LUFTWAFFENMATERIALKOMMANDO **GAF T.O. 1F-MIG29-1**

FLIGHT MANUAL
MIG-29

CHANGE NOTICE	LATEST CHANGED PAGES SUPERSEDE THE SAME PAGES OF PREVIOUS DATE. INSERT CHANGED PAGES INTO BASIC PUBLICATION. DESTROY SUPERSEDED PAGES.

This Flight Manual is incomplete without GAF T.O. 1F-MIG29-1CL-1.
See INDEX GAF T.O. 0-1-1A for current status of Flight Manual, Safety and Operational Supplements, Flight Crew Checklist.

PUBLISHED UNDER AUTHORITY OF THE
BUNDESMINISTERIUM DER VERTEIDIGUNG
- FÜHRUNGSSTAB DER LUFTWAFFE -
- (BMVg Fü L) -

DSK: L7001219304
ESG 150

30 SEPTEMBER 1994
CHANGE 4 - 20 SEPTEMBER 2001

LIST OF EFFECTIVE PAGES

NOTE

Information that has been changed is indicated by a vertical line on the outer margins of the page, an asterisk, a screen, or a miniature pointing hand.

TOTAL NUMBER OF PAGES IN THIS PUBLICATION IS INCLUDING FRONT PAGES AND EMPTY PAGES IS 462, CONSISTING OF THE FOLLOWING:

Dates of issue for original and changed pages

Original . . . . .0 . . . . 30 September 1994
Change 1 .1. . . . . 15 November 1995
Change 2 .2. . . . . .20 June 1997
Change 3 .3. . . . . 30 October 2000
Change 4 .4 . . . . 20 September 2001

With Change 4, the following supplements are considered to be incorporated into the manual, the status of the changed pages has been included in the List of Effective Pages, and the title pages of those supplements are to be destroyed:
GAF T.O. 1F-MIG29-1S-30; GAF T.O. 1F-MIG29-1S-35, GAF T.O. 1F-MIG29-1S-36, GAF T.O. 1F-MIG29-1S-37

Page	Issue	Page	Issue	Page	Issue
* Title	4	1-25	2	1-61	2
* A thru D	4	* 1-26 thru 1-28	4	* 1-62	OS-35
* E blank	4	1-29	2	1-63 thru 1-65	0
F	2	* 1-30 thru 1-31	4	1-66	1
G blank	2	1-32	2	* 1-67	4
H	2	1-33	0	* 1-67A	4
* I	4	1-34	2	1-67B	2
J thru M	2	1-35	1	1-68	2
* 1-1 thru 1-4	4	* 1-36 thru 1-42	4	1-69	1
* 1-4A thru 1-4B	4	1 43	2	1-70	0
1-5	1	* 1-44 thru 1-45	4	* 1-71	4
* 1-6	4	1-46	2	1-72 thru 1-76	2
1-7	0	* 1-46A thru 1-46B	4	* 1-77	4
1-8 thru 1-12	2	1-46C	2	1-78 thru 1-79	2
1-12A	2	* 1-46D	4	* 1-80	4
1-12B blank	2	* 1-46E thru 1-46H	4	1-81	2
1-13	1	1-46I	2	* 1-82	4
1-14 thru 1-15	0	1-46J blank	2	1-83	2
1-16	2	* 1-47 thru 1-51	4	* 1-84 thru 1-90	4
* 1-17 thru 1-19	4	1-52 thru 1-53	2	* 1-90A thru 1-90B	4
1-20	2	* 1-54 thru 1-56	4	* 1-91	4
1-21 thru 1-22	0	1-57 thru 1-59	2	1-92 thru 1-93	0
* 1-23 thru 1-24	4	1-60	0	* 1-94 thru 1-97	4

The information in this manual is reflected in the checklist GAF T.O. 1F-MIG29-1CL-1
*) The asterisk indicates pages changed, renewed, added or deleted by the current change.

Additional copies of this publication can be obtained from LwMatKdo I C 3.

