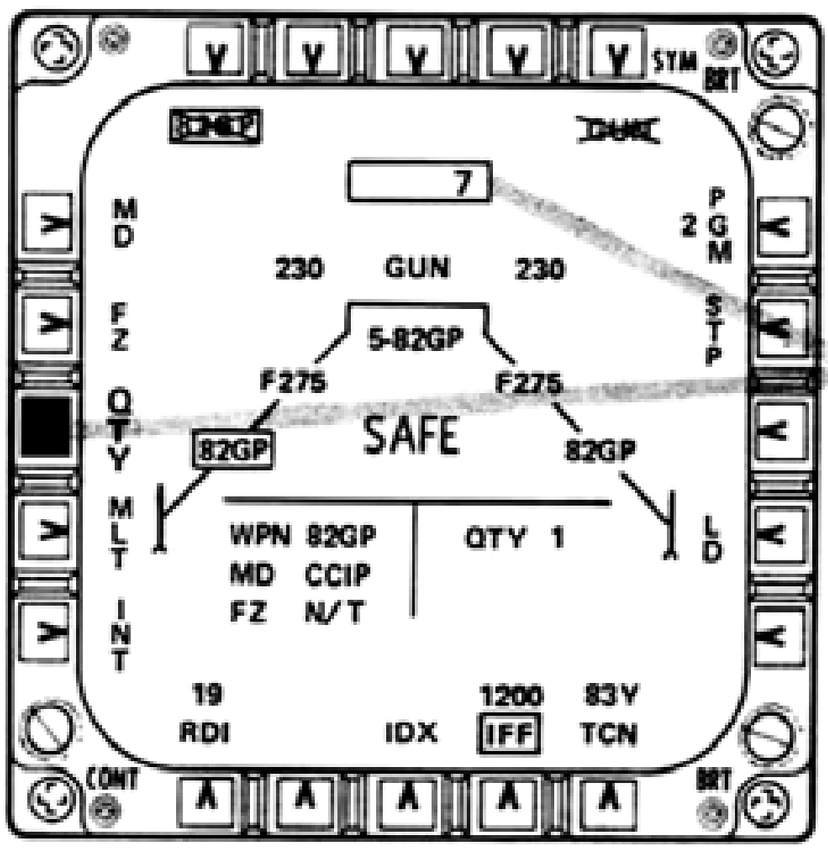
FUSE ARMING OPTIONS

6. PB-4 SELECTS FUZE ARMING OPTIONS.

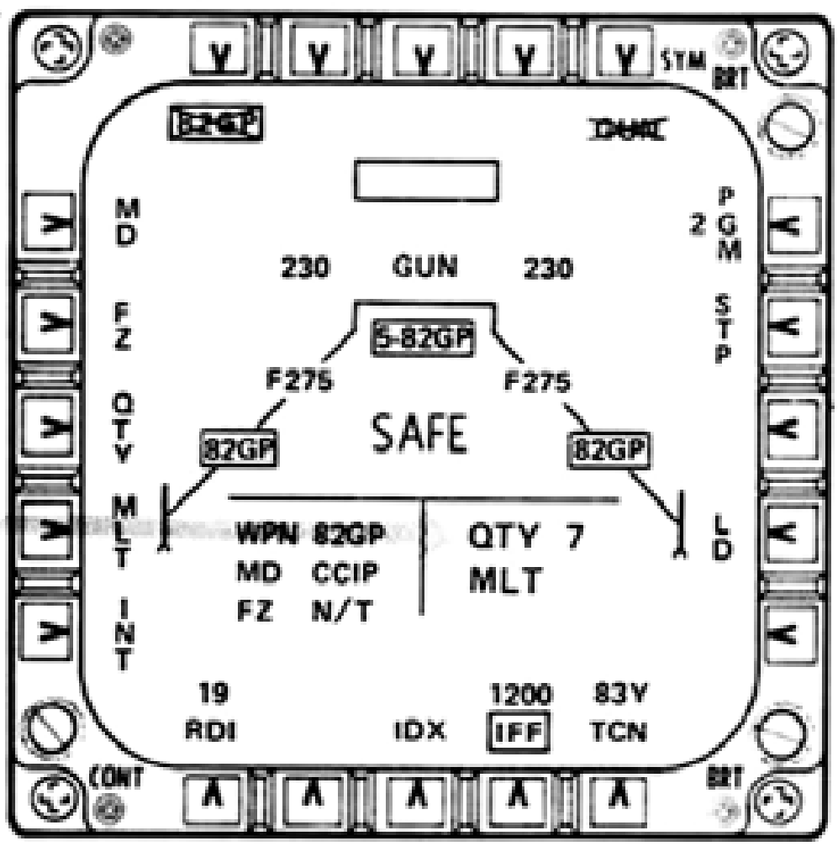


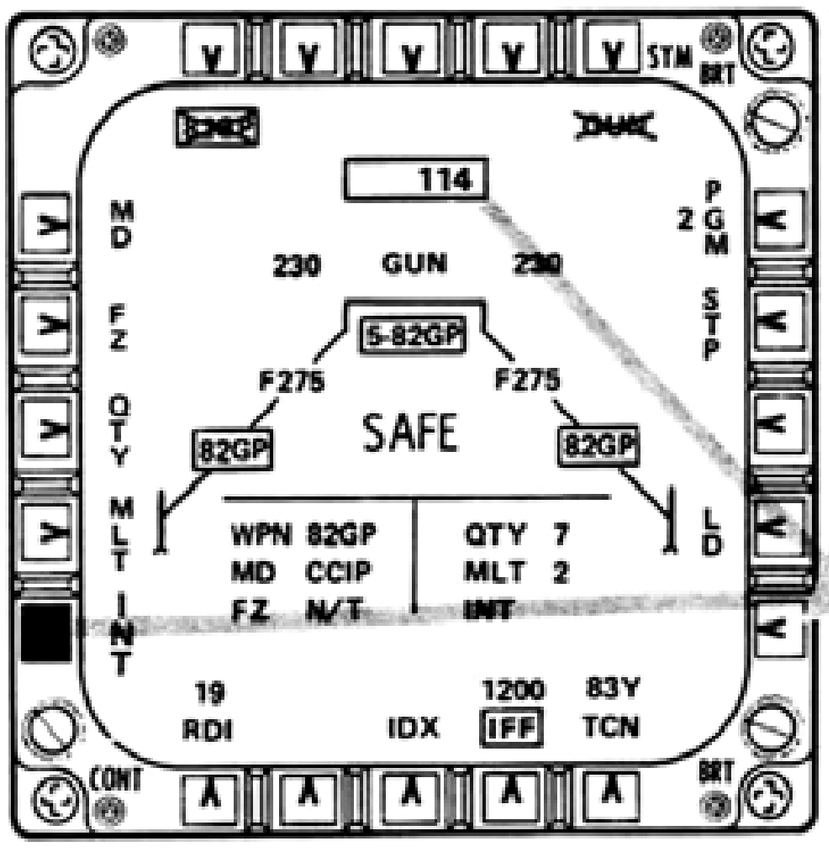
7. FUZE ARMING OPTION PB-3 SELECTS NOSE AND TAIL FUZE ARMING.





8. PB-3 ENTERS SCRATCH-PAD VALUE FOR NUMBER OF BOMBS TO BE RELEASED.





IF QTY IS MORE THAN ONE

9. PB-2 ENTERS SCRATCH-PAD VALUE FOR NUMBER OF BOMBS TO BE RELEASED SIMULTANEOUSLY.

IF MLT IS LESS THAN QTY

10. PB-1 ENTERS SCRATCH-PAD VALUE FOR DISTANCE BETWEEN IMPACTS.

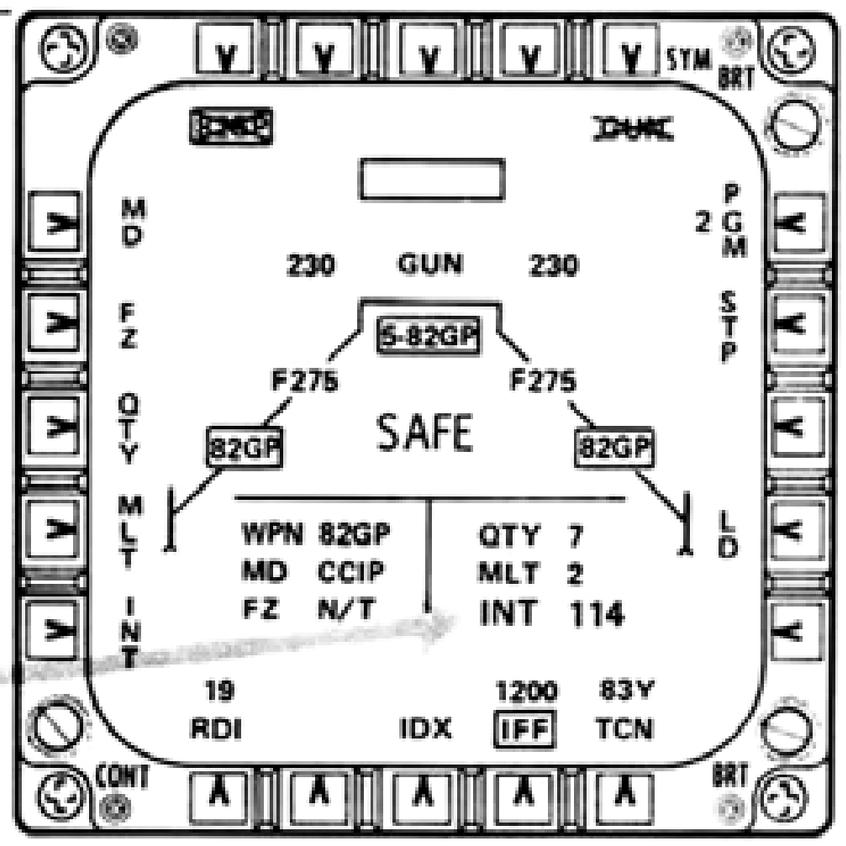


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Figure 1-62 (Sheet 2).

Delivery Mode

The stores display is used to select CCIP or MAN mode options.

PB-5 MD—Push	-CCIP or MAN appears at PB-5 or PB-4 respectively.

CCIP or MAN is used to select CCIP or manual weapons delivery mode.

PB-5 CCIP—Push	-Enters CCIP weapons delivery mode into the MC program. -Returns to stores display. CCIP appears next to MD in the delivery data.
PB-4 MAN—Push	-Enters manual weapons delivery mode into the MC program. -Enables and selects depressed reticle option.

The DEP is used to enter 0 to 150 mils depression number into the depressed reticle option scratchpad.

PB-4 DR--Push	-Enters scratchpad mils value number into the MC program. -Returns to stores display. MAN appears next to MD and mils depression number appears next to DR in the weapons delivery data.

Fuze Arming Options

The stores display is used to select the fuze arming options.

PB-4	-Selects fuze arming options.

Nose, tail, or nose and tail are the fuze arming options.

PB-5 N—Push	-Enters nose only fuze arming into the MC program. -Returns to stores display. Letter N appears next to FZ in the delivery data.
PB-4 T—Push	-Enters tail only fuze arming into the MC program. -Returns to stores display. Letter T appears next to FZ in the delivery data.
PB-3 N/T—Push	-Enters nose and tail fuze arming into the MC program. -Returns to stores display. Label N/T appears next to FZ in the delivery data.

Multiple/Ripple Release

The stores display and DEP are used to program more than one release for a weapons delivery pass. Total number of weapons to be released, number of weapons to be released simultaneously, and distance between weapons impacts are entered into the stores display scratchpad for entry into the MC program.

PB-3 QTY--Push	-Enters the scratchpad value into the MC program for total number of weapons to be released. -Scratchpad number appears next to QTY in the delivery data. Delivery data label MLT appears if the total number of weapons to be released is more than one.

If QTY is more than one:

PB-2 MLT--Push	-Enters scratchpad value into the MC program for the number of weapons to be released simultaneously. -Scratchpad number appears next to MLT in the delivery data. Delivery data label INT appears if the number of weapons to be released simultaneously is less than the total number of weapons to be released.

If MLT is less than QTY:

PB-1 INT—Push	-Enters scratchpad value (0 to 999) into the MC program for the desired horizontal distance in feet between impacts of ripple released weapons. -Scratchpad number appears next to INT in the delivery data.

RADAR SYSTEM

The AN/APG-67(V) radar system is a digital, multi-mode, pulse doppler radar powered by the 28 vdc main bus and the main ac No. 1 bus. In A/A mode the radar provides search, acquisition, and track of airborne targets, and sends data to the MC for missile launch envelope and gunsight computations. In A/A search the radar detects high and low altitude targets at all aspect angles, and at ranges up to 80 miles, with detection primarily dependent on target size. The A/A search modes are range while search (RWS), velocity search (VS), track while scan (TWS), and automatic acquisition (AUTO ACQ). Targets, once detected, can be acquired for tracking either automatically or manually and the system enters single target track (STT). The A/G radar display aids navigation to the target area. A/G target detection and designation are provided in MAP and SEA displays. A/G moving target detection and designation are provided in ground moving track indicator (GMTI) and SEA2 displays. Expand (EXP) and doppler beam sharpening (DBS) are options of either the MAP or SEA modes. Moving target track (MTT) display is entered from either GMTI or SEA2 display with track option selected when a target is designated. The radar provides ranging for normal A/G weapons delivery. The radar system includes both initiated and continuous BIT. BIT status is reported to the right of the RDR label on the BIT display.

RADAR POWER SELECTOR

The radar power selector is a three position selector on the right console, labeled RDR.

OFF	-Removes power from the radar system and cages the radar antenna. The radar label (RDR) on the Index display, PB-5, is blanked with radar power selector OFF.
STBY	-Powers up all radar circuits except RF transmission and antenna motion. During automatic timeout period, approximately 2-1/2 minutes, the radar warms-up, and performs BIT.
OPR	-Activates antenna motion circuits and, when weight is off wheels and timeout out period complete, RF transmission. Radar initializes in RWS mode.

ANTENNA ELEVATION

Antenna elevation is manually controlled by the antenna elevation control on the throttle. Elevation angle is ±60 degrees, and is indicated on the left side of the radar display by an antenna elevation caret.

A/A

Multiple elevation sweeps may be selected to increase vertical search area. In one bar scan the antenna sweeps back and forth in a single horizontal plane. In two bar scan the antenna shifts elevation for the return sweep. In four bar scan the antenna makes 4 sweeps, with each successive sweep at a lower angle of elevation. In RWS and

VS the selectable radar scans are 1, 2, or 4 bar. PB-6 selects the desired scan and the label indicates the selected scan. In TWS, bar scan is automatic, depending on selected azimuth scan, 4 bar for 20 degrees, 2 bar for 40 degrees and 1 bar for 80 degrees.

A/G

In MAP, GMTI, SEA, and SEA2, optimum antenna elevation is computed by the MC and indicated by an optimum antenna elevation symbol. The antenna elevation control should be used to position the elevation caret on the optimum antenna elevation symbol to provide best radar coverage for the range selected and aircraft altitude.

RADAR DDI PUSHBUTTONS

Radar DDI pushbutton functions are shown in figure 1-63 (A/A) and figure 1-65 (A/G).

Radar Frequency/Channel

The X-band radar operates on one of four channels/frequencies selectable by PB-5 labeled with a number 1 thru 4. The number indicates the channel selected. Pressing PB-5 steps the radar to the next channel. In RWS, PRF must be LO prior to channel change. Channel may not be changed in TWS, MAP, or SEA.

Video Gain – A/G

In MAP, SEA, and EXP/DBS, PB-1 with decrease arrow symbol, and PB-2 with increase arrow symbol, are used to change the radar receiver video gain. The video gain is initialized to the mid level. Push and hold PB-1 decreases (PB-2 increases) the video gain to the desired level. When TDC is used to change video gain, change occurs when the TDC is pressed and held with cursor over selected arrow.

Marker Intensity

In radar search modes, PB-14 and PB-15 function to change the video intensity of radar generated symbols; acquisition cursor, designator cursor cross hair, targets, elevation and range carets, launch cues, range and elevation scales, TWS priority one target bracket and the MAP PPI grid. Push and hold PB-14 increases (PB-15 decreases) intensity. Maximum change occurs within 3 seconds. When TDC is used to change marker intensity, change occurs as long as TDC is pressed and held with cursor over selected arrow.

Radar Declutter

On radar displays, PB-17 is labeled DCL. Pressing PB-17 causes DCL to be boxed and velocity vector and horizon line are blanked from the display. Pressing again unboxes DCL and resumes full display. In TWS, declutter also eliminates all but the three highest priority targets.

Pulse Repetition Frequency

The radar uses three transmitting pulse repetition frequencies (PRF), selected manually or automatically. In RWS PB-1 is labeled to correspond to selected PRF. VS uses high PRF automatically selected by the MC. Only medium PRF is available in TWS. A/G radar initializes in low PRF.

LO	-Low PRF for search.
MED	-Medium PRF for search.
AUTO	-Radar selects appropriate PRF. (lo, medium, high). High PRF is not available for manual selection.

Azimuth Scan Angle

Azimuth scan angle, in degrees, is shown above PB-19. The selectable scan angles are 20, 60, and 120 degrees (RWS, VS, MAP, SEA); or 20, 60, and 90 degrees (GMTI, SEA2); or 20, 40, and 80 degrees (TWS). When pressed, PB-19 steps the scan to the next applicable wider scan angle. When 20 or 60 degree scan is selected, the center of the scan may be moved by the cursor. Greater target detection range is achieved with smaller scan angles for a given antenna scan rate, as more radar energy is directed toward the target for a given period of time.

Radar Target History — A/A

In RWS PB-10 is labeled 1 thru 4, for target history options. Previous target positions are displayed with reduced image intensity to display the trend of target movement. When PB-10 label is number 1, only the present target position is presented. With a number 2 the most recent previous target position is also shown. Each higher number presents an additional target history trailing image at reduced intensity. When PB-10 is pressed, the number steps upward 1, 2, 3, 4, and then 1.

Radar Range Control

In RWS, TWS, MAP, GMTI, SEA, and SEA2, PB-11 is labeled with an upward pointing arrow. When pressed, the range scale doubles, 5, 10, 20, 40, 80, and back to 5. Radar range selected is indicated by the label between PB-11 and PB-12. PB-12, labeled with a downward pointing arrow decreases range by one half, 80, 40, 20, 10, 5, and back to 80.

Velocity Reject — A/A

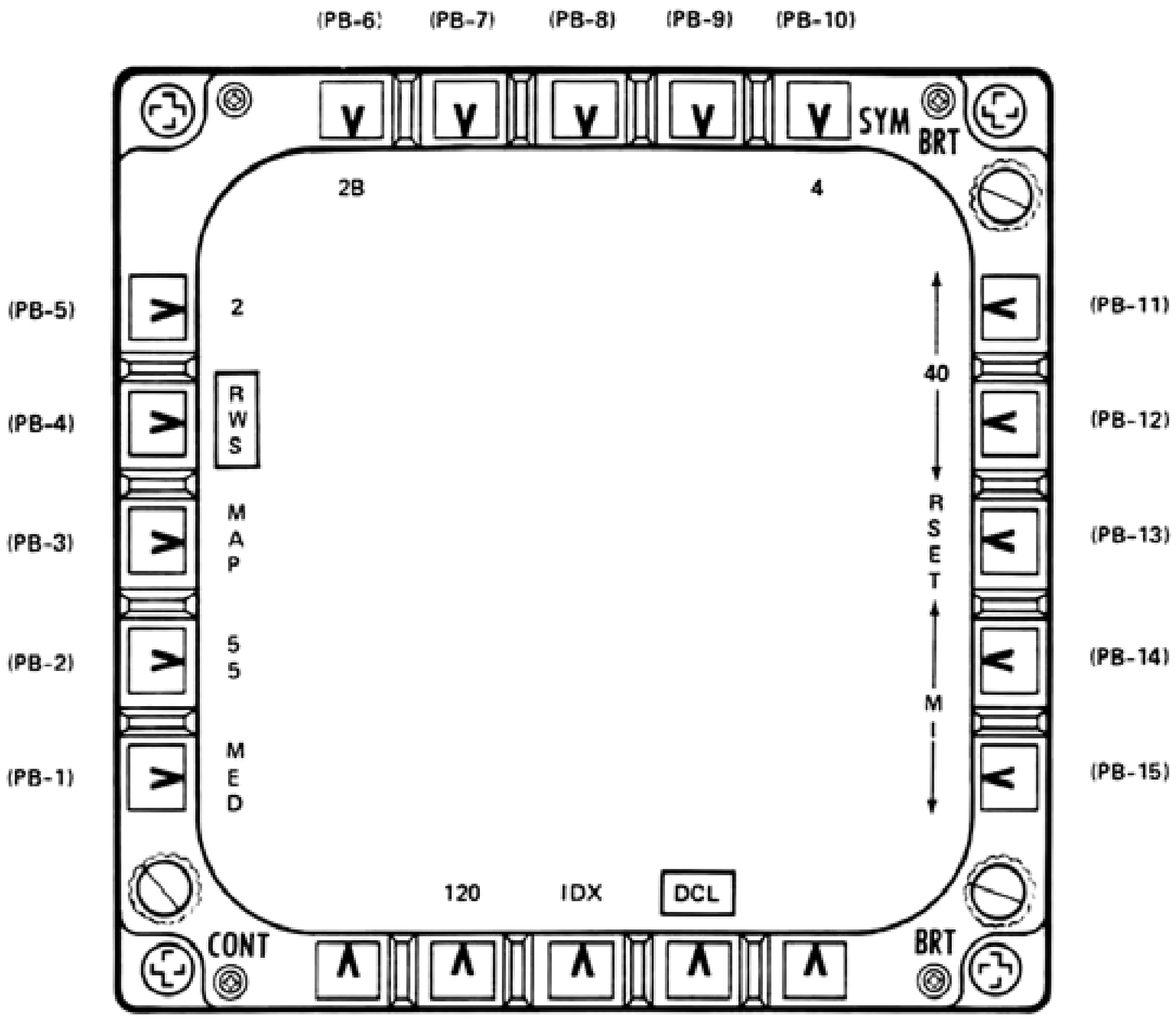
In RWS and AUTO ACQ PB-2 label shows 25, 55, or 80, indicating minimum target velocity for system display.

RADAR OPTIONS SELECT — TDC

Each pushbutton label, except IDX, on a radar display has an area of sensitivity, or gate, around the label that is sensitized to cursor positioning (figure 1-64 (A/A) and figure 1-66 (A/G)). When the cursor passes thru a gate, the corresponding pushbutton label and adjacent labels are blanked. The options for the designated pushbutton label appear on the display. To select one of these options or the original label if no options, the designator cursor cross hair is positioned over the desired option/label, and the TDC is released. Releasing TDC actuates the selected radar option and stows the cursor.

RADAR DDI PUSHBUTTONS (TYPICAL)

A/A DISPLAY



PB-1 PRF SELECT. STEPS THRU LO, MED, AND AUTO IN RWS.
PB-2 VELOCITY REJECT. STEPS THRU 25, 55 AND 80 IN RWS AND AUTO ACQ.
PB-3 MAP MODE SELECT. APPEARS ONLY IN NAV MODE.
PB-4 SEARCH MODE SELECT. STEPS THRU RWS, VS AND TWS. SELECTION BOXED.
PB-5 RADAR CHANNEL/FREQUENCY SELECT. STEPS THRU CHANNEL 1, 2, 3 AND 4.
PB-6 ANTENNA ELEVATION SCAN SELECT. STEPS THRU 1-BAR, 2-BAR AND 4-BAR.
PB-7 NO FUNCTION
PB-8 NO FUNCTION
PB-9 NO FUNCTION
PB-10 TARGET HISTORY. STEPS THRU 1, 2, 3 AND 4.
PB-11 RANGE INCREASE. STEPS THRU 5, 10, 20, 40 TO 80.
PB-12 RANGE DECREASE. STEPS THRU 80, 40, 20 10 TO 5.
PB-13 TARGET PRIORITY RESET (TWS ONLY).
PB-14 MARKER INTENSITY INCREASE.
PB-15 MARKER INTENSITY DECREASE.
PB-16 NO FUNCTION
PB-17 RADAR DECLUTTER.
PB-18 INDEX DISPLAY SELECT.
PB-19 ANTENNA AZIMUTH SCAN SELECT. STEPS THRU 120, 60 AND 20 (RWS) OR 90, 40, AND 20 (TWS).
PB-20 NO FUNCTION

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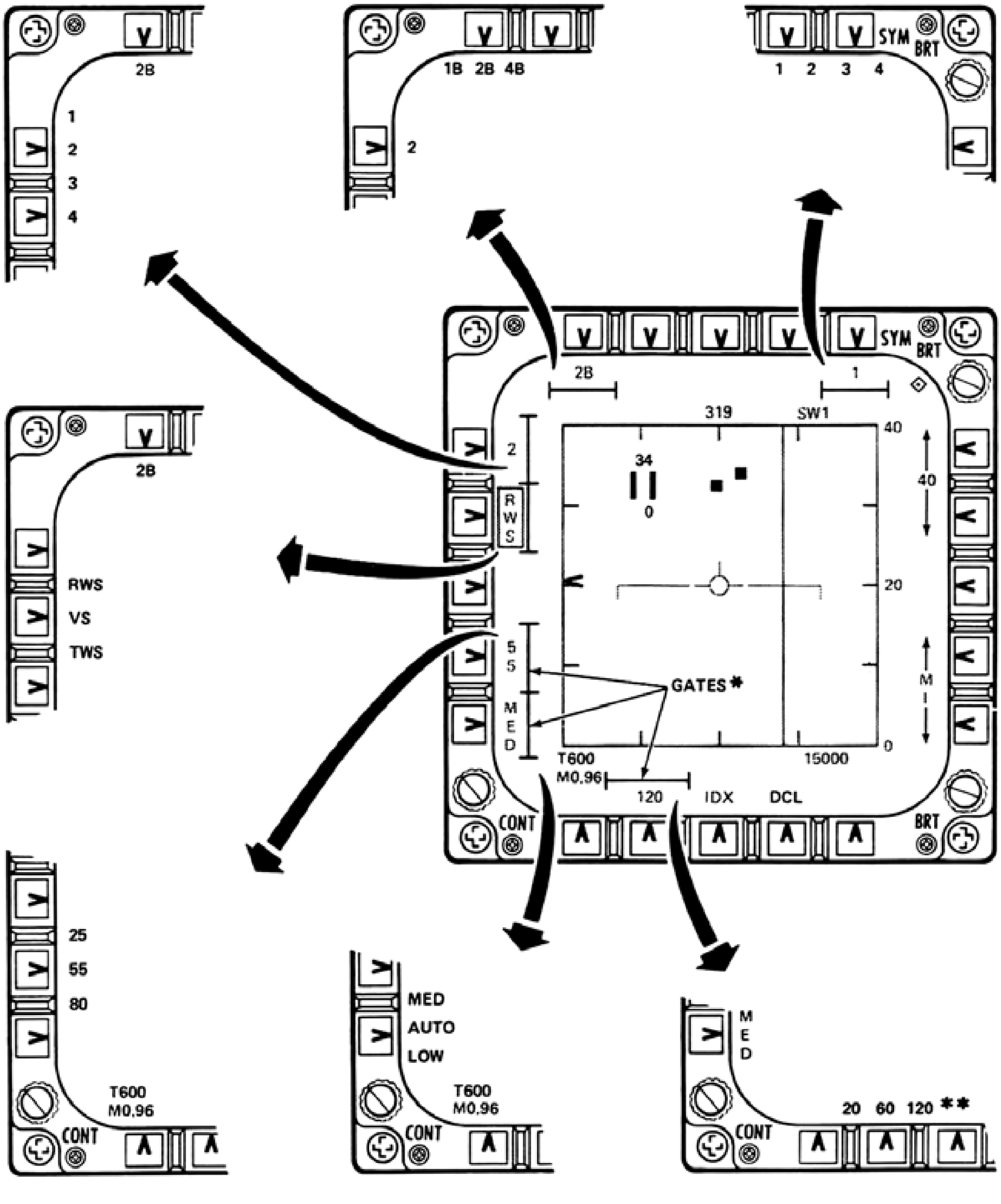
Figure 1-63.

RADAR OPTION GATES/LABELS (TYPICAL)

A/A DISPLAY



* GATES NOT VISIBLE

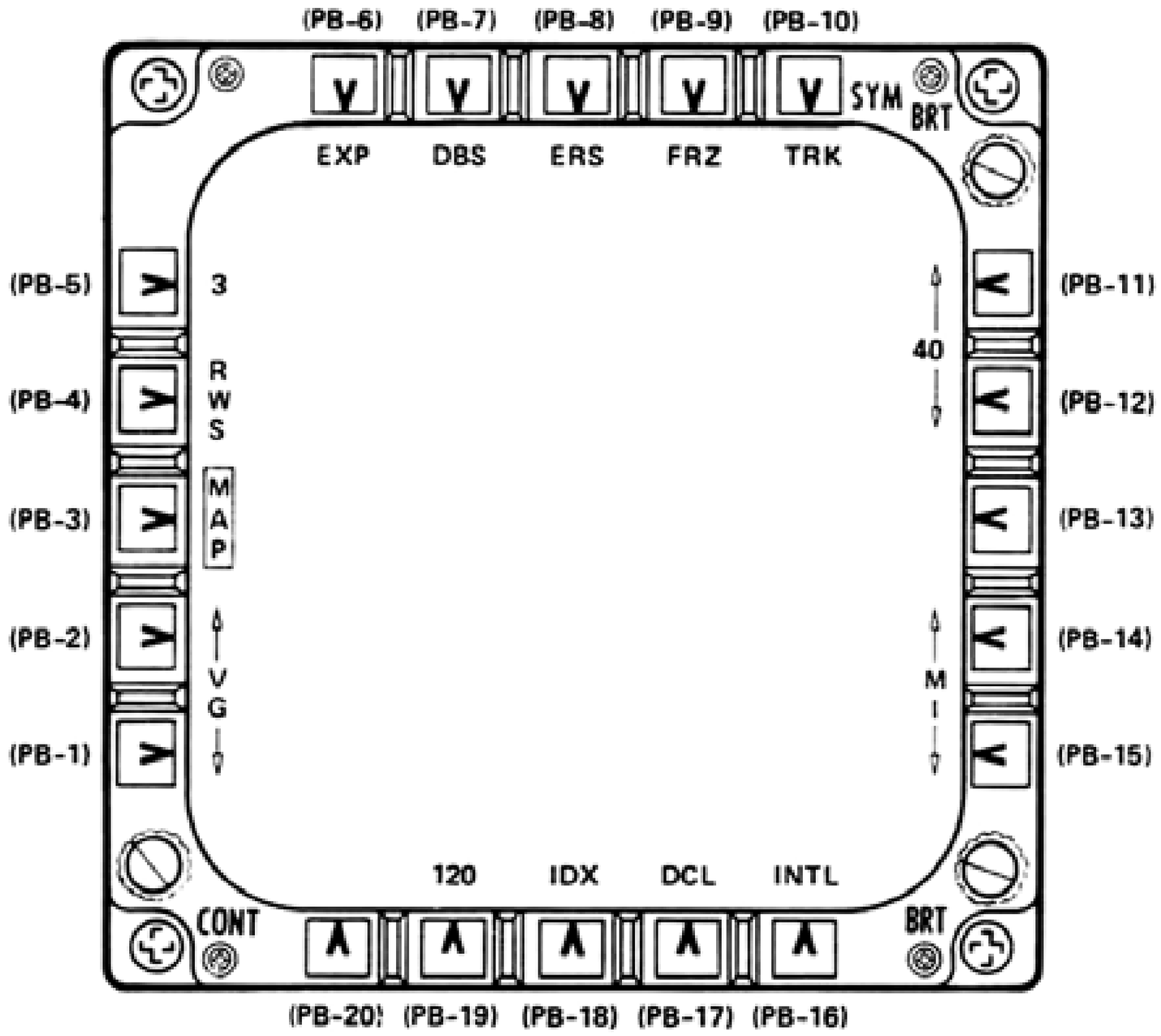
** (20 40 80 TWS)

20-1-1-93(1)A

Figure 1-64.

RADAR DDI PUSHBUTTONS (TYPICAL)

A/G DISPLAY



PB-1 RECEIVER VIDEO GAIN DECREASE (MAP, SEA). NO FUNCTION (GMTI, SEA2).

PB-2 RECEIVER VIDEO GAIN INCREASE (MAP, SEA). NO FUNCTION (GMTI, SEA2).

PB-3 MODE SELECT. STEPS THRU MAP, GMTI, SEA, SEA2. SELECTION BOXED.

PB-4 A/A SEARCH MODE SELECT. APPEARS IN NAV MODE.

PB-5 RADAR CHANNEL/FREQUENCY SELECT. STEPS THRU CHANNEL 1, 2, 3, AND 4 (GMTI, SEA2). NO FUNCTION (MAP, SEA).

PB-6 EXPAND SELECT (MAP, SEA, EXP, DBS).

PB-7 DOPPLER BEAM SHARPENING SELECT (MAP, SEA, EXP, DBS).

PB-8 ERASE SELECT. APPEARS ONLY WHEN FREEZE OPTION IS SELECTED.

PB-9 FREEZE OPTION SELECT.

PB-10 MOVING TARGET TRACK SELECT (GMTI, SEA2).

PB-11 RANGE INCREASE. STEPS THRU 5, 10, 20, 40, 80, AND 5.

PB-12 RANGE DECREASE. STEPS THRU 80, 40, 20, 10, 5, AND 80.

PB-13 NO FUNCTION.

PB-14 MARKER INTENSITY INCREASE.

PB-15 MARKER INTENSITY DECREASE.

PB-16 INTERLEAVE SELECT. APPEARS ONLY IN GMTI.

PB-17 RADAR DECLUTTER.

PB-18 INDEX DISPLAY SELECT.

PB-19 ANTENNA AZIMUTH SCAN SELECT. STEPS THRU 20, 60, AND 120 (MAP, SEA) OR STEPS THRU 20, 60, AND 90 (GMTI, SEA2).

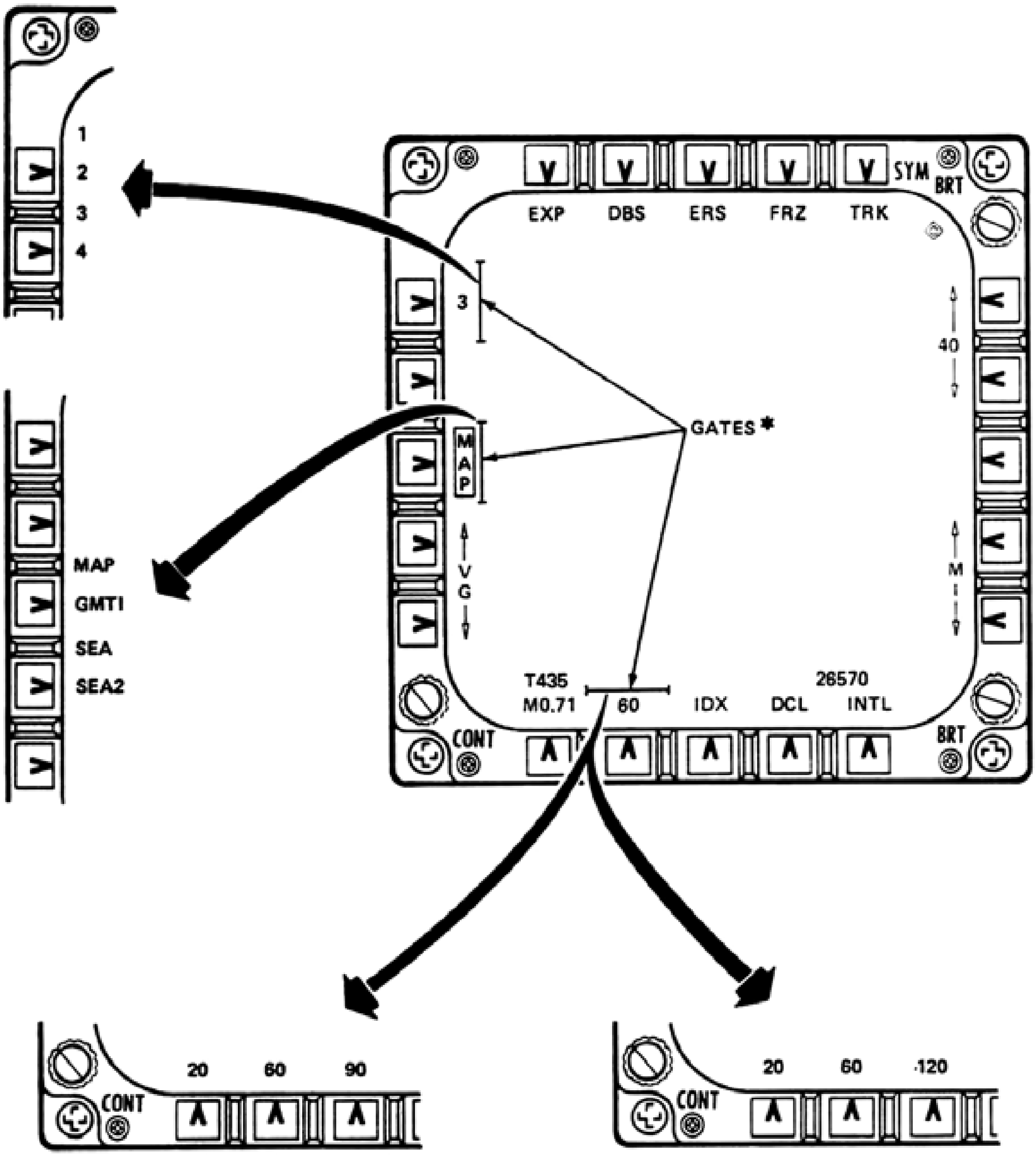
PB-20 NO FUNCTION.

20-1-1-92(2)

Figure 1-65.

RADAR OPTION GATES/LABELS

A/G DISPLAY



GMTI/SEA2

MAP/SEA

* GATES NOT VISIBLE

20-1-1-93(2)

Figure 1-66.

AIR-TO-AIR MASTER MODE

WEAPONS DELIVERY SYMBOLS

Weapons delivery displays are presented on the left or right DDI, and the HUD. The displays provide the pilot information to acquire, track, and deliver weapons on a target. The right DDI is normally used for the radar display.

Hud Symbols

Typical HUD symbols are shown in figure 1-67, sheets 1 and 2.

DDI Symbols

Typical DDI radar display symbols mode are shown in figure 1-68, sheets 1 and 2.

HEAD-UP-DISPLAY

The HUD provides head-up navigation, flight reference, and weapons aiming and delivery information. When the pilot selects a weapon with the A/A weapon select switch on the control stick the HUD displays either A/A missiles or guns depending on weapon selected. The HUD symbology (figure 1-69) provides target track information and steering commands to maneuver the aircraft into the weapon launch envelope. The HUD displays each have specialized symbology to optimize attack with selected weapon.

RANGE WHILE SEARCH

Range while search (RWS) is optimized for long range search of head-on aspect targets, either look-up or look-down, and look-down of tail-on aspect targets. When an A/A missile is selected the radar is initialized in RWS. RWS may also be selected by PB-4 when labeled. The RWS display presents radar video in a target range, relative bearing, B-scope format (figure 1-70).

VELOCITY SEARCH

Velocity search (VS) provides detection of high closing velocity, head-on targets in clutter. Targets are detected and displayed in reference to closing velocity. Ground clutter and weather are not displayed. VS is selected by PB-4 when labeled. The label VS is boxed when selected (figure 1-71).

TRACK WHILE SCAN

Track while scan (TWS) provides multiple target detection and tracking of up to ten targets. The targets are priority ranked according to closing velocity and range. Priority is established by time to intercept. Target data for highest priority targets is retained for recall and display on the DDI. The eight highest priority targets are displayed with aspect angle pointers, indicating target direction of flight. The aspect angle pointer points toward the relative target heading to the nearest 45 degrees. The priority one target is automatically designated as the launch and steering target; shown as a solid diamond with bracket, aspect angle pointer, mach, and target altitude (figure 1-72). Target priority may be changed by designating any selected target. The selected target becomes priority one. When priority one target is designated the system goes into STT. Target priority is reset by PB-13 labeled RSET. When RSET is pressed, targets are displayed in system selected priority.

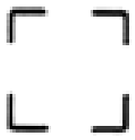
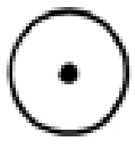
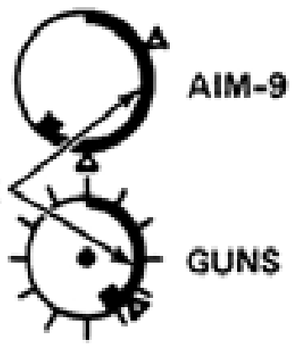
TARGET ACQUISITION

Target acquisition specifies to the system the target to be tracked. Acquisition is manual or automatic, depending on A/A mode, and places the weapons delivery system into STT mode. Target acquisition is automatic in AUTO ACQ, without the pilot designating a target. The radar searches in one of the three AUTO ACQ modes until a target is detected.

Manual Acquisition

Manual acquisition is accomplished in RWS, VS, or TWS radar search. The acquisition cursor is positioned over the desired target with the TDC. When the TDC is pressed, the acquisition cursor changes to a cross hair for more accurate placement. When the TDC is released the radar locks-on to the target and enters STT. In TWS, if other than number one priority target is to be acquired the TDC is first used to make the target priority one. A second designation locks-on the target and places the system in STT.

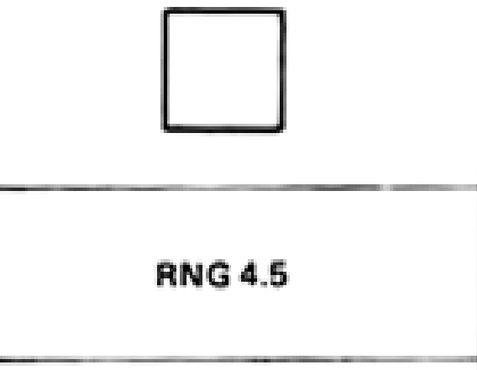
HUD SYMBOLS – A/A MODE (TYPICAL)

SYMBOL	NAME	FUNCTION
	AIM-9 FIELD OF VIEW CIRCLE	A TARGET INSIDE BOUNDARY CAUSES A TONE IN PILOT'S HEADSET WHEN IR ENERGY IS DETECTED BY AIM-9 SEEKER HEAD. APPEARS IN AIM-9 SEARCH DISPLAY. IS REPLACED BY ASE CIRCLE WHEN RADAR LOCKS ON TARGET AND ENTERS STT.
	AIM-9 ALLOWABLE STEERING ERROR (ASE) CIRCLE	APPEARS IN AIM-9 STT. THE STEERING DOT IS PLACED INSIDE BOUNDARY BY AIRCRAFT POSITIONING FOR AIM-9 ANGLE-OFF LAUNCH PARAMETERS.
	BORESIGHT SEARCH	INDENTIFIES RADAR SEARCH LIMITS IN AUTO ACQ BORESIGHT.
	BREAKAWAY X	APPEARS AND FLASHES INSIDE MINIMUM FIRING RANGE.
	GHOST TARGET LOCATOR	APPEARS WHEN RADAR TARGET TRACKING DATA UNRELIABLE.
	17 MIL GUN RETICLE (NONTRACKING)	APPEARS IN GUN SEARCH MODES. AT 1500-FEET RANGE A 25-FOOT WINGSPAN WILL FIT INSIDE THE RETICLE.
	17 MIL GUN RETICLE (TRACKING)	APPEARS IN GUN STT. AT 1500-FEET RANGE A 25-FOOT WINGSPAN WILL FIT INSIDE THE RETICLE. EACH TIC MARK ON CIRCUMFERENCE EQUALS 1000-FEET RANGE.
220 GUN 220	GUN ROUNDS REMAINING	GUNS SELECTED AND NUMBER OF ROUNDS REMAINING FOR EACH GUN.
SW2	MISSILES REMAINING	INDICATES AIM-9 MISSILE SELECTED AND NUMBER OF MISSILES REMAINING.
 5200 FT RANGE	RANGE BAR	APPEARS WHEN RADAR ENTERS STT. INDICATES RANGE TO TRACKED GUN TARGET. INDICATES WITH CUES WHEN AT MAXIMUM OR MINIMUM MISSILE LAUNCH RANGE. BAR DISAPPEARS WHEN RANGE DATA NOT AVAILABLE.
SAFE	SAFE SYMBOL	APPEARS WHEN A/A WEAPON SELECTED AND MASTER ARM SWITCH SAFE. A WEAPON-NOT-READY SYMBOL WILL BE SUPER-IMPOSED OVER GUN OR MISSILES REMAINING INDICATION. APPEARS ON GROUND WHEN MASTER ARM AT ARM OR SAFE.