LIST OF EFFECTIVE PAGES (CONTINUED)

Page	Issue
1-98	2
* 1-99	4
1-100	0
1-101 thru 1-102	2
1-103	0
* 1-104	4
1-105	2
* 1-106 thru 1-108	4
1-109	1
* 1-110	4
1-110A	2
* 1-110B	4
1-110C	2
1-110D blank	2
1-111	2
* 1-112 thru 1-116	4
1-117	2
* 1-118	4
1-119	2
* 1-119A thru 1-119B	4
* 1-120	4
1-121	1
* 1-122 thru 1-123	4
1-124	2
2-1	2
2-2	0
2-3	2
2-4	0
2-5	2
2-6	1
2-7	0
2-8 thru 2-9	2
2-10	0
2-11	1
2-11A thru 2-11B	1
* 2-12 thru 2-13	OS-37
2-14 thru 2-15	2
2-16	1
2-17	0
2-18 thru 2-19	1
2-20 thru 2-22	0
2-23 thru 2-25	2
2-26	0
2-27	2
2-28 blank	2
3-1 thru 3-3	2
3-4 thru 3-5	1
3-6	OS-32
3-7	OS-22
3-8	1
3-9	2
3-10	1
3-11 thru 3-17	OS-32
3-18	2
* 3-19	OS-35
* 3-20	4
3-20A	OS-32
3-20B	2
3-21	OS-32
3-22 thru 3-23	2
3-24 thru 3-25	OS-32
3-26	1
3-27	OS-32
3-28 thru 3-29	1
3-30	2
3-31	OS-18
3-32	2
3-33 thru 3-34	OS-34
3-35 thru 3-36	1
4-1	2
4-2 blank	2
4-3	2
4-4 thru 4-6	0
4-7	1
4-8 thru 4-11	0
4-12	1
4-13	2
4-14 blank	2
5-1	2
5-2 blank	2
5-3 thru 5-4	2
* 5-5 thru 5-6	OS-35
* 5-7 thru 5-8	4
* 5-9	OS-35
* 5-10	4
5-11	2
* 5-12 thru 5-13	OS-35
* 5-14	OS-36
* 6-1	4
* 6-2 blank	4
* 6-3 thru 6-15	4
* 6-16 blank	4
7-1	0
7-2 blank	0
7-3	OS-21
7-4	1
7-5 thru 7-6	0
7-7	1
7-8 thru 7-9	0
7-10 blank	0
* A-1 thru A-2	4
* A1-1	4
A1-2	2
* A1-3	4
A1-4	2
A1-5 thru A1-8	2
* A2-1 thru A2-12	4
* A3-1 thru A3-6	4
* A4-1 thru A4-11	4
* A4-12 blank	4
* A5-1 thru A5-8	4
* A6-1 thru A6-2	4
* A7-1 thru A7-5	4
* A7-6 blank	4
* A8-1 thru A8-10	4
A8-11	2
* A8-12 thru A8-15	4
A8-16	2
* A8-17 thru A8-18	4
A8-19	2
* A8-20 thru A8-21	4
A8-22	2
A8-23	OS-31
A8-24 thru A8-25	2
A8-26 blank	2
B-1	2
B-2 blank	2
B-3 thru B-49	2
B-50 blank	2
* I-1 thru I-7	4
* I-8 blank	4
FO-1	2
FO-2 blank	2
FO-2A	2
FO-2B blank	2
FO-3	2
FO-4 blank	2
FO-5	2

*) The asterisk indicates pages changed, renewed, added, or deleted by the current change.

LIST OF EFFECTIVE PAGES (CONTINUED)

Page	Issue	Page	Issue	Page	Issue
FO-6 blank	2				
FO-7	1				
FO-8 blank	1				
FO-9	0				
FO-10 blank	0				
FO-11	2				
FO-12 blank	2				
FO-13	0				
FO-14 blank	0				
FO-15	0				
FO-16 blank	0				
FO-17	2				
FO-18 blank	2				
FO-19	2				
FO-20 blank	2				
FO-21	2				
FO-22 blank	2				
FO-23	2				
FO-24 blank	2				
FO-25	0				
FO-26 blank	0				
FO-27	2				
FO-28 blank	2				
FO-29	0				
FO-30 blank	0				
FO-31	2				
FO-32 blank	2				
FO-33	1				
FO-34 blank	1				
FO-35	1				
FO-36 blank	1				
FO-37	2				
FO-38 blank	2				

*) The asterisk indicates pages changed, renewed, added, or deleted by the current change.