20-1-1-86(1)A

Figure 1-67 (Sheet 1).

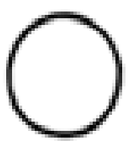
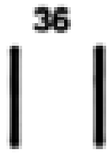
HUD SYMBOLS – A/A MODE (CONTINUED)

SYMBOL	NAME	FUNCTION
SHOOT	SHOOT SYMBOL	APPEARS IN STT WHEN: ① MASTER ARM SWITCH IS IN -- ARM. ② WEAPON IS READY. ③ STEERING DOT IS IN ASE CIRCLE. ④ TARGET BETWEEN MAX AND MIN RANGE.
○	AIM-9 ALLOWABLE STEERING ERROR DOT	APPEARS IN AIM-9 STT. PROVIDES LEAD ANGLE STEERING FOR MANEUVERING AIRCRAFT INTO MISSILE LAUNCH POSITION. DOT DEPICTS PREDICTED TARGET POSITION AT MISSILE IMPACT.
◯	SUPERSEARCH LIMITS	APPEARS WHEN AUTO ACQ SUPERSEARCH SELECTED. INDICATES 20 DEGREE BY 20 DEGREE RADAR SEARCH LIMITS.
KTS 350	TARGET AIRSPEED	APPEARS IN GUNS-STT. INDICATES TARGET CAS.
VC 200	TARGET CLOSING VELOCITY	APPEARS IN AIM-9 STT. INDICATES TARGET CLOSURE SPEED (KNOTS). A NEGATIVE NUMBER INDICATES OPENING.
□	TARGET LOCATOR BOX	APPEARS IN AIM-9 AND GUNS STT MODE. INDICATES RADAR LINE-OF-SIGHT TO THE TARGET.
RNG 4.5	TARGET RANGE	APPEARS IN AIM-9 STT. INDICATES SLANT RANGE TO TARGET IN NAUTICAL MILES.
| | | | | |	VERTICAL SEARCH LIMITS	EXTENDS UPWARD TO DEPICT RADAR SEARCH LIMITS IN AUTO ACQ VERTICAL ACQUISITION.
✕	WEAPON-NOT-READY	SUPERIMPOSES OVER GUNS OR MISSILES REMAINING SYMBOL WHEN MASTER ARM SWITCH IS IN SAFE POSITION, OR WHEN SELECTED WEAPON IS NOT READY FOR FIRING.
	WEAPON RANGE CUE	APPEAR IN AIM-9 AND GUNS STT. IN AIM-9 INDICATES MAXIMUM AND MINIMUM MISSILE LAUNCH RANGE. IN GUNS, INDICATES MAXIMUM FIRING RANGE.

20-1-1-87(1)A

Figure 1-67 (Sheet 2).

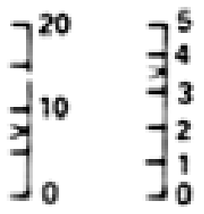
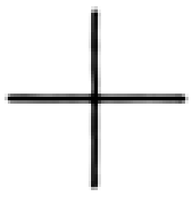
DDI SYMBOLS – A/A MODE (TYPICAL)

SYMBOL	NAME	FUNCTION
	ACQUISITION CURSOR	POSITIONED BY THE TDC. ALLOWS RADAR TO BE DIRECTED TO A SPECIFIC TARGET FOR LOCK-ON, OR FOR TDC SELECTION OF DDI PB OPTIONS.
SW2	AIM-9 WEAPON SYMBOL	INDICATES AIM-9 MISSILE SELECTED AND NUMBER OF MISSILES REMAINING.
T475	AIRCRAFT AIRSPEED	INDICATES AIRCRAFT KTAS IN ALL RADAR DISPLAYS.
26500	AIRCRAFT ALTITUDE	AIRCRAFT PRESSURE ALTITUDE.
270	AIRCRAFT HEADING	INDICATES AIRCRAFT MAGNETIC HEADING.
	AIM-9 ALLOWABLE STEERING ERROR (ASE) CIRCLE	APPEARS IN AIM-9 STT. THE STEERING DOT IS PLACED WITHIN THE CIRCLE FOR AIRCRAFT POSITIONING FOR AIM-9 LAUNCH PARAMETERS.
	AIM-9 STEERING DOT	APPEARS IN AIM-9 STT. PROVIDES LEAD ANGLE STEERING FOR MANEUVERING AIRCRAFT TO MISSILE LAUNCH POSITION. DOT DEPICTS PREDICTED TARGET POSITION AT MISSILE IMPACT.
	VELOCITY VECTOR SYMBOL	REFERENCE FOR AIRCRAFT ATTITUDE IN RELATION TO HORIZON LINE SYMBOL. REMAINS IN FIXED POSITION.
	ANTENNA ELEVATION SCALE	RANGE SCALE FOR ANTENNA ELEVATION CARET. CENTER TIC MARK IS AIRCRAFT HORIZON. INDICATES ± 60 DEGREES ANTENNA LIMITS.
	ANTENNA ELEVATION CARET	INDICATES ANTENNA ELEVATION POSITION ON ANTENNA ELEVATION SCALE.
36 	BEAM COVERAGE UPPER ALTITUDE	INDICATES THE RADAR BEAM MAXIMUM ALTITUDE AT THE CURSOR RANGE IN THOUSANDS OF FEET. DIGITS ARE ABOVE ACQUISITION CURSOR.
16	BEAM COVERAGE LOWER ALTITUDE	INDICATES THE RADAR BEAM MINIMUM ALTITUDE AT THE CURSOR RANGE IN THOUSANDS OF FEET. DIGITS ARE BELOW ACQUISITION CURSOR.
	BREAKAWAY X	APPEARS AND FLASHES INSIDE MINIMUM FIRING RANGE.

20-1-1-89(1)A

Figure 1-68 (Sheet 1).

DDI SYMBOLS – A/A MODE (CONTINUED)

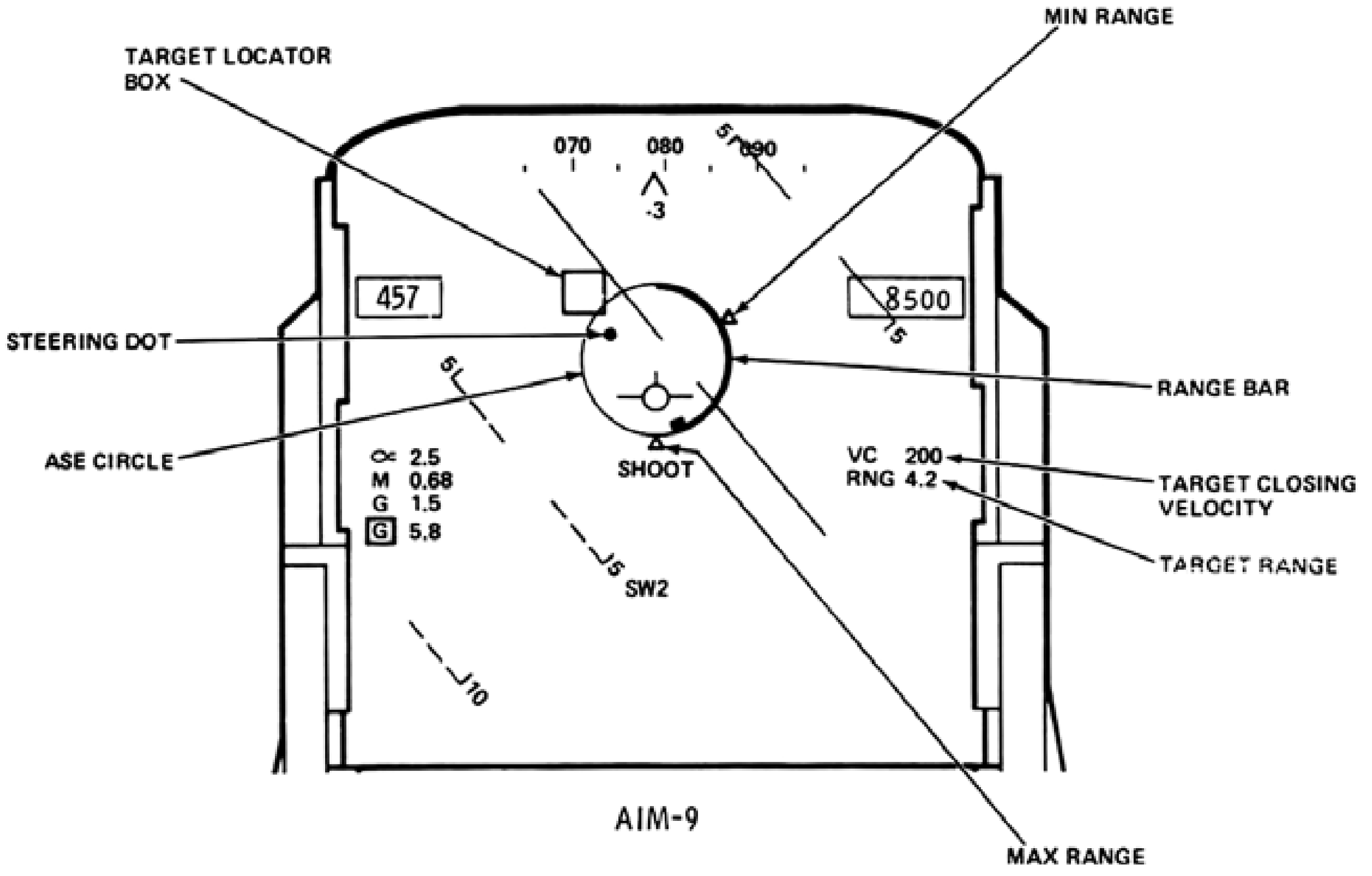
SYMBOL	NAME	FUNCTION
TARGET DIRECTION	FILED OR LOCKED-ON TARGET	IN TWS AND STT TARGETS HAVE AN ASPECT ANGLE POINTER EXTENDING IN TARGET DIRECTION OF FLIGHT.
GUN	GUN SYMBOL	APPEARS WHEN THE M-39 GUNS ARE SELECTED IN STT.
	HORIZON LINE SYMBOL	REPRESENTS HORIZON FOR ATTITUDE REFERENCE.
M0.70	MACH NUMBER	INDICATES AIRCRAFT MACH NUMBER IN ALL RADAR DISPLAYS.
0.9 19	NO. 1 PRIORITY TARGET	AUTOMATICALLY DESIGNATED AS LAUNCH AND STEERING TARGET IN TWS. LEFT OF TARGET AND BRACKET IS TARGET MACH NUMBER; RIGHT OF BRACKET IS TARGET ALTITUDE IN THOUSANDS OF FEET.
	NO. 2 PRIORITY TARGET	DESIGNATED NO.2 PRIORITY TARGET IN TWS. ASPECT ANGLE POINTER EXTENDS IN DIRECTION OF FLIGHT.
	RANGE SCALE	WITH TARGET RANGE CARET SHOWS TARGET RANGE.
SHOOT	SHOOT CUE	THE SHOOT CUE APPEARS IN STT WHEN MISSILE LAUNCH OR GUN FIRING SOLUTIONS ARE SATISFIED.
2500	TARGET DIFFERENTIAL ALTITUDE	APPEARS TO THE RIGHT OF ANTENNA ELEVATION CARET IN STT. INDICATES ALTITUDE DIFFERENTIAL BETWEEN AIRCRAFT AND TARGET. NEGATIVE NUMBER INDICATES TARGET BELOW AIRCRAFT.
1225	TARGET CLOSING VELOCITY	APPEARS TO THE LEFT OF TARGET RANGE CARET IN TWS AND STT. INDICATES TARGET CLOSING VELOCITY IN KNOTS
	TARGET RANGE CARET	APPEARS TO THE LEFT OF THE RADAR RANGE SCALE IN TWS AND STT. INDICATES TARGET RANGE.
	TDC/CURSOR ASSIGNMENT SYMBOL	APPEARS ON UPPER RIGHT CORNER WHEN CURSOR IS ASSIGNED TO A DDI.
	TARGET	TARGETS THAT ARE RADAR DETECTED BUT NOT DESIGNATED OR PRIORITY RANKED.
	TARGET CLOSURE SCALE	IN VS MODE, REPLACES RANGE SCALE. INDICATES A MAXIMUM OF 2400 KNOTS CLOSURE. READ ACROSS FROM TARGET TO SCALE FOR CLOSURE VELOCITY.
	CROSS HAIRS DESIGNATOR CURSOR	ACQUISITION CURSOR CHANGES TO CROSS HAIRS DESIGNATOR CURSOR WHEN TDC IS PRESSED AND HELD.

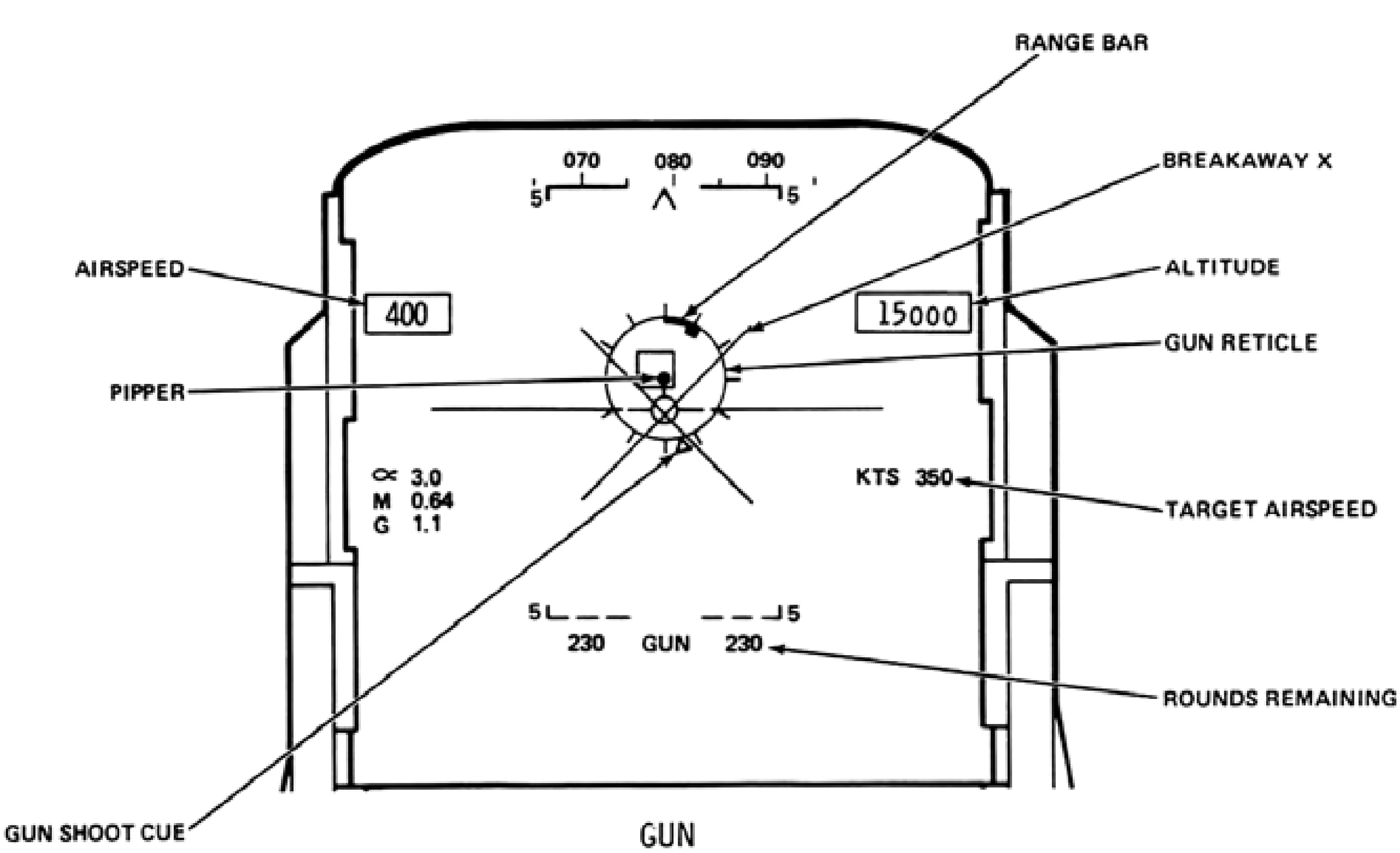
20-1-1-90(1)A

Figure 1-68 (Sheet 2).

HUD – A/A MODE

SINGLE TARGET TRACK (TYPICAL)

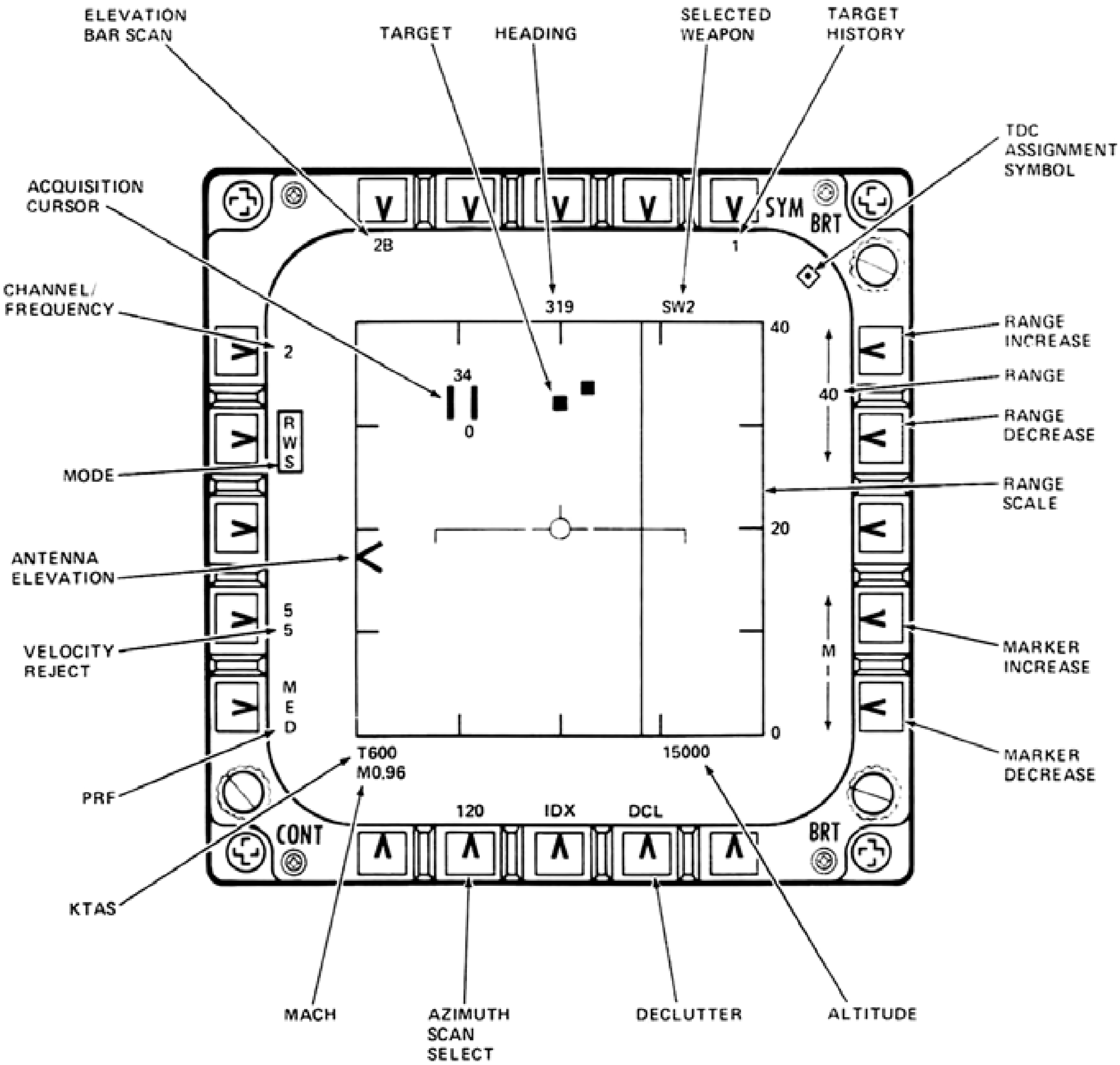




20-1-1-91(1)A

Figure 1-69.

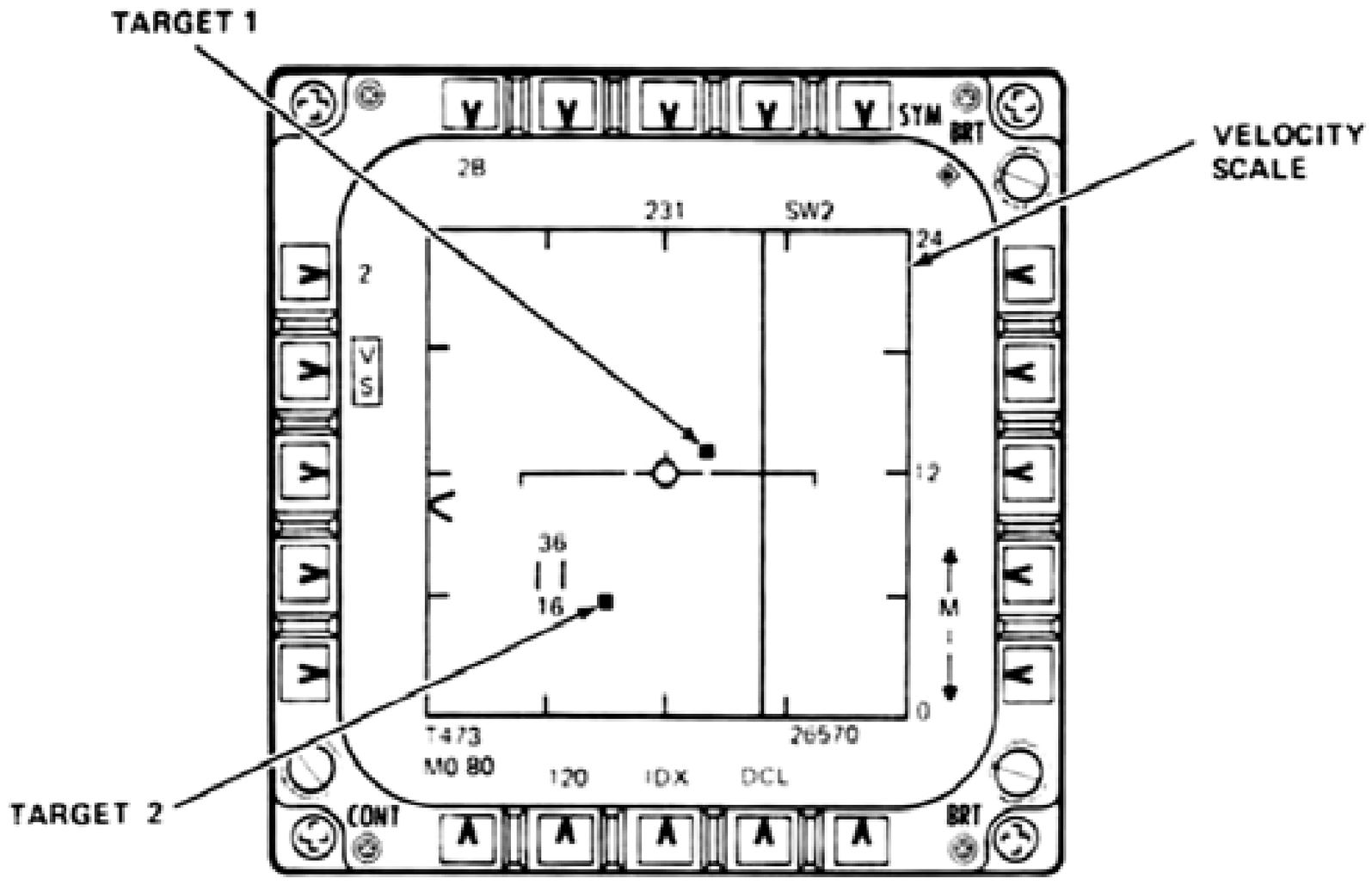
RWS DISPLAY (TYPICAL)



20-1-1-94(1)

Figure 1-70.

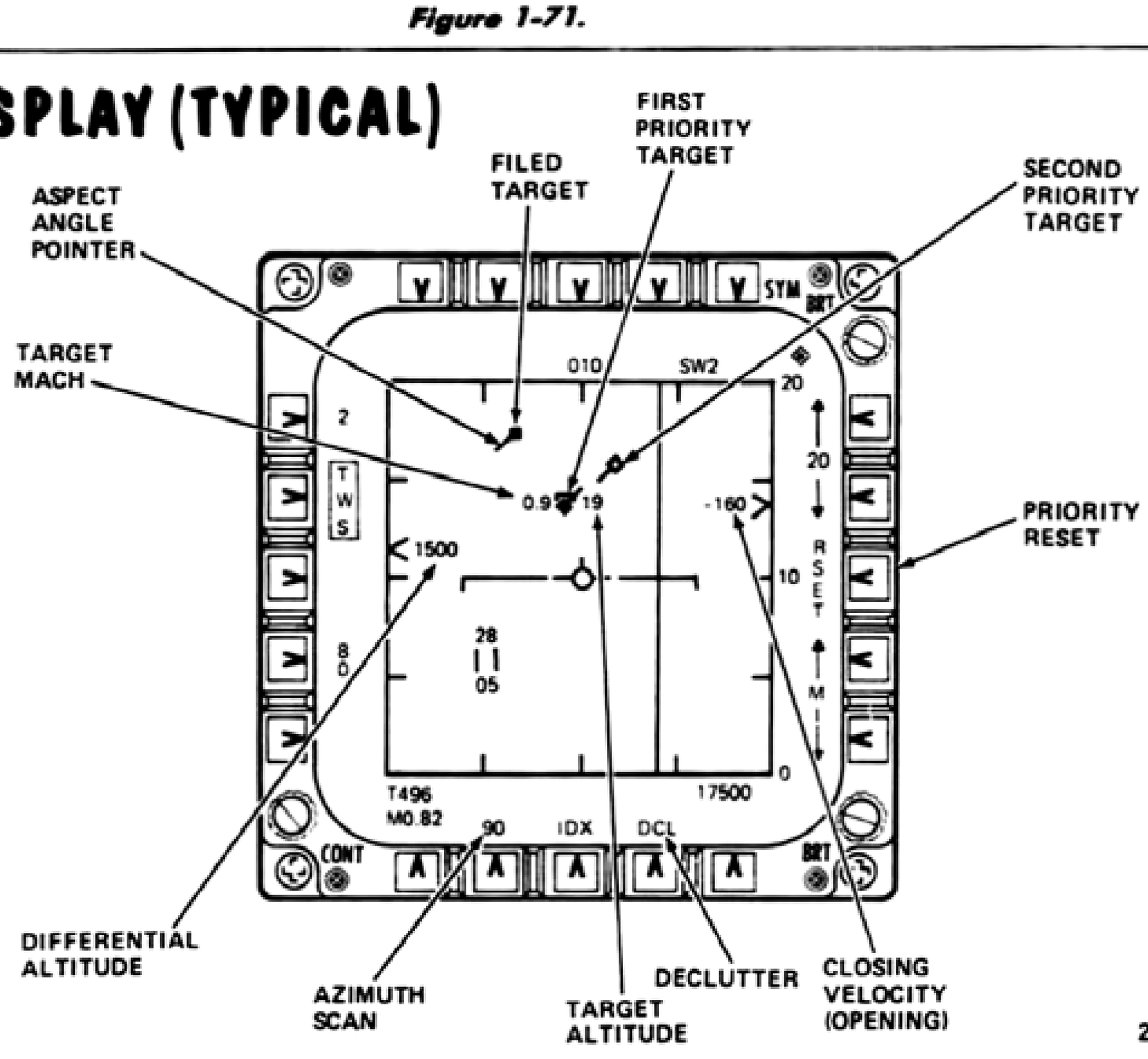
VS DISPLAY (TYPICAL)



20-1-1-95(1)

Figure 1-71.

TWS DISPLAY (TYPICAL)



20-1-1-96(1)A

Figure 1-72.

Automatic Acquisition

Automatic Acquisition (AUTO ACQ) is used for close-in, head-up, maneuvering situations, such as those encountered in a dogfight, with target acquisition being automatic. AUTO ACQ search is selected by the sensor control switch on the control stick. The three selectable AUTO ACQ search modes are super search, vertical acquisition, and boresight (figure 1-73). The radar searches at medium PRF until a target is detected within 10 NM, (5 NM in vertical acquisition). The system locks on to the target automatically, and enters STT. When in STT from AUTO ACQ reselecting AUTO ACQ with the sensor control switch, rejects the tracked target, and restarts the selected AUTO ACQ search. AUTO ACQ overrides all other modes.

BORESIGHT

In boresight, the radar is caged to the aircraft armament reference line (ARL) at zero degrees azimuth and minus two degrees elevation. The system locks-on to the first radar detected target within 10 NM. A dashed ellipse on the HUD, 7 degrees vertical by 4.5 degrees horizontal, shows the approximate radar coverage.

SUPER SEARCH

In super search, the system locks on to the first radar detected target in the HUD field of view within 10 NM. Approximate radar coverage is shown on the HUD by a dashed 20 degree circle.

VERTICAL ACQUISITION

In vertical acquisition, the system locks on to the first radar detected target within 5 NM. Two parallel dashed lines on the HUD, ± 4 degrees in azimuth and from 0 to +60 degrees in the plane of the aircraft vertical axis, show the approximate radar coverage.

Sensor Conrol Switch

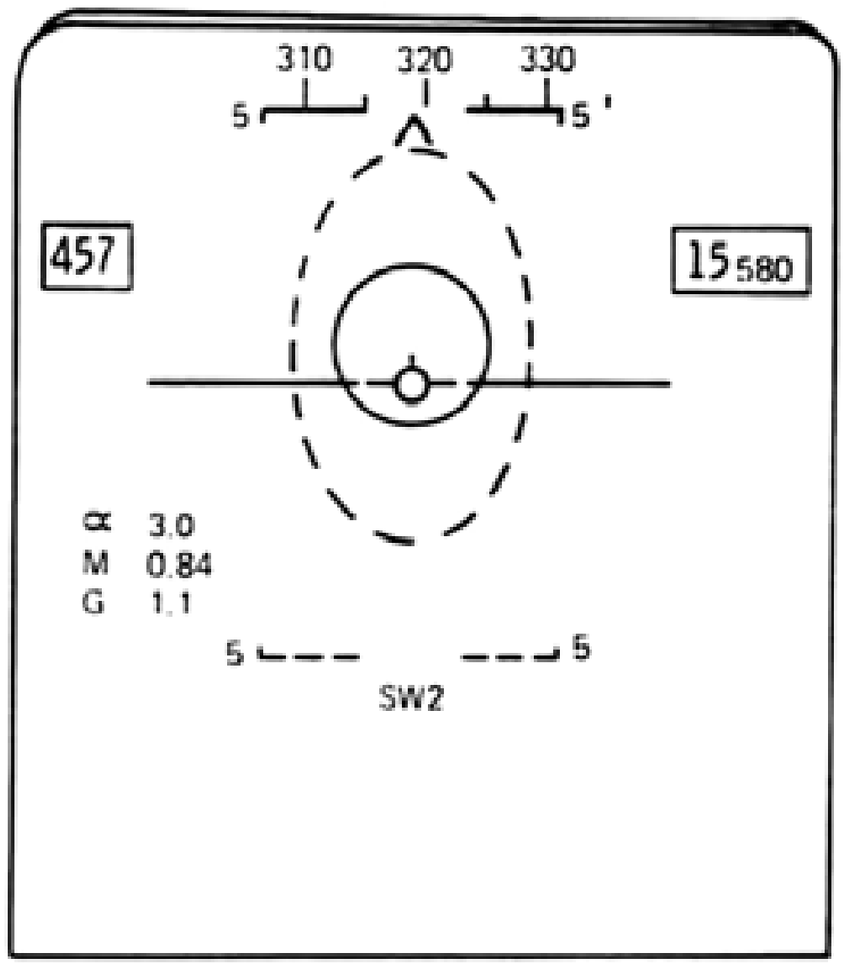
The sensor control switch has five positions and is springloaded to the neutral center position. In A/A mode the control selects the three AUTO ACQ modes.

Forward	- Selects AUTO ACQ boresight.
Left or right	- Selects AUTO ACQ super search.
AFT	- Selects AUTO ACQ vertical acquisition.

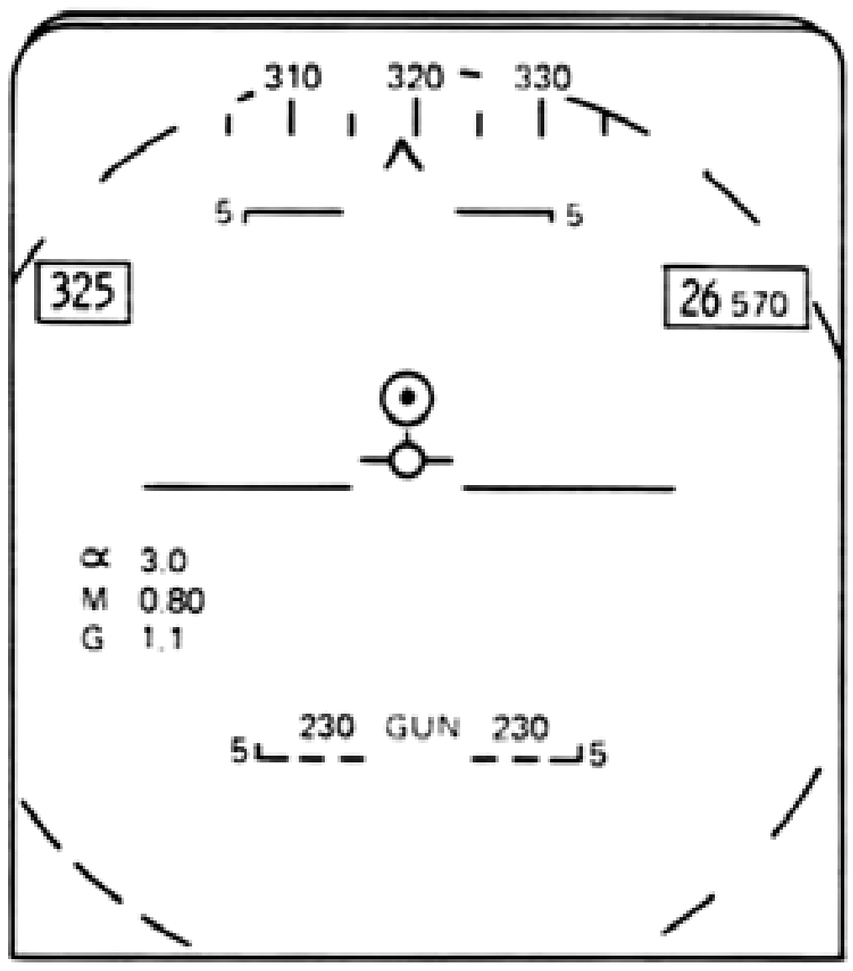
SINGLE TARGET TRACK

The radar enters single target track (STT) (figure 1-74) after target acquisition from any A/A search mode. When tracking a target the radar provides data to the MC for missile and gun launch computations, and for presentation of HUD and DDI weapons delivery displays. The radar automatically selects range and the best PRF for existing conditions. When target lock-on is lost, the radar automatically predicts target future position for four seconds while searching an area covering possible target maneuvers. If track is not re-established, a re-acquisition search in azimuth, range, and velocity begins where the position track was lost. If track is still not re-established the radar returns to the previously selected search mode (RWS, VS, TWS, or AUTO ACQ).

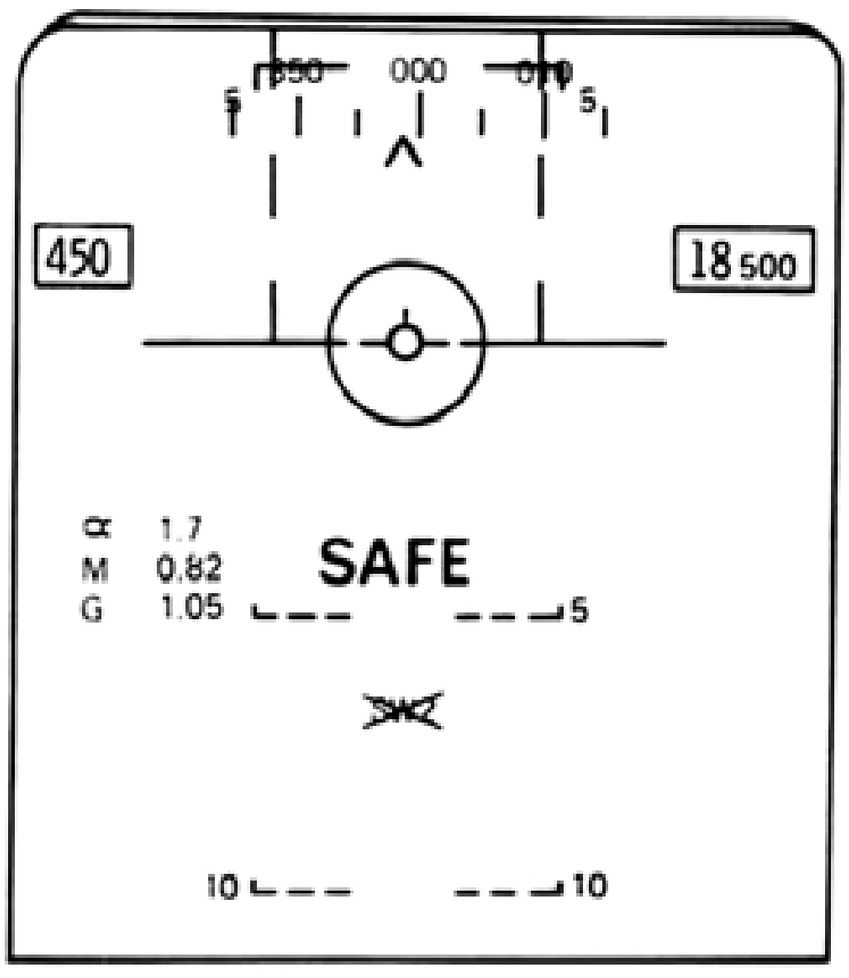
HUD AUTO ACQ DISPLAYS (TYPICAL)



BORESIGHT



SUPERSEARCH



VERTICAL ACQUISITION

20-1-1-97(1)

Figure 1-73.

STT DISPLAY (TYPICAL)

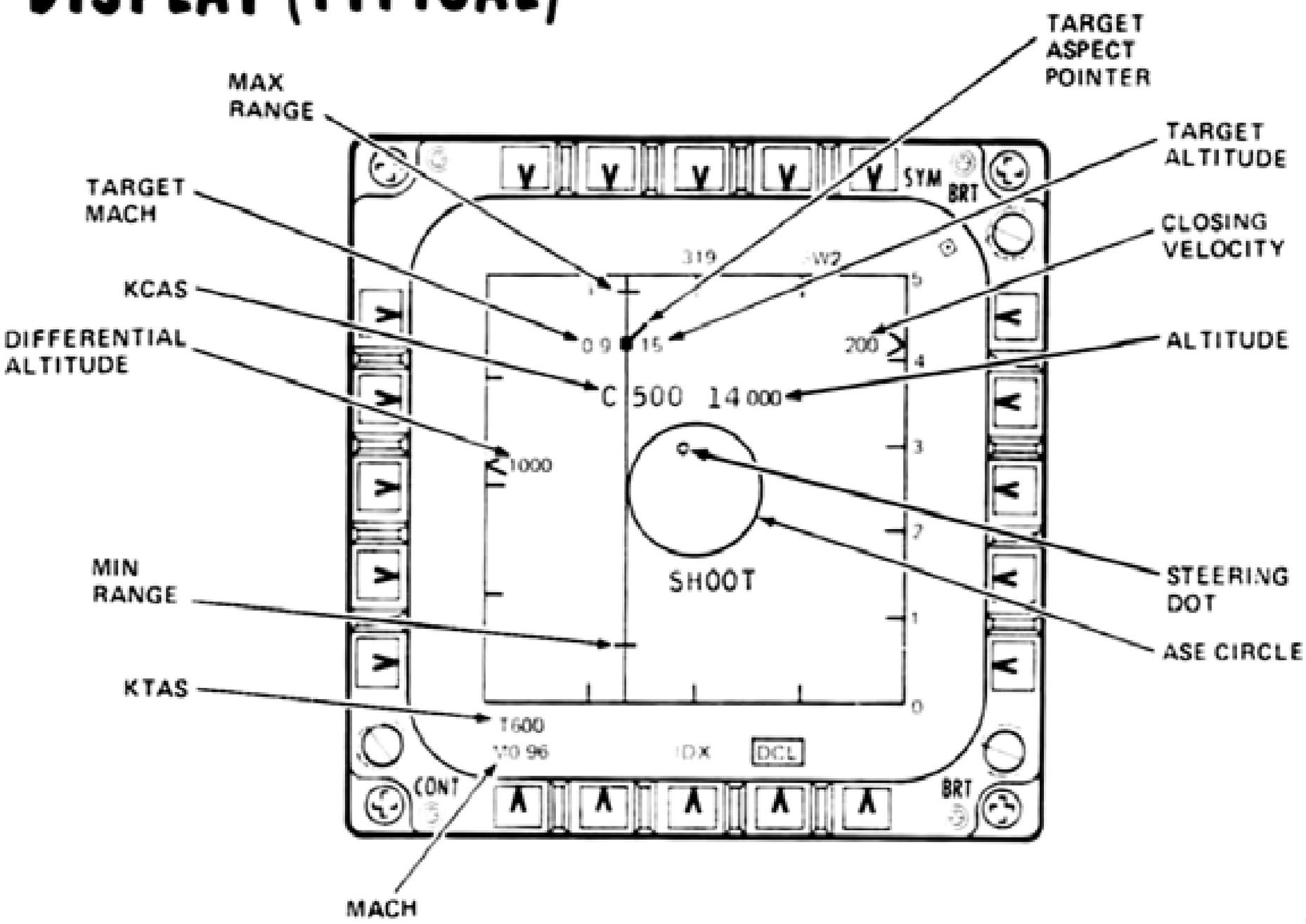


Figure 1-74.