INFORMATION SUMMARY

- List of Safety and Operational Supplements -

1. List of incorporated supplements

With Change 4 the following supplements are considered incorporated into the manual:

Type and No. of Supplement	Date	Short Title	Affected Page(s)
GAF T.O. 1F-MIG29-1S-35	6 Mar 01	Changes to Limitations	1-62, 1-119B, 1-120, 3-19, 3-20, 5-5, 5-6, 5-9, 5-10, 5-12, 5-13, 6-5, 6-6
GAF T.O. 1F-MIG29-1S-36	3 May 01	Minimum Equipment List	5-14
GAF T.O. 1F-MIG29-1S-37	19 Jul 01	Taxi Checks	2-12, 2-13

2. List of supplements not incorporated

The following table lists supplements which atill have to be observed.
This table is to be updated by the holder.

Type and No. of Supplement	Date	Short Title	Affected Page(s)
GAF T.O. 1F-MIG29-1S-27	12 Apr 99	GPS / TSPI-POD	FSIntOS
GAF T.O. 1F-MIG29-1S-30	1 Sep 99	ICAO II and GPS	

TABLE OF CONTENTS

SECTION 1
DESCRIPTION AND OPERATION 1-1

SECTION 2
NORMAL PROCEDURES 2-1

SECTION 3
EMERGENCY PROCEDURES 3-1

SECTION 4
CREW DUTIES 4-1

SECTION 5
OPERATING LIMITATIONS 5-1

SECTION 6
FLIGHT CHARACTERISTICS 6-1

SECTION 7
ALL WEATHER OPERATION 7-1

APPENDIX A
PERFORMANCE DATA A-1

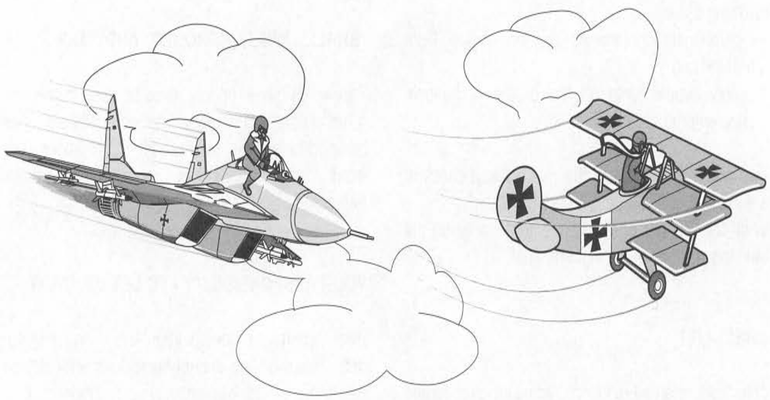
APPENDIX B
COCKPIT MARKING REFERENCE LIST B-1

INDEX
ALPHABETICAL INDEX I-1

FOLDOUT PAGES

FOREWORD

Шек сикс фор МЙГс



SCOPE

This manual contains the necessary information for safe and efficient operation of the MiG-29 aircraft. These instructions provide you with a general knowledge of the aircraft and its characteristics and specific normal and emergency operating procedures. Your experience is recognized; therefore, basic flight principles are avoided. Instructions in this manual are for a crew inexperienced in the operation of this aircraft. This manual provides the best possible operating instructions under most circumstances. Multiple emergencies, adverse weather, terrain etc. may require modification of the procedures.

PERMISSIBLE OPERATION

The flight manual takes a "positive approach" and normally states only 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.

HOW TO BE ASSURED OF HAVING LATEST DATA

Refer to GAF T.O. 0-1-1A for a listing of all current flight manuals, safety supplements, operational supplements, and checklists. Also, check the flight manual cover page, the title block of each safety and operational supplement, and all status pages contained in the flight manual or attached to formal safety and operational supplements. Clear up all discrepancies before flight. For the latest data refer to the INDEX GAF T.O. 0-1-1A, which is issued every three month and the status page of the latest supplement. If you have any questions about the date of issue, check with your supply personel.