AIR-TO-GROUND MASTER MODE

WEAPONS DELIVERY SYMBOLS

Symbols for weapons delivery displays are presented on the left or right DDI, and the HUD. The symbols provide the pilot information to acquire the target and deliver weapons. The right DDI is normally used for the radar display.

HUD Symbols

Typical HUD symbols are shown in figure 1-75, sheets 1 and 2.

DDI Symbols

Typical DDI radar display symbols are shown in figure 1-76, sheets 1 and 2.

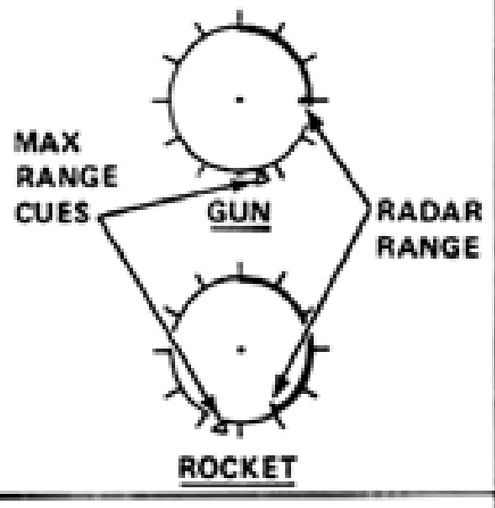
HEAD UP DISPLAY

The HUD provides head-up navigation, flight reference, and weapons aiming and delivery information. Basic flight symbology is displayed on the HUD in A/G delivery mode. When the A/G master mode is selected, the weapons delivery program and weapons ready status are displayed on the HUD. HUD displays include CCIP, continuous computed release point or AUTO release, and manual. The flight path vector symbol indicates true flight path vector.

Continuous Computed Impact Point

CCIP for bomb, rocket, or gun is computed by the MC for display on the HUD (figure 1-77). The CCIP depicts computed weapon impact point if a weapon is released/fired at that instant. The preset delivery program, radar range, and weapons ballistics are used for computing bomb, rocket, or gun CCIP. Range, when the target designator is assigned to the HUD, is the radar slant range from the aircraft to the point on the ground indicated by the target designator symbol. The displayed impact line (DIL) that connects the CCIP reticle and the flight path vector symbol provides azimuth steering reference. The aircraft is maneuvered to hold the target on the DIL until the reticle drifts up to the target. Weapon delivery is accomplished by pressing the weapon release button for bomb/rocket attack or squeezing the trigger to the second detent for gun attack. The CCIP reticle symbol and DIL flash when the last bomb of the program is released. The gun or rocket CCIP is computed for maximum weapon range (5500 feet gun, 6500 feet

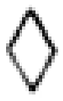
HUD SYMBOLS – A/G MODE (TYPICAL)

SYMBOL	NAME	FUNCTION
◇	TARGET DESIGNATOR DIAMOND	APPEARS WHEN TARGET DESIGNATOR ASSIGNED TO HUD. USED TO DESIGNATE OR LOCATE TARGETS VISUALLY.
CCIP	CCIP MODE	CONTINUOUS COMPUTED IMPACT POINT WEAPON DELIVERY SELECTED.
⊣|	BOMB CCIP RETICLE	BOMB CCIP WEAPON DELIVERY AIMING SYMBOL. COMPUTED WEAPON IMPACT POINT WHEN BOMB RELEASED IMMEDIATELY.
	GUN OR ROCKET CCIP RETICLE	GUN OR ROCKET CCIP WEAPON DELIVERY AIMING SYMBOL. MAXIMUM RANGE CUES AND RADAR RANGE SHOWN.
AUTO	AUTO MODE	TARGET HAS BEEN DESIGNATED IN CCIP MODE. AUTO WEAPON DELIVERY IS SELECTED.
MAN 34	MANUAL MODE/ DEPRESSION	MANUAL WEAPON DELIVERY SELECTED. MILS SIGHT DEPRESSION SHOWN.
	MANUAL RETICLE	MANUAL DELIVERY DEPRESSED RETICLE. APPEARS IN MANUAL WEAPON DELIVERY.
	DISPLAY IMPACT LINE (DIL)	STEERING CUE TO AID IN ALIGNING BOMB OR GUN/ROCKET CCIP RETICLE OVER TARGET. CONNECTS RETICLE TO THE FLIGHT PATH VECTOR.

20-1-1-86(2)

Figure 1-75 (Sheet 1).

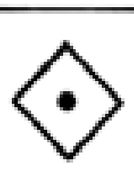
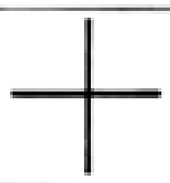
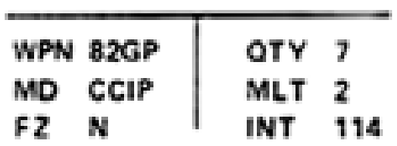
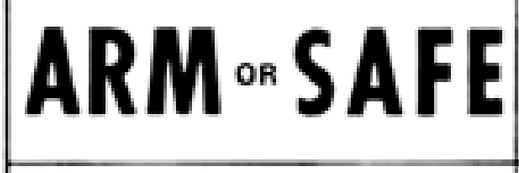
HUD SYMBOLS – A/G MODE (CONTINUED)

SYMBOL	NAME	FUNCTION
	AZIMUTH STEERING LINE	APPEARS PERPENDICULAR TO HORIZON IN AUTO WEAPON DELIVERY. STEERING CUE TO AID BOMB DELIVERY.
	AUTO RELEASE STEERING DIAMOND	PROVIDES STEERING TO WEAPON RELEASE POINT FOR AUTO MODE.
SAFE	MASTER ARM SWITCH STATUS	INDICATES MASTER ARM SWITCH IN SAFE WHEN WEAPON SELECTED.
	WEAPON-NOT-READY	WEAPON NOT READY FOR RELEASE/FIRING. SUPER-IMPOSED OVER: WEAPON DELIVERY MODE – BOMBS. RKT LABEL – ROCKETS. GUN LABEL – GUNS.
	AUTO RELEASE CUE	CENTERED ON AZIMUTH STEERING LINE PARALLEL TO HORIZON IN AUTO WEAPON DELIVERY. BOMB AUTOMATICALLY RELEASES WHEN CUE MOVES THRU FLIGHT PATH VECTOR.
	PULLUP CUE	CENTERED THREE DEGREES BELOW HUD FLIGHT PATH VECTOR FOR CCIP OR AUTO DELIVERIES. MOVEMENT OF PULLUP CUE TOWARDS FLIGHT PATH VECTOR PROVIDES NOTICE OF IMPENDING BREAKAWAY.
	BREAKAWAY X	FLASHES TO INDICATE 4G WITHIN 2 SECONDS PULLUP RECOVERY IS REQUIRED TO AVOID THE GROUND.
RKT	ROCKETS	ROCKET DELIVERY SELECTED
230 GUN 230	GUNS AND AMMO	GUNS SELECTED AND INDICATES NUMBER OF ROUNDS REMAINING FOR EACH GUN.
TGT 1.4	TARGET RANGE	AUTO WEAPON RELEASE RANGE IN NM TO TARGET.
SEC 15	TIME-TO-GO	AUTO WEAPON RELEASE TIME IN SECONDS TO RELEASE.

20-1-1-87(2)

Figure 1-75 (Sheet 2).

DDI SYMBOLS – A/G MODE (TYPICAL)

SYMBOL	NAME	FUNCTION
	TDC/CURSOR ASSIGNMENT SYMBOL	APPEARS ON UPPER RIGHT CORNER OF DISPLAY WHEN CURSOR IS ASSIGNED TO DDI.
	ACQUISITION CURSOR	POSITIONED ON DISPLAY BY TDC. ALLOWS RADAR TO BE DIRECTED TO A SPECIFIC TARGET FOR DESIGNATION, OR FOR TDC SELECTION OF DDI PB FUNCTIONS.
	DESIGNATOR CURSOR CROSS HAIR	ACQUISITION CURSOR CHANGES TO DESIGNATOR CURSOR CROSS HAIR WHEN TDC IS PRESSED AND HELD.
	STABILIZED TARGET MARKER	DESIGNATOR CURSOR CROSS HAIR CHANGES TO TARGET MARKER WHEN TDC IS RELEASED (TRACK DESELECTED IN GMTI OR SEA2). INDICATES DESIGNATED TARGET. MARKER IS CENTER OF EXP OR DBS OPTION DISPLAY.
	DELIVERY DATA	APPEARS IN STORES DISPLAY. A/G WEAPONS DELIVERY PROGRAM DATA SHOWN.
	MASTER ARM SWITCH STATUS	APPEARS IN STORES DISPLAY. INDICATES POSITION OF MASTER ARM SWITCH.
	WEAPON NOT READY	APPEARS SUPERIMPOSED OVER WEAPON LABEL AT PBs 6, 7, 8, OR 10 IN STORES DISPLAY. MASTER ARM SWITCH IN SAFE.
	STORES BOX	APPEARS AROUND SELECTED WEAPONS IN STORES DISPLAY. SELECTED WEAPON READY AND ARMED WHEN AROUND LABEL AT PBs 6, 7, 8, OR 10.
	HOT GUNS	GUNS MAY BE FIRED ON A/G WEAPON DELIVERY PASS WHEN HG BOXED.
	ANTENNA ELEVATION CARET	INDICATES ANTENNA ELEVATION POSITION. FULL SCALE DEFLECTION ± 60 DEGREES.

20-1-1-89(2)

Figure 1-76 (Sheet 1).

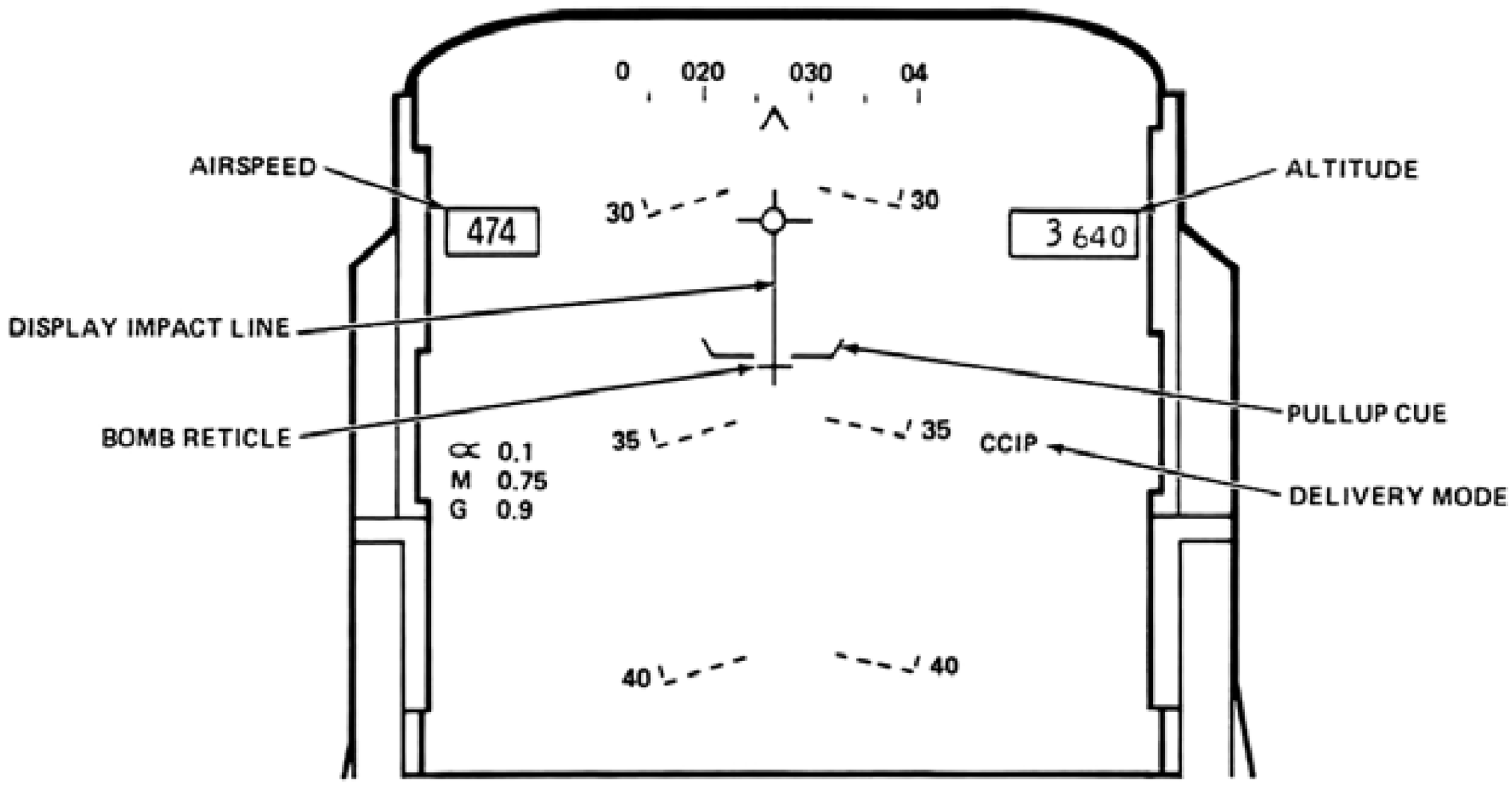
DDI SYMBOLS – A/G MODE (CONTINUED)

SYMBOL	NAME	FUNCTION
	OPTIMUM ANTENNA ELEVATION (WHEN INSTALLED)	INDICATES ANTENNA ELEVATION FOR OPTIMUM RADAR COVERAGE.
	TARGET	RADAR DETECTED MOVING TARGET IN GMTI OR SEA2. DESIGNATED TARGET IN MTT.
	BREAKAWAY X	FLASHES TO INDICATE 4G WITHIN 2 SECONDS PULLUP RECOVERY IS REQUIRED TO AVOID THE GROUND.
	INCREASE ARROW	INCREASES VIDEO GAIN, RANGE, OR MARKER INTENSITY WHEN SELECTED.
	DECREASE ARROW	DECREASES VIDEO GAIN, RANGE, OR MARKER INTENSITY WHEN SELECTED.
	MINIATURE AIRCRAFT	APPEARS IN A/G RADAR DISPLAYS WHEN FREEZE OPTION IS SELECTED. INDICATES AIRCRAFT PRESENT POSITION ON FREEZE DISPLAY.
RNG 1750	TARGET RANGE	SLANT RANGE TO TARGET ON WEAPON DELIVERY PASS. APPEARS IN AGR DISPLAY.
AZ -02°	TARGET AZIMUTH	AZIMUTH TO TARGET RELATIVE TO AIRCRAFT GROUND TRACK. NEGATIVE SIGN (-) INDICATES LEFT, BLANK INDICATES RIGHT. APPEARS IN AGR DISPLAY.
ELV -11°	ELEVATION	ANTENNA ELEVATION OF TARGET RELATIVE TO ARL. NEGATIVE SIGN (-) INDICATES TARGET IS BELOW ARL. BLANK INDICATES TARGET ABOVE ARL. APPEARS IN AGR DISPLAY.

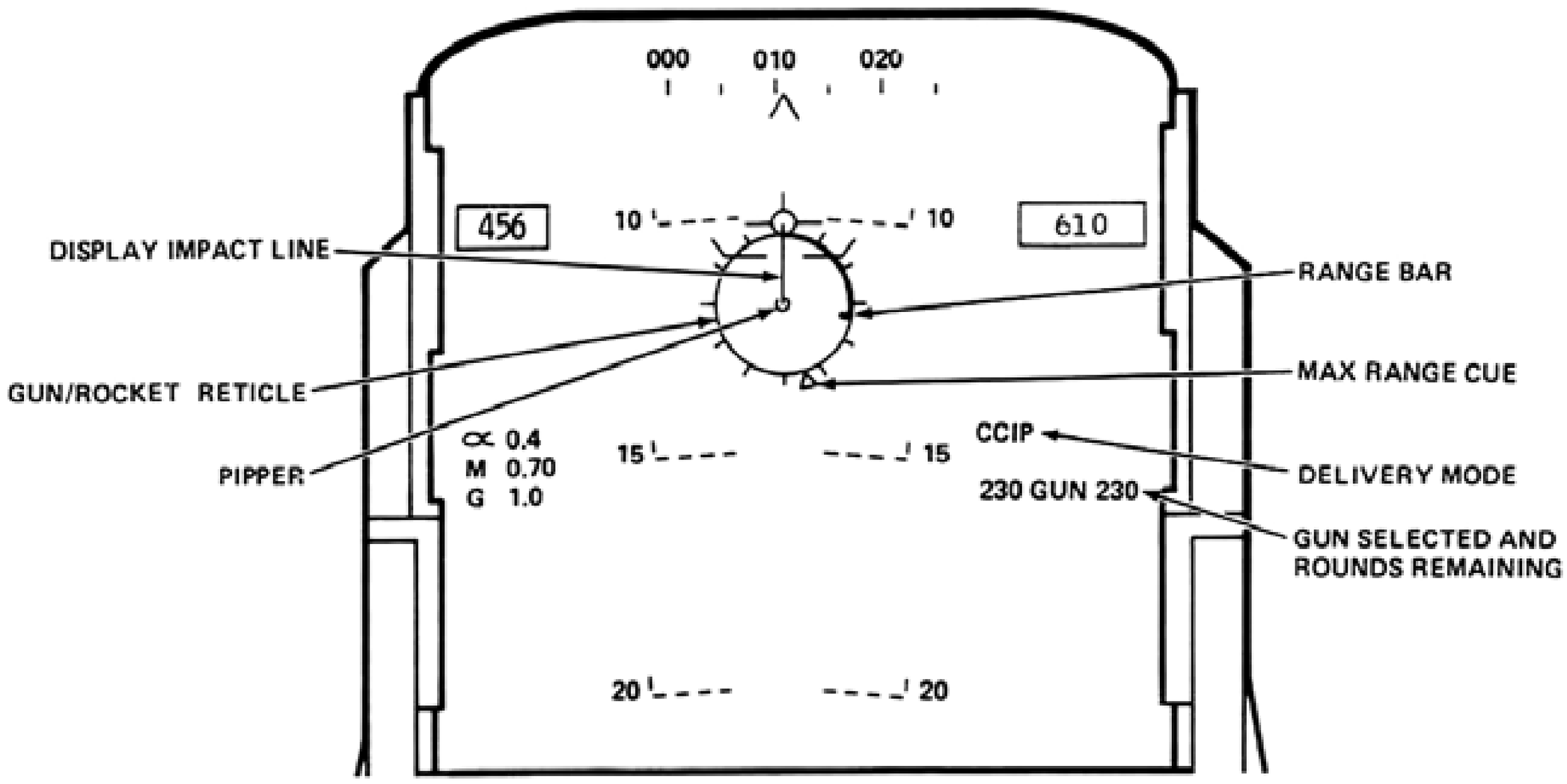
20-1-1-90(2)

Figure 1-76 (Sheet 2).

CCIP WEAPONS DELIVERY – HUD



BOMB (TYPICAL)



GUN (TYPICAL) *

* ROCKET SIMILAR

20-1-1-109(1)

Figure 1-77.

rocket) if the CCIP range bar exceeds weapon maximum range. A flashing breakaway symbol appears on the HUD when the pullup symbol is coincident with the flight path vector to indicate a four g within two seconds pullup dive recovery is required to avoid the ground.

Automatic Weapon Release

AUTO weapons release is used for bomb deliveries. AUTO is selected by designating a target (radar or HUD) when the system is in CCIP. The AUTO display (figure 1-78) appears on the HUD after target designation. The CCIP label changes to AUTO, and time to go and target range are added to the display information. The azimuth steering line (ASL) and the heading scale auto release steering diamond appear on the HUD, and the target designator diamond appears over the target. The aircraft is flown to center the ASL on the flight path vector symbol. The MC uses wind, ballistics of the weapon, and computed weapon time of flight to position the ASL for steering to the weapon release point. The release cue appears on the ASL three degrees above the flight path vector at 15 seconds to go. The release cue moves down the ASL at three seconds to go and reaches the flight path vector at zero seconds. The weapon release button is pressed and held before zero seconds to go. The first weapon is released at zero seconds, and time to go is blanked. When the last weapon of the program is released, the release cue is blanked and the ASL flashes until the weapon release button is released. The weapon delivery program is interrupted if the weapon release button is released before the program is completed. The flashing breakaway symbol appears when four g in two seconds pullup dive recovery is required to avoid the ground. When the target designator is assigned to the HUD, the DDI radar display changes to an air to ground ranging (AGR) display (figure 1-79) after target designation. If the TD is assigned to the radar display for target designation, the radar display automatically changes to the AGR display at six seconds time to go.

Manual

Manual (figure 1-80) weapons delivery is provided as one of the A/G options. Manual delivery data may be entered in the MC during preflight as one of the weapons delivery programs. The depressed reticle is used for manual delivery. The aircraft is flown to a predetermined point in space at an altitude, airspeed, and dive angle, and the weapon release button/trigger pressed to deliver weapons on the target.

TARGET DESIGNATION

Target designation specifies to the system the target to be marked by the stabilized target marker or tracked. Designation is manual. When the target designator is assigned to the radar DDI, the acquisition cursor is positioned over the desired target with the TDC. When the TDC is pressed the acquisition cursor changes to a cross hair for more accurate placement. The system marks the target with a stabilized target marker and the cursor returns to the stowed position when the TDC is released. If TRK (track) is boxed in either GMTI or SEA2, the radar locks on to the target and enters moving target track (MTT) when the target is designated.

MAP

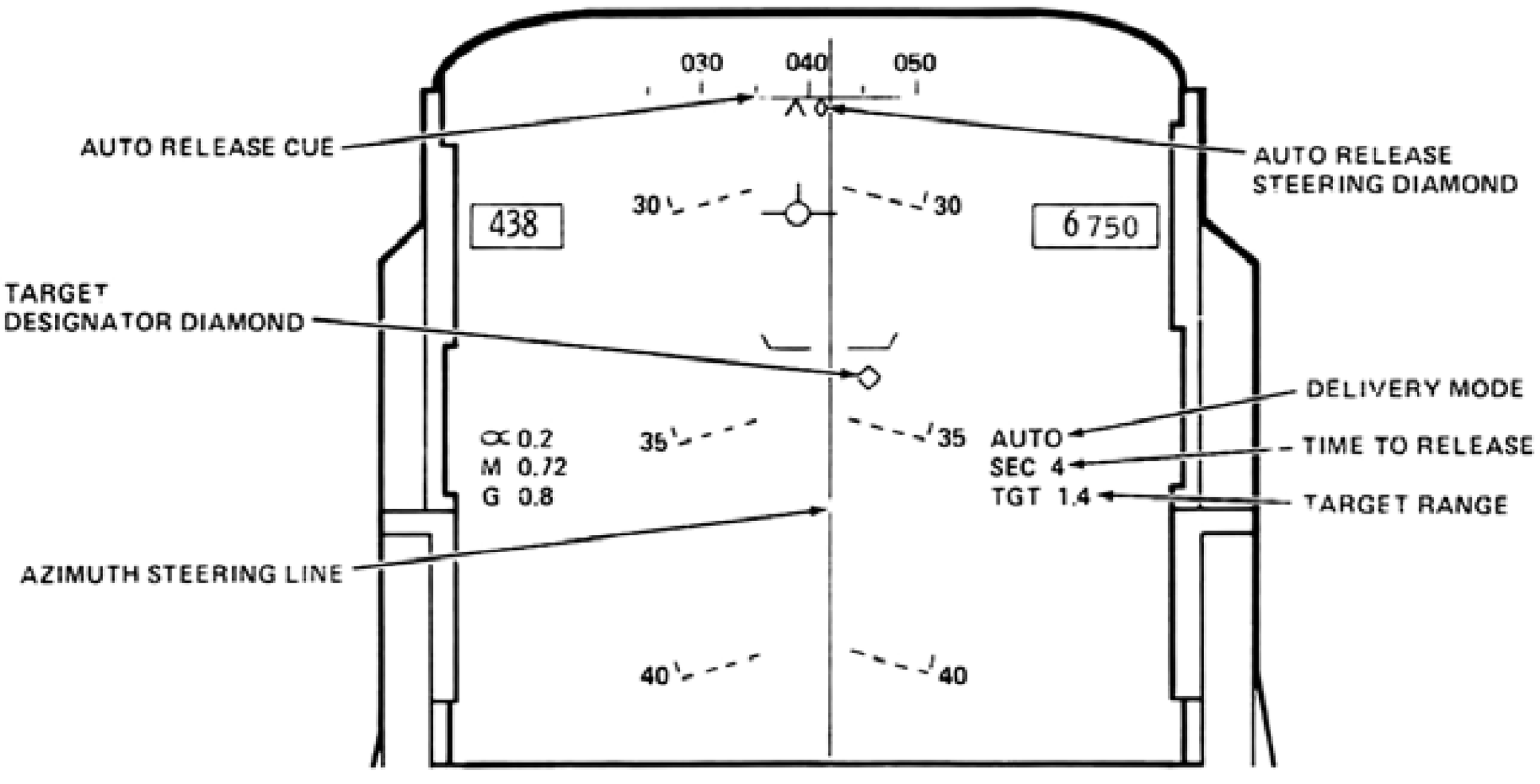
The real beam ground mapping (MAP) display (figure 1-81) consists of a PPI grid with radial lines at 30 and 60 degrees left and right of zero degree azimuth line, and equally spaced range arcs with the range of the top arc indicated between PB-11 and PB-12. The display appears on the right DDI when the A/G mode select switch is pressed, or on either DDI when PB-3 labeled MAP is selected from a NAV radar mode, or when MAP is TDC selected. Radar returns appear at the bearing and at a proportionate range as measured from the bottom of the PPI display. Antenna scans and ranges are selectable using pushbuttons or TDC radar option select.

Expand

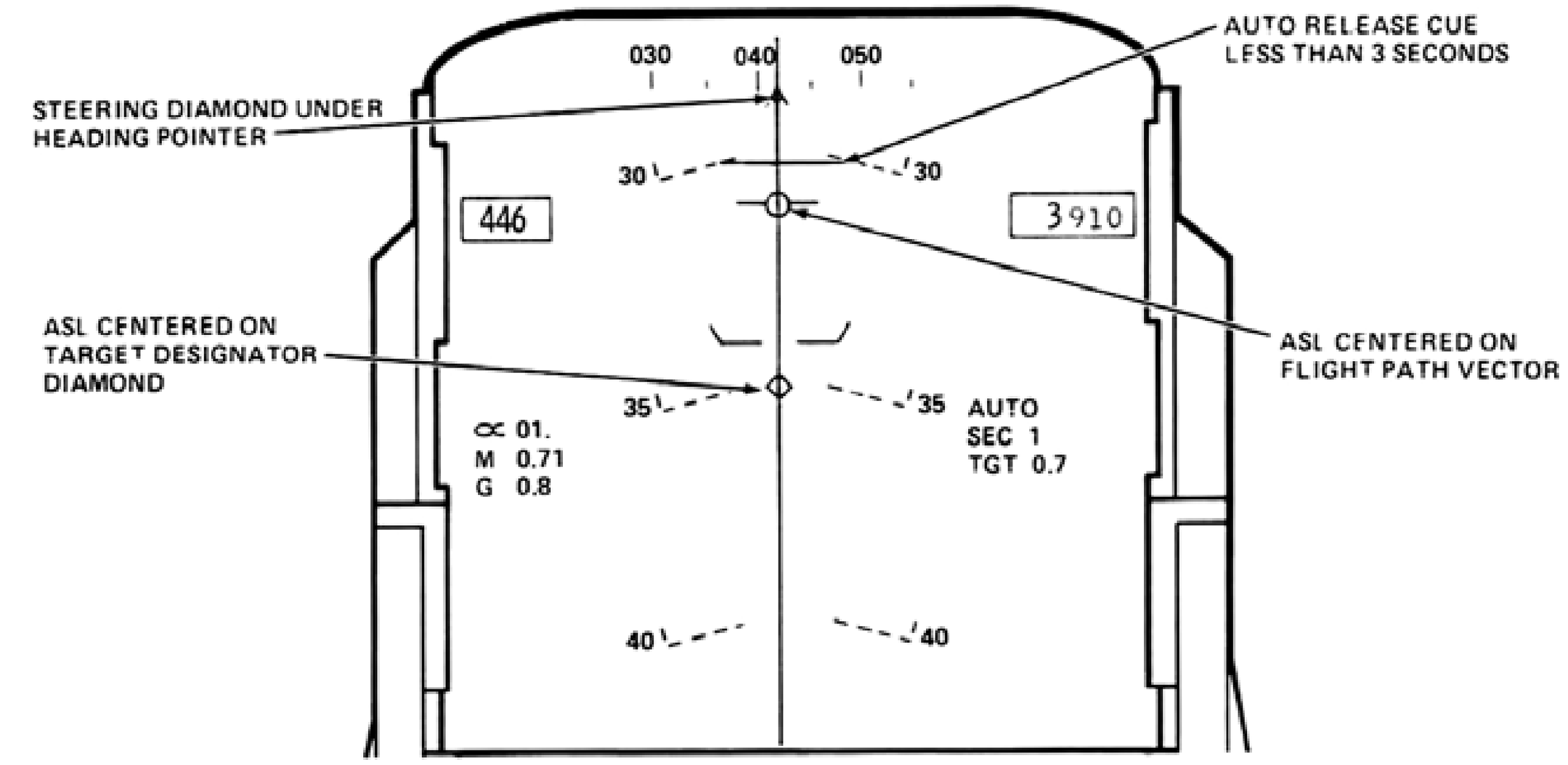
The expanded display is an expanded option of 10, 20, 40 or 80 NM MAP or SEA (figure 1-82). Expand is selected by PB-6 labeled EXP from MAP, SEA, or DBS if DBS is not in 5 NM range. Expand can be selected prior to target designation but the display does not expand until target designation. There is a two to eight second delay before the display expands. EXP is boxed, and azimuth scan and range selections are deleted when expand is selected. The radar area around the target automatically expands by a 4:1 ratio centered on the stabilized target marker. The expanded area is up to 30 degrees azimuth in width and one fourth of the selected range in length (2.5 NM long in 10 NM range, 5 NM in 20 NM, 10 NM in 40 NM, and 20 NM in 80 NM). Bearing from the present

AUTO WEAPONS DELIVERY — HUD

ASL NOT CENTERED



ASL CENTERED

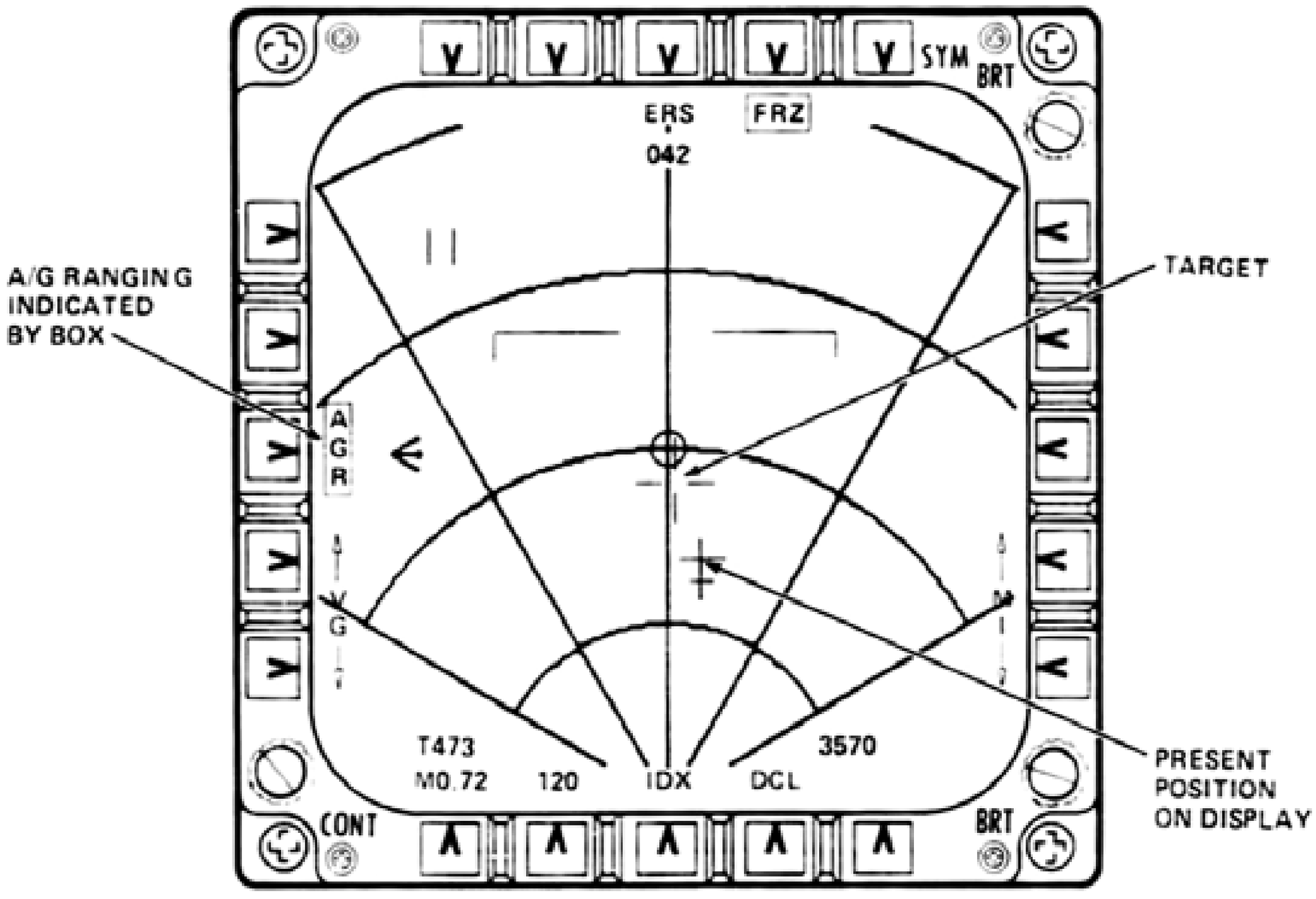


20-1-1-110(1)

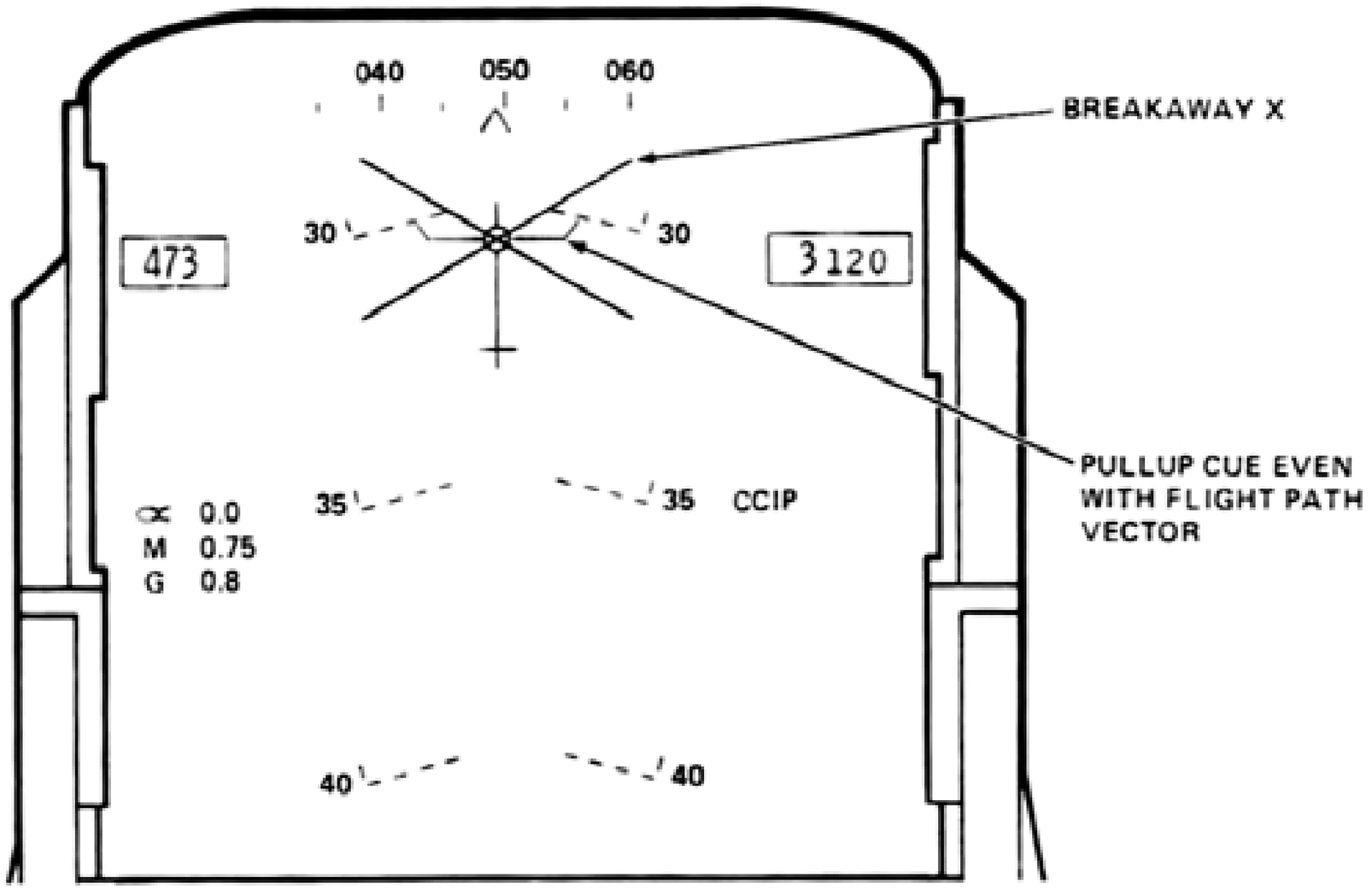
Figure 1-78.

WEAPONS DELIVERY (TYPICAL)

AIR TO GROUND RANGING – RADAR



HUD – MINIMUM ALTITUDE WARNING

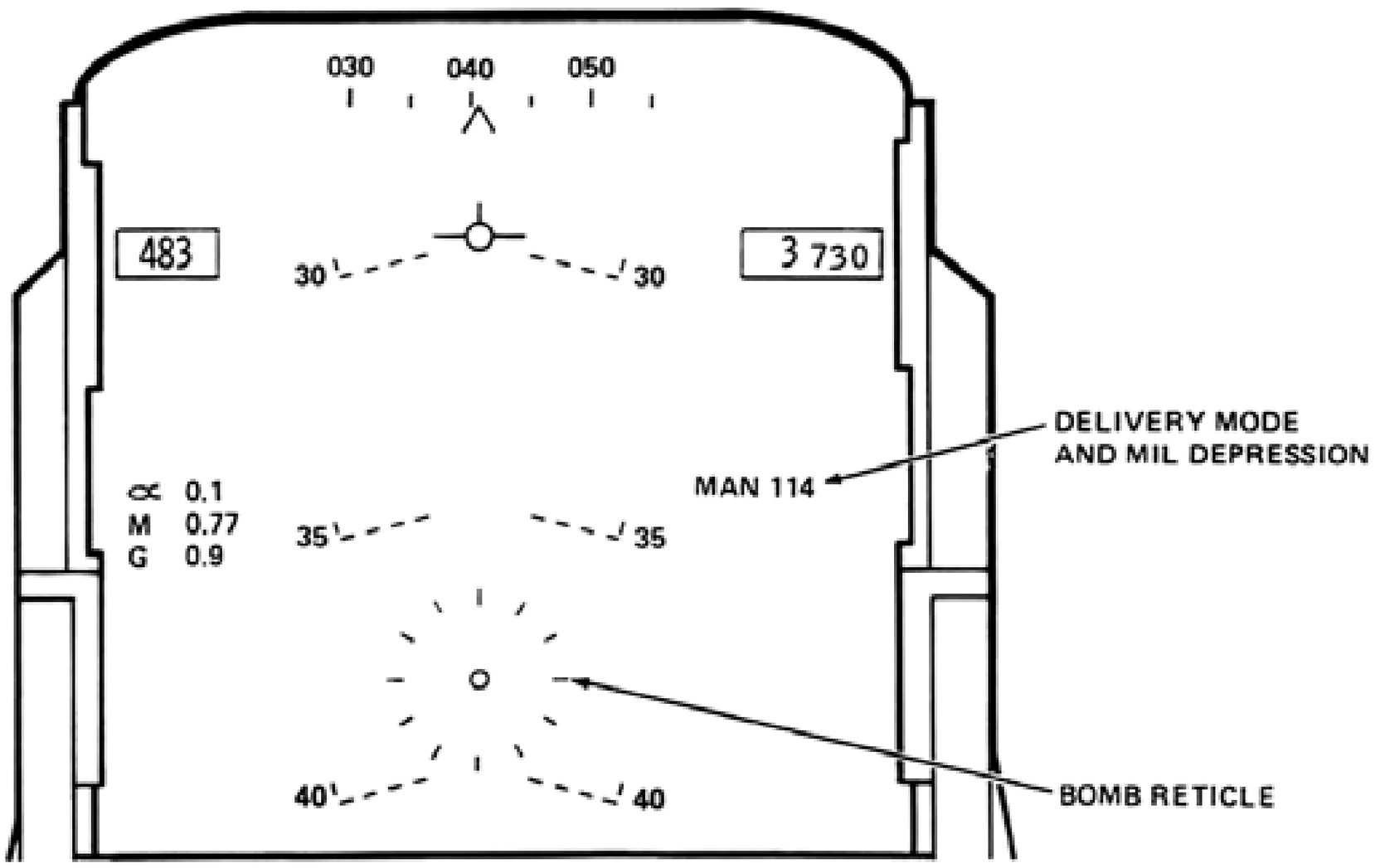


20-1-1-112(1)

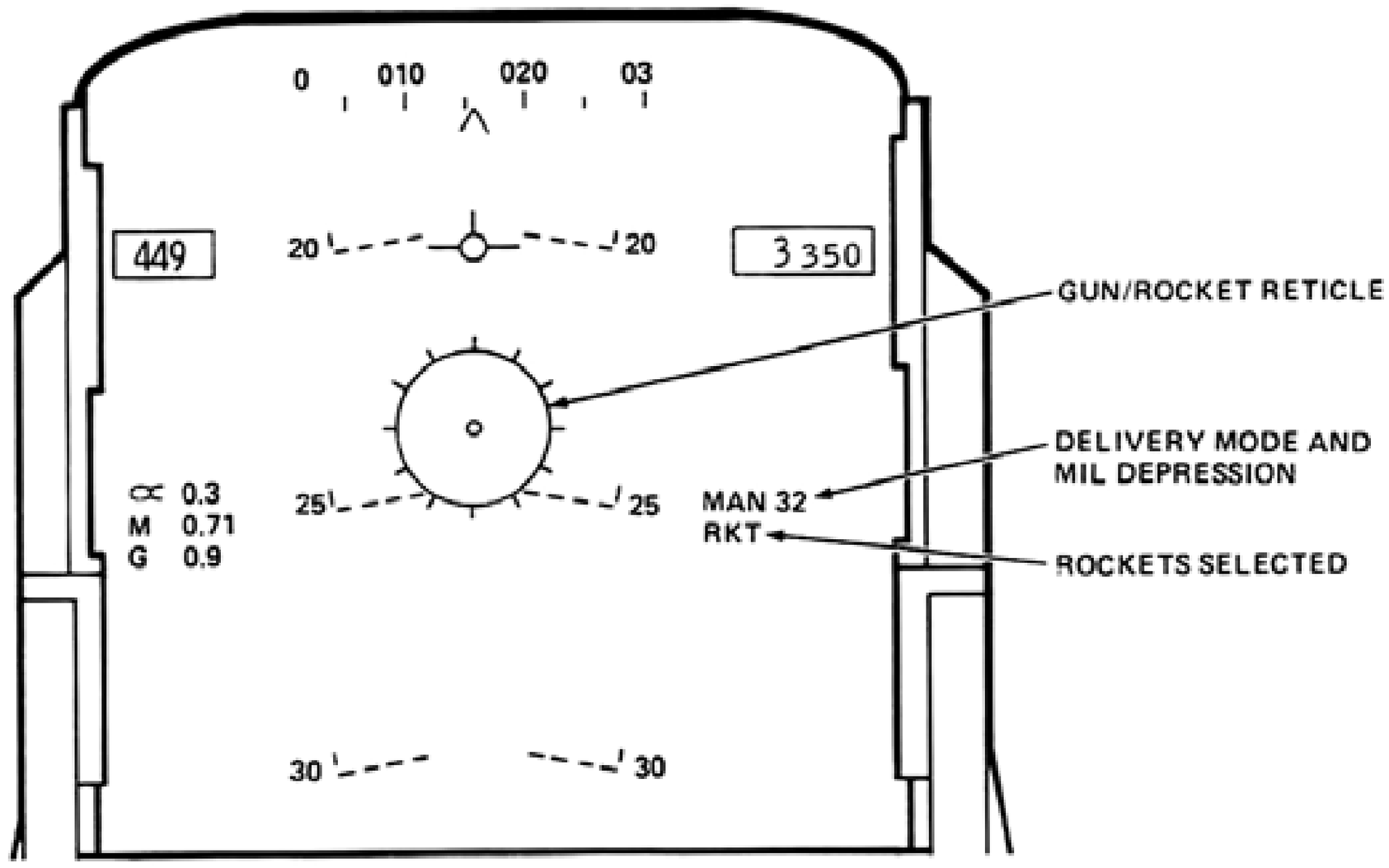
Figure 1-79.