SAFETY SUPPLEMENTS

Information involving safety will be promptly forwarded to you in a safety supplement. Urgent information is published in interim safety supplements. The supplement title block and status page should be checked to determine the supplement's effect on the manual and other outstanding supplements.

OPERATIONAL SUPPLEMENTS

Information involving changes will be forwarded to you by operational supplements. The procedure for handling operational supplements is the same as for safety supplements.

HOW TO HANDLE THE SUPPLEMENTS

The supplements have to be inserted in the following order:

- Operational supplements on top of the flight manual and
- Safety supplements on top of the operational supplements.

Pen and ink changes in the manual and checklist are not authorized unless otherwise stated.
Write the number of the supplement alongside the effected portions of the flight manual.

CHECKLIST

The flight manual contains itemized procedures with necessary amplifications. The checklist contains itemized procedures without the amplification. Primary line items in the flight manual and checklist are identical. If a formal safety or operational supplement affects your checklist, the affected checklist page will be replaced by an interim change.

CHANGE SYMBOLS

The change symbol is a black line in the outer margin of the affected paragraph. It indicates text and tabular illustrations changes made to the current issue. Changes to illustrations (except tabular and plotted illustrations) are indicated by a pointing hand. Changes to the list of effective pages are indicated by an asterisk.

▌ ☛ *

WARNINGS, CAUTIONS AND NOTES

WARNING	Operating procedures, techniques, etc., which could result in personal injury or loss of life if not carefully followed.
CAUTION	Operating procedures, techniques, etc., which could result in damage to equipment if not carefully followed.
NOTE	Operating procedure, techniques, etc., which are considered essential to emphasize.

"SHALL", "WILL", "SHOULD" AND "MAY"

The words "shall" or "will" shall be used to express a mandatory requirement. The word "should" shall be used to express non-mandatory provisions. The word "may" shall be used to express permissiveness.

<u>YOUR</u> RESPONSIBILITY - TO LET US KNOW

Every effort is made to keep this manual up-to-date. However, we cannot correct an error unless we know of its existence. In this regard, it is essential that you do your part. For any questions and information use the following address:

LwMatKdo III A
Postfach 90 61 10 / 503
51127 Köln

DEFICIENCY REPORT AND PROPOSALS FOR CORRECTION OR IMPROVEMENT

Discrepancies and proposals for correction or improvement concerning this manual shall be reported to LwMatKdo I C 1 using AFTO Form 22, Publication Deficiency Report in three copies.

NOTE

Discrepancies in publications which endanger personnel or jeopardize Flight Safety have to be reported immediately by telex to LwMatKdo I C and to LwMatKdo III A.

LIST OF ABBREVIATIONS

A

A/A	Air to Air
A/C	Aircraft
A/D	Aerodrome
AB	Afterburner
AC	Alternating Current, Aircraft Commander
ACCRY	Accessory
ACFT	Aircraft
ACN	Aircraft Classification Number
ACS	Armament Control Switch
ADC	Air Data Computer
ADF	Automatic Direction Finding
ADI	Attitude Director Indicator
AFCS	Automatic Flight Control System
AGL	Above Ground Level
Ah	Ampere-Hours
AIL	Aileron
AIS	Aircraft Instrumentation Subsystem
ALT	Altitude
AJ	Active Jammer
Aj1, Aj2	Nozzle Area
AM	Amplitude Modulation
ANT	Antenna
AOA	Angel of Attack
AOB	Angle of Bank
AP	Autopilot
APS	Auxiliary Power System
APU	Auxiliary Power Unit
ASAP	As Soon As Possible
ATC	Air Trafic Control
ATT	Attitude
AUTO	Automatic

B

BAT	Battery
BIT	Built-In Test
BITE	Built-In Test Equipment
BRG	Bearing
BS	Boresight

C

C	Celsius
CAJ	Compensation Active Jammer
CAS	Calibrated Airspeed
CC	Close Combat
CCW	Counter Clockwise
CDP	Compressor Discharge Pressure
CG	Center of Gravity
CHAN	Channel