MANUAL WEAPONS DELIVERY – HUD

BOMB (TYPICAL)



ROCKETS (TYPICAL)*



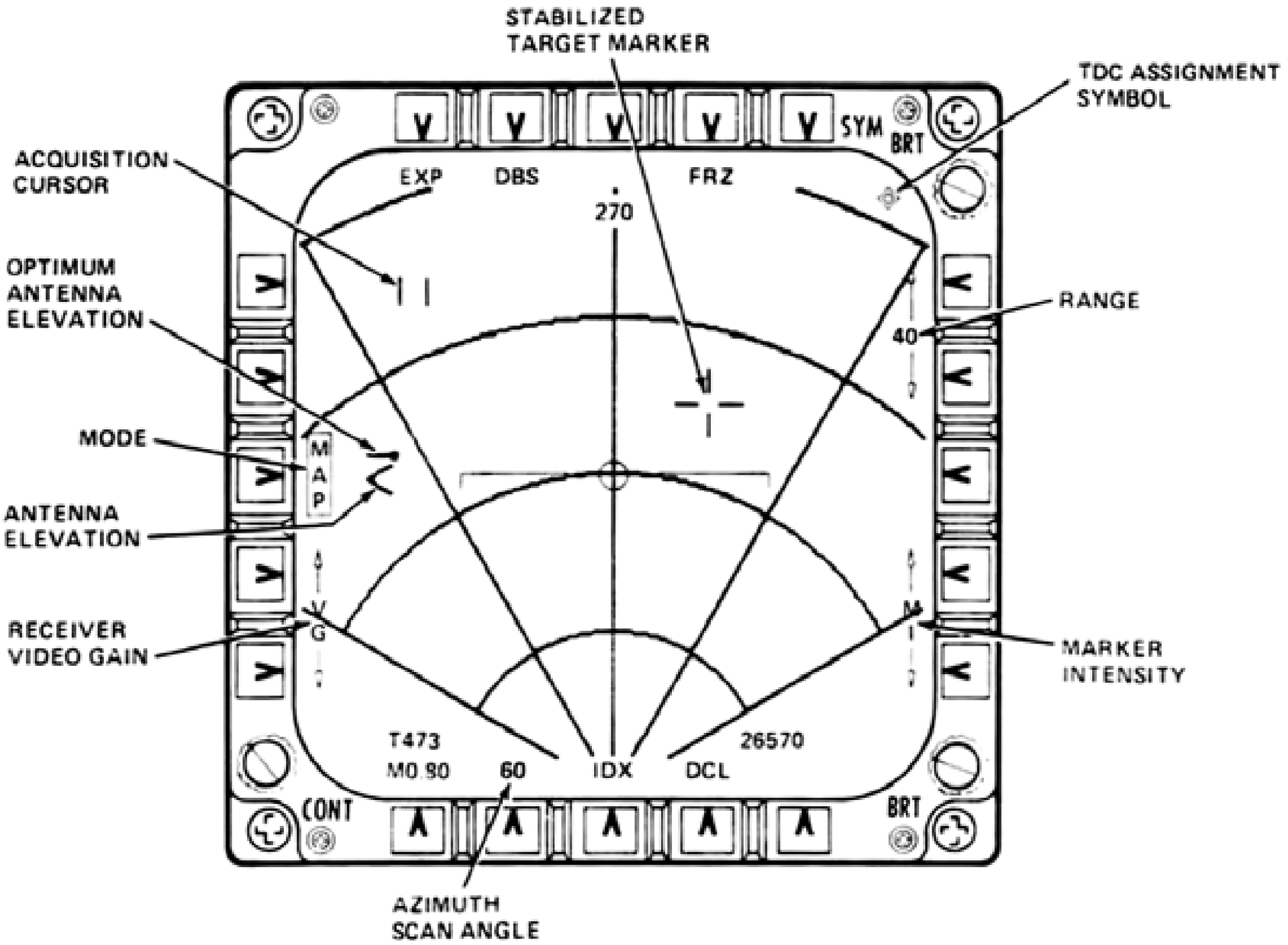
* GUN SIMILAR

20-1-1-111(1)

Figure 1-80.

MAPPING DISPLAYS (TYPICAL)

MAP



SEA

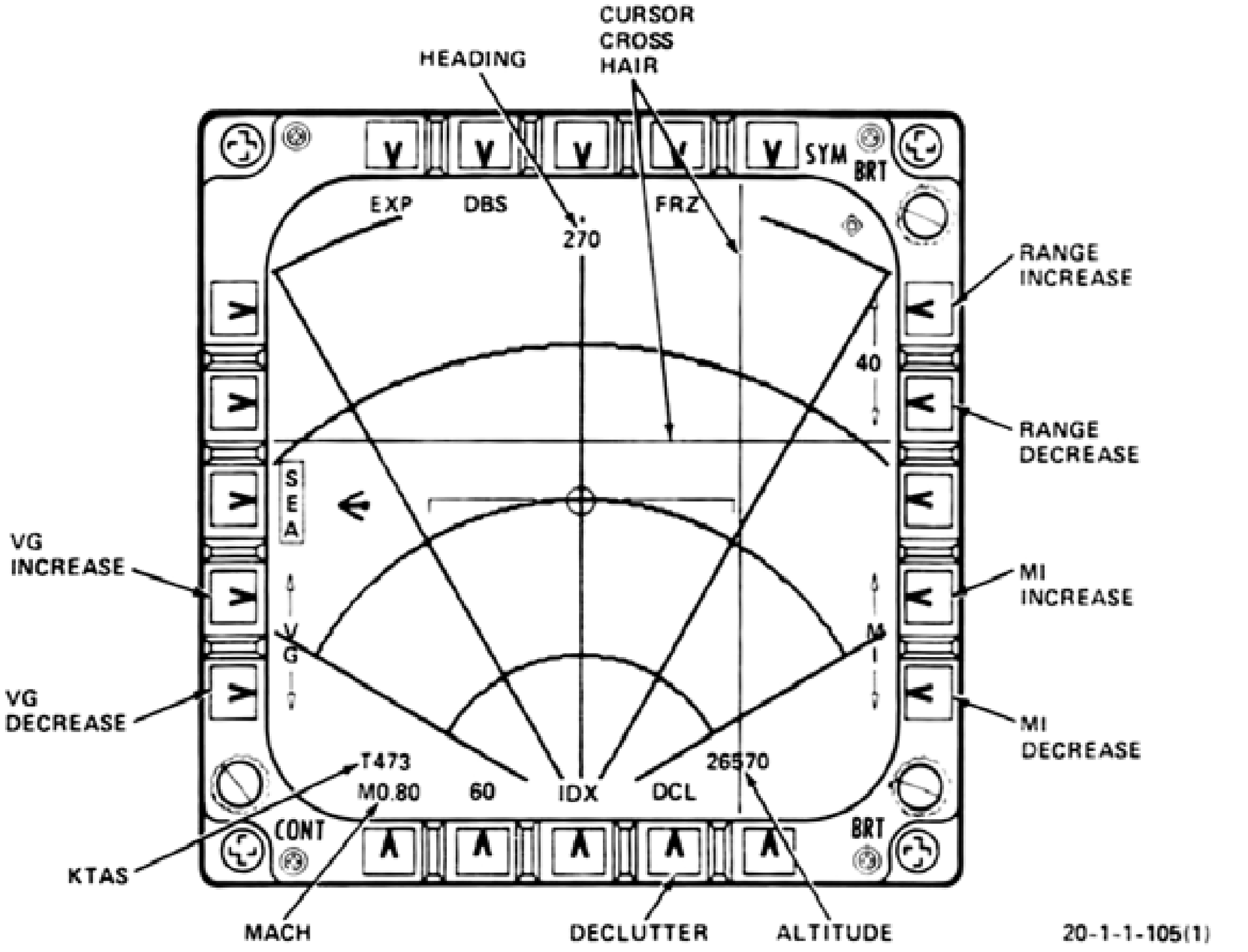
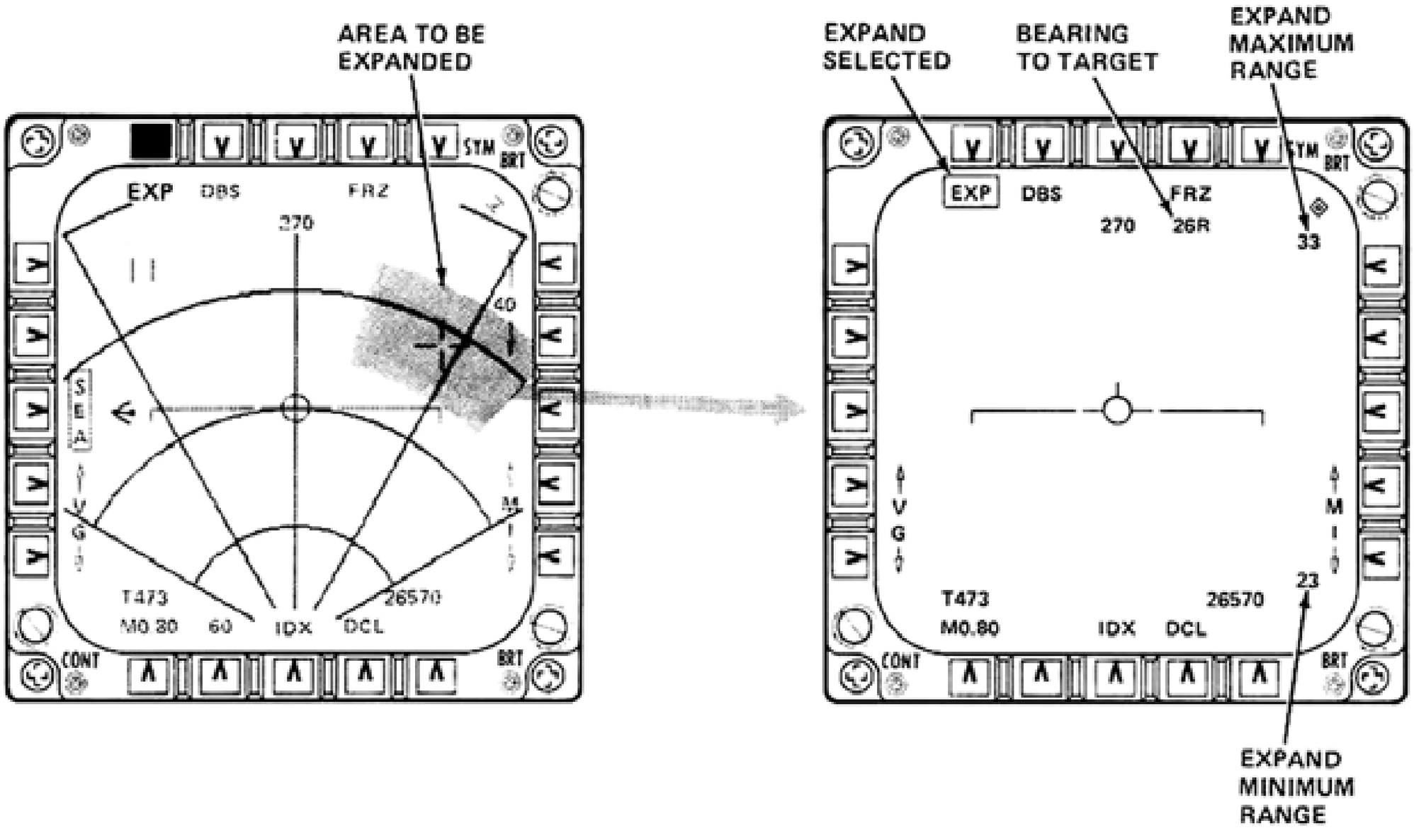


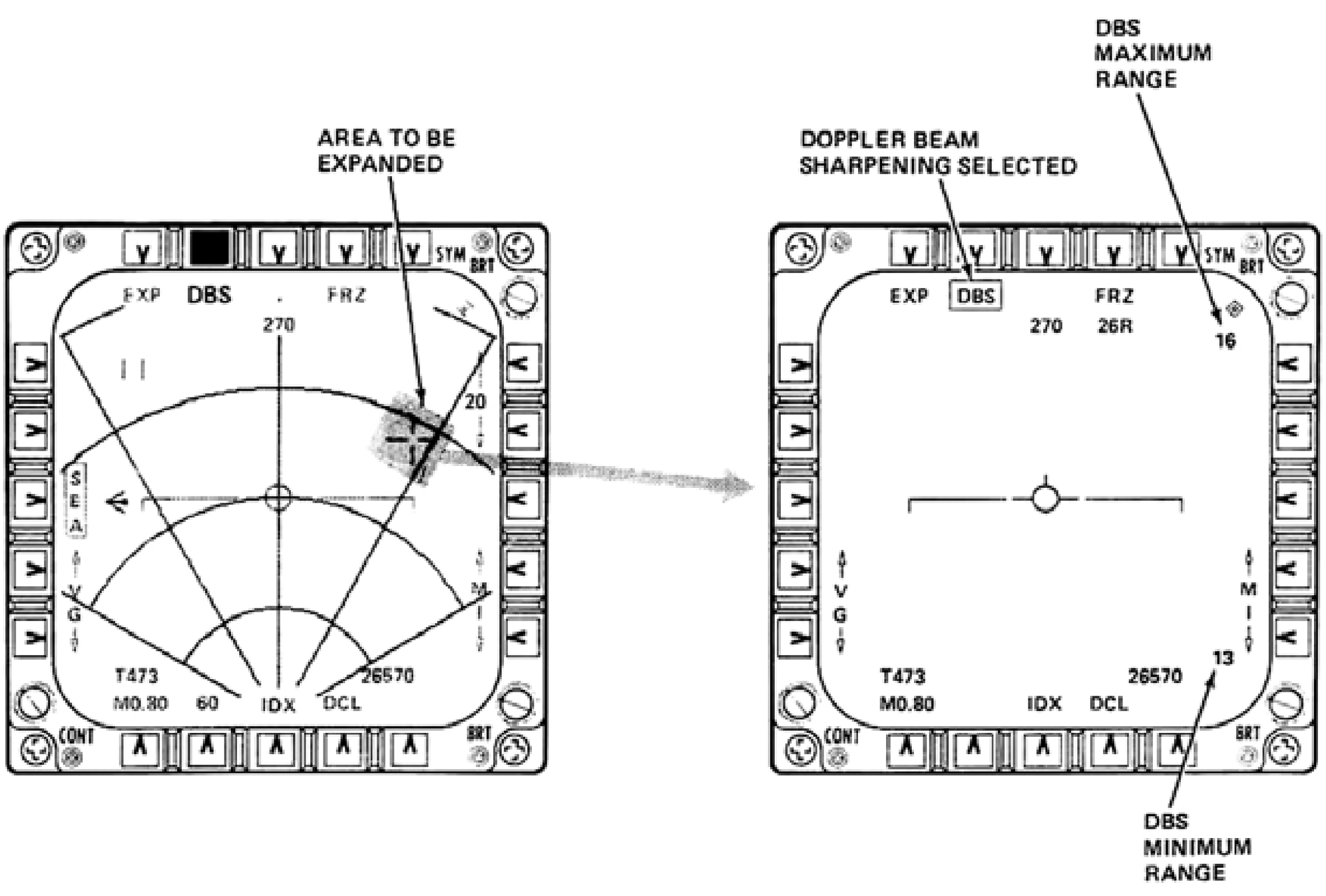
Figure 1-81.

EXPANDED DISPLAYS (TYPICAL)

EXPAND



DBS



20-1-1-108(1)

Figure 1-82.

position to the designated target in degrees left (L) or degrees right (R) of the aircraft track is indicated under the FRZ label at PB-9. The target position can be designated again while in expand if a target update is required. Selecting the boxed EXP returns the radar to the previous display and unboxes EXP.

Doppler Beam Sharpening

Doppler beam sharpening (DBS) (figure 1-82) is an expanded option of 10 or 20 NM MAP or SEA. DBS is selected by PB-7 labeled DBS from the MAP, SEA, or expanded display. DBS is boxed, and azimuth scan and range selections are deleted when DBS is selected. DBS can be selected prior to target designation but does not appear until after the target is designated. DBS provides a 40:1 azimuth resolution improvement for targets more than 15 degrees off of aircraft track. Within 15 degrees of aircraft track, DBS is enabled but the system uses real beam returns for display. There is a two to eight second delay before DBS appears on the DDI. DBS is an expanded area B-sweep display centered on the stabilized target marker. For ranges more than 16 NM DBS covers an area 5 NM square, for ranges between 8 NM and 16 NM the area is 2.5 NM square, and for ranges less than 8 NM the area is 1.25 NM square. Bearing from the present position to the designated target in degrees left or degrees right of the aircraft track is indicated under the FRZ label at PB-9. The target position can be designated again while in DBS if a target update is required. Selecting the boxed DBS returns the radar to the previous display and unboxes DBS.

Freeze

The freeze option is available in all A/G radar displays except MTT. Selecting PB-9 labeled FRZ interrupts radar transmissions, boxes FRZ, and enables the erase PB-8 labeled ERS (figure 1-83). The video is not updated in freeze. An aircraft symbol appears and moves across the display denoting present position on video freeze. All radar generated symbols and returns are erased when ERS at PB-8 is selected. Selecting the boxed FRZ returns the radar system to the previous operating display and unboxes FRZ.

SEA

SEA mapping (figure 1-81) is used for detecting land mass or floating targets on large bodies of water. SEA is selected from an A/G display when PB-3 is stepped to SEA or when SEA is TDC selected. The SEA display has the same PPI, radar ranging, antenna elevation, and azimuth scans as the MAP display. SEA state motion is filtered out of the radar returns.

GROUND MOVING TARGET INDICATOR

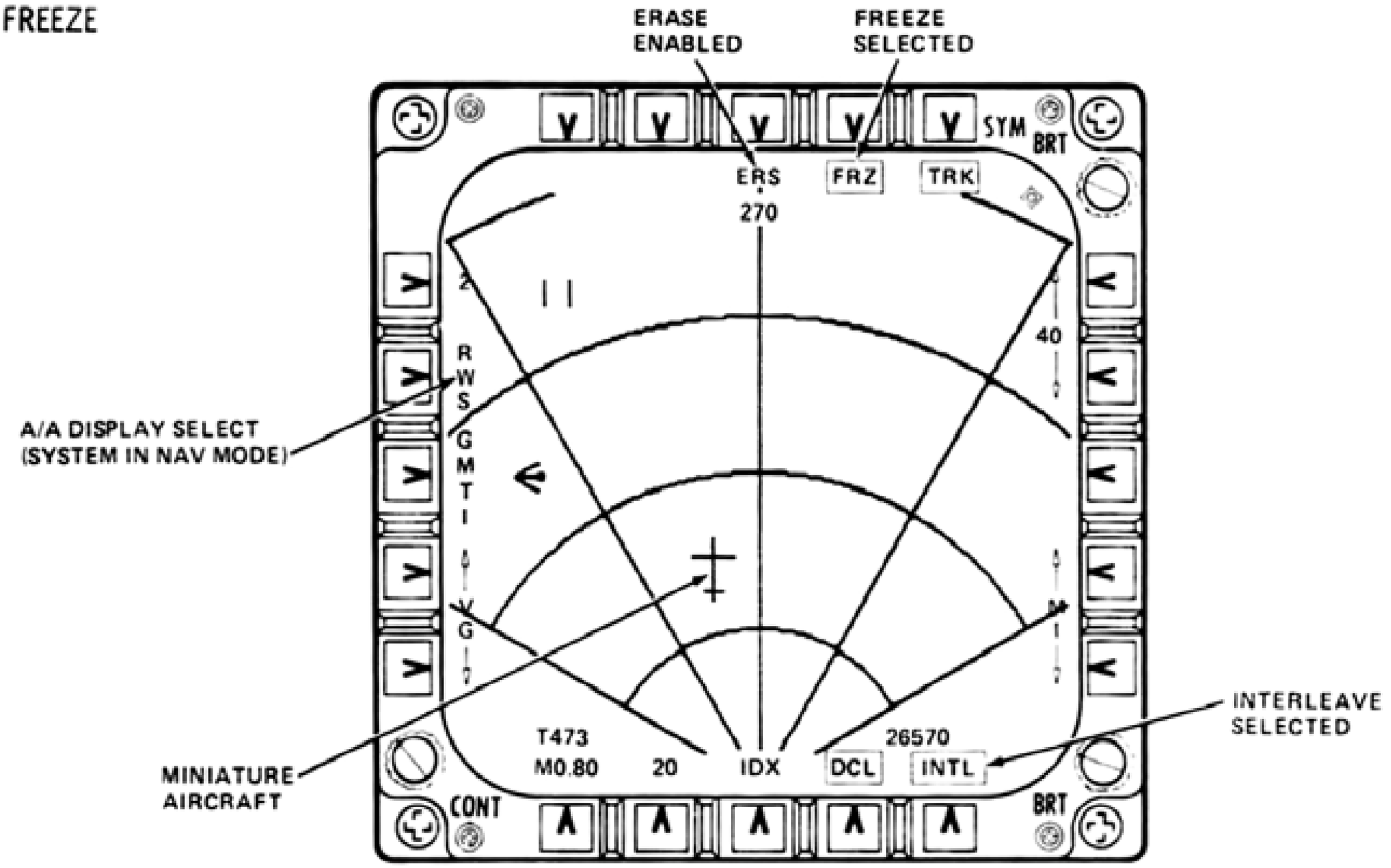
Ground moving target indicator (GMTI) (figure 1-84) is used to detect and track moving targets with a speed of five knots or more. GMTI is selected from an A/G display when PB-3 is stepped to GMTI or when GMTI is TDC selected. When GMTI is selected the PB-3 label changes to a boxed GMTI, the track option at PB-10 labeled TRK is automatically selected and boxed, interleave at PB-16 labeled INTL is selectable, and EXP and DBS labels are blanked. Target radar returns are all the same size regardless of actual target dimensions. When the track option is deselected and target is designated, the moving target drifts away from the stabilized target marker and can be used to provide a rough estimate for speed and direction of travel of the target.

Moving Target Track

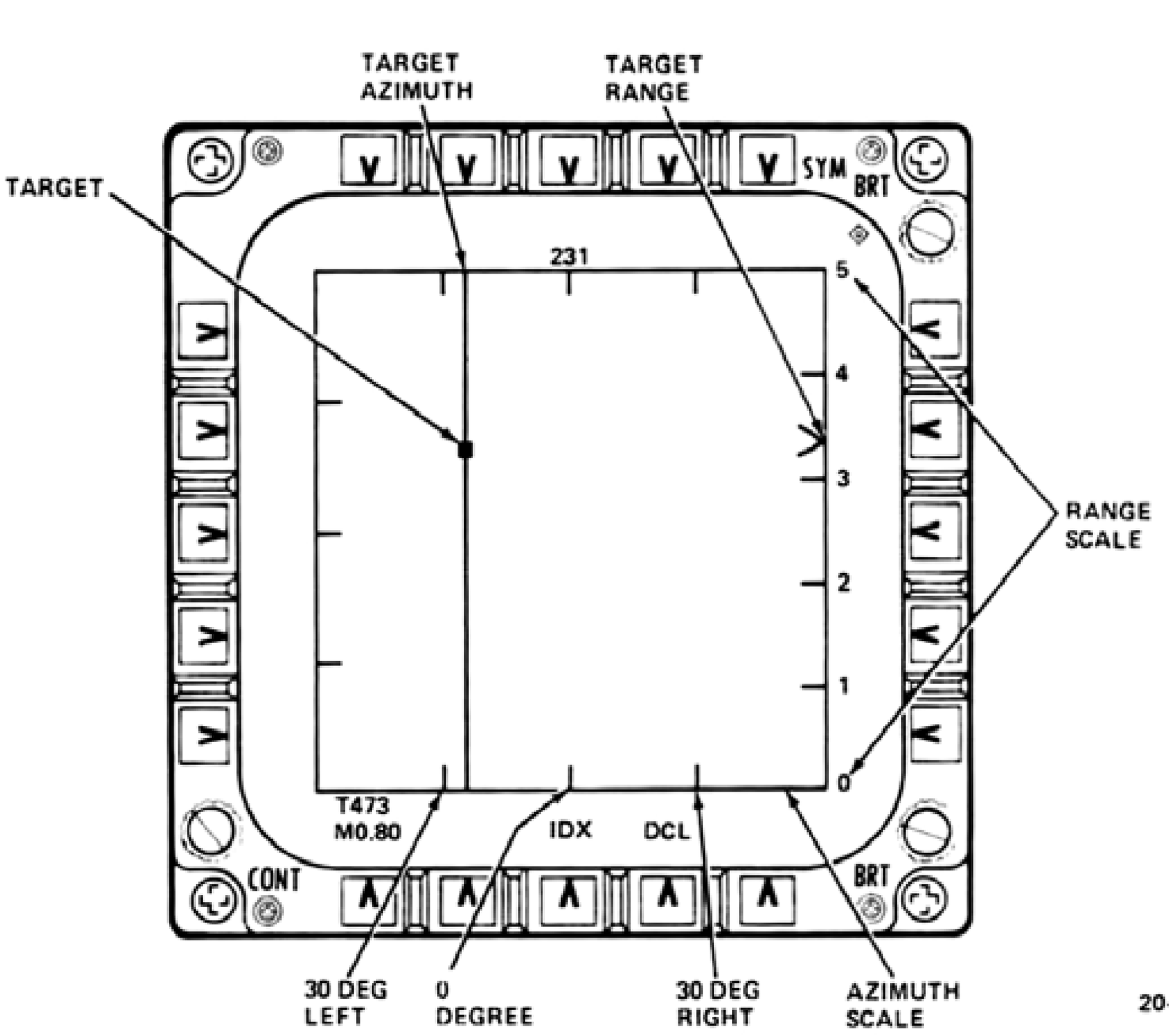
Moving target track (MTT) (figure 1-83) is automatically selected when a target is designated in GMTI or SEA2 unless the track option has been deselected. The MTT display is similar to the A/A mode STT. The system tracks the moving target in MTT and all other targets are blanked. The B-sweep centers on the target and position of the B-sweep left or right indicates target azimuth from aircraft track. Target range is indicated on the right side of the DDI by the target range caret on the range scale. Antenna elevation is indicated on the left side of the DDI by the antenna elevation caret on the antenna elevation scale. When target lock-on is lost, the radar automatically predicts target future position for four seconds while searching an area covering possible target maneuvers. If track is not re-established, a re-acquisition search in azimuth, range, and velocity begins where the position track was lost. If track is still not re-established the radar returns to the previously selected search mode.

A/G DISPLAYS (TYPICAL)

FREEZE



MTT

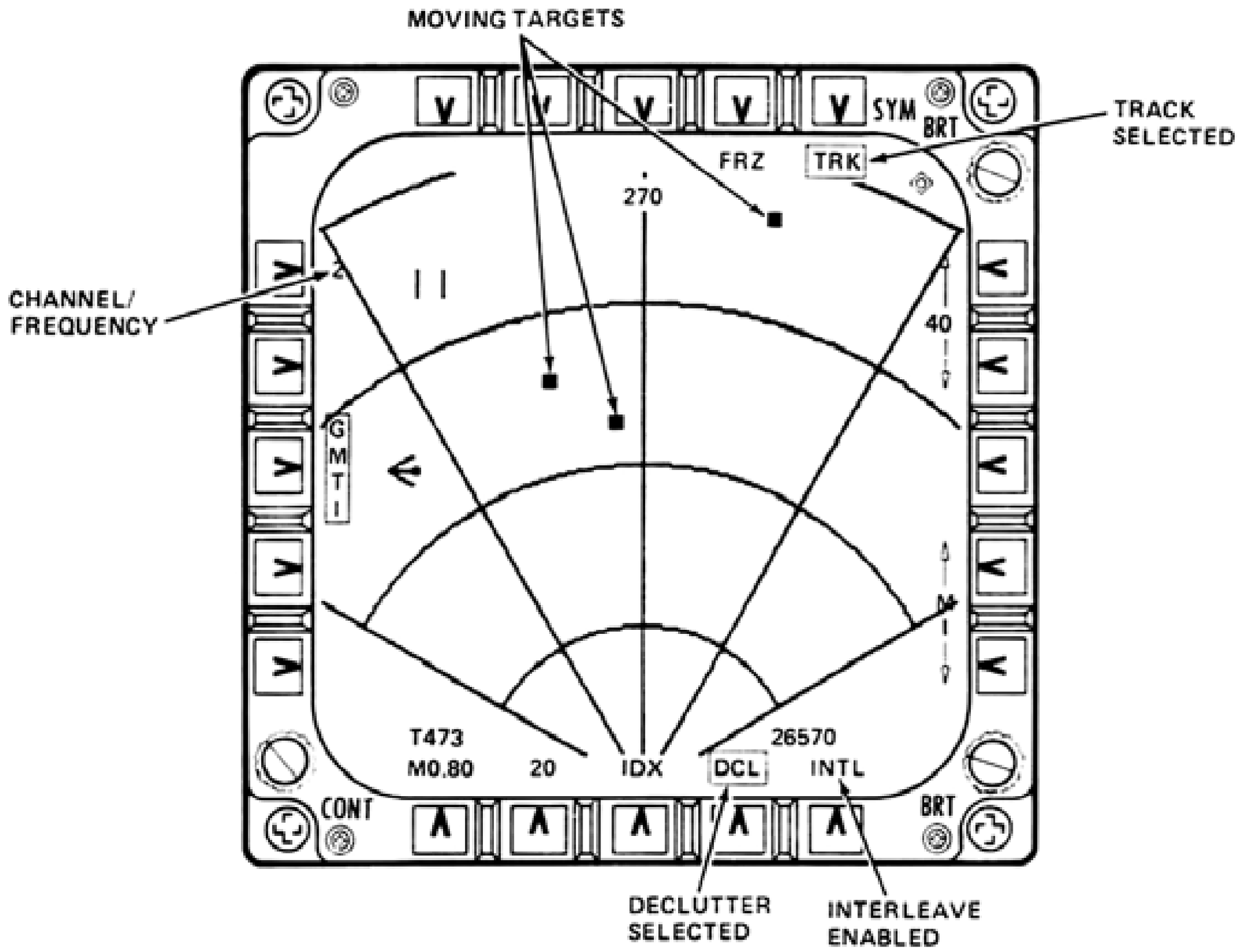


20-1-1-107(1)

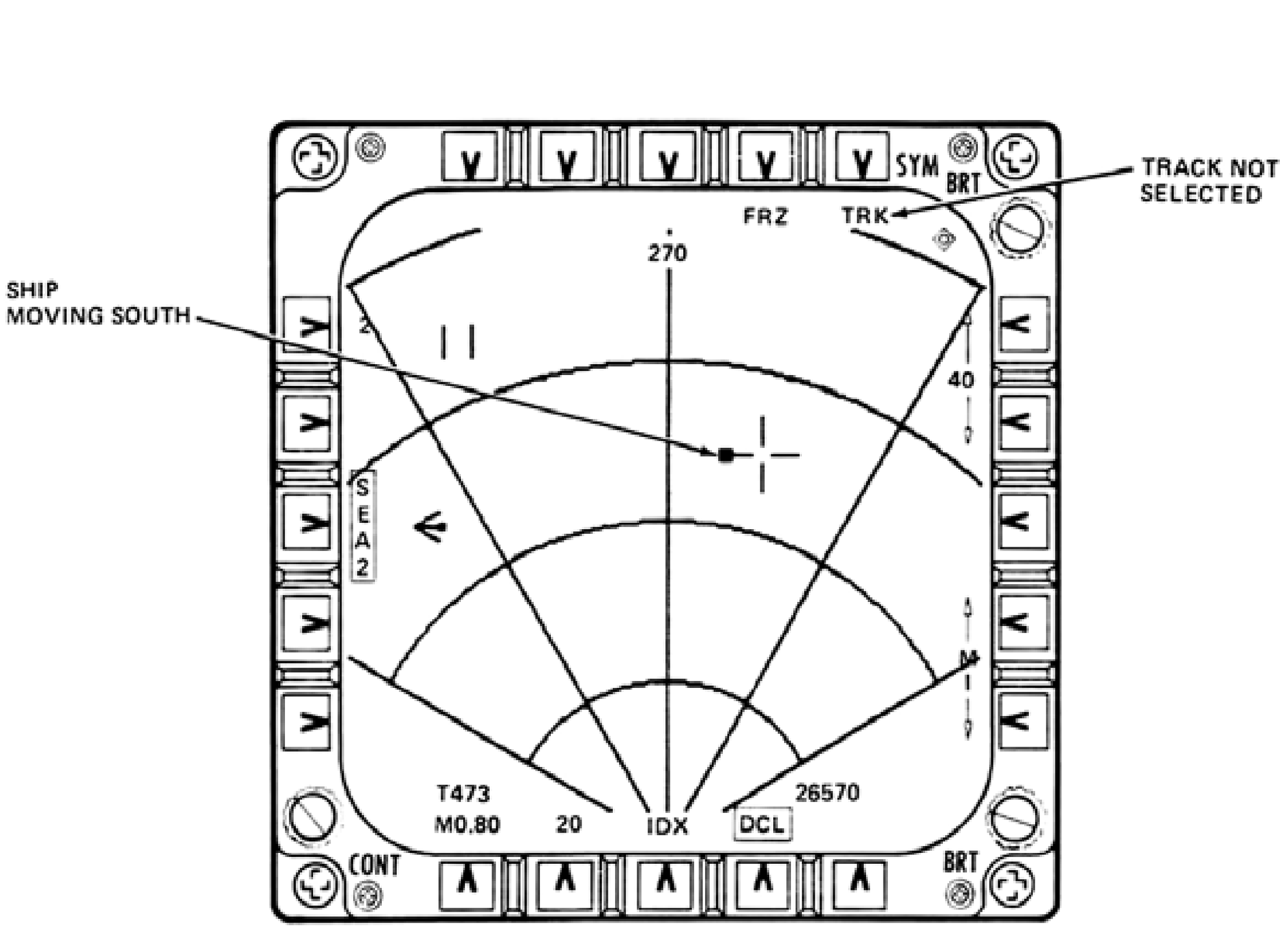
Figure 1-83.

MOVING TARGET INDICATOR DISPLAYS (TYPICAL)

GMTI



SEA2



20-1-1-106(1)

Figure 1-84.

Interleave

Initially, only moving targets appear on the GMTI display and ground reference mapping points are not shown. Selecting the interleave PB-16 labeled INTL boxes INTL label and provides a MAP display overlain by GMTI targets on every fourth scan of the radar. Interleave makes indentification of roads and bridges easier. Interleave is only applicable to GMTI.

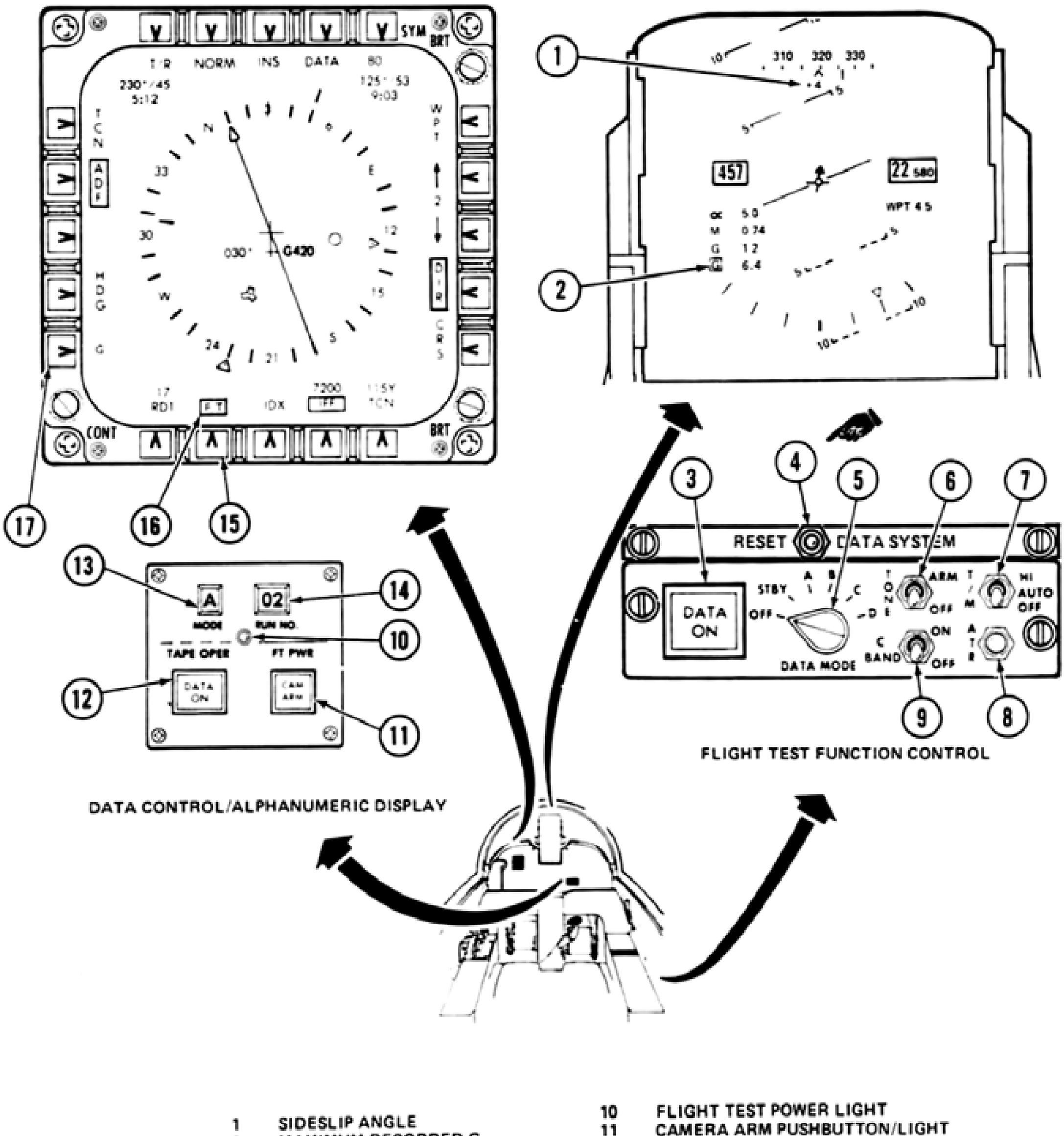
SEA MOVING TARGET INDICATOR

SEA2 (figure 1-84) is used to detect and track SEA moving targets with a speed of five knots or more. SEA2 is similar to GMTI. SEA2 is selected from an A/G display when PB-3 is stepped to SEA2 or when SEA2 is TDC selected. When SEA2 is selected, the PB-3 label changes to a boxed SEA2, the track option at PB-10 is automatically selected and boxed, and the EXP and DBS labels are blanked. When the track option is not selected and a target is designated, the moving target drifts away from the stabilized target marker and can be used to provide a rough estimate for speed and direction of travel of the target, or the stabilized target marker can be used to mark the point that a target disappears or submerges.

FLIGHT TEST SYSTEMS

Flight test equipment includes a data control/ alphanumeric display panel and a function control panel (figure 1-85). These flight test systems are powered when the data mode selector is set to mode A, B, C, or D. Flight test information is also supplied to the HUD and the HSD. Selecting PB-19 on the HSD boxes the flight test (FT) label, activates PB-1 and labels it G, and presents the HUD peak g and sideslip angle symbols. Selecting PB-1 labeled G, resets the HUD peak g to zero. When PB-19 is selected again, flight test box and PB-1 G label are removed, PB-1 is deactivated, and HUD peak g and sideslip symbols are removed. For a complete description of the flight test equipment, see Supplement to Utility Flight Manual for Flight Test Systems, published under separate cover by Northrop Flight Test.

FLIGHT TEST SYSTEMS CONTROLS/INDICATORS



1	SIDESLIP ANGLE
2	MAXIMUM RECORDED G
3	DATA ON PUSHBUTTON
4	DATA SYSTEM RESET
5	DATA MODE SELECTOR
6	TONE SWITCH
7	TELEMETRY SWITCH
8	ATR PUSHBUTTON
9	C-BAND SWITCH
10	FLIGHT TEST POWER LIGHT
11	CAMERA ARM PUSHBUTTON/LIGHT
12	DATA ON PUSHBUTTON/LIGHT
13	MODE SWITCH POSITION INDICATOR
14	RUN NUMBER INDICATOR
15	FLIGHT TEST DATA SELECT
16	FLIGHT TEST DATA INDICATION
17	G RESET

20-1-1-65(2)B

Figure 1-85.

GROUND SAFETY PINS

Figure 1-86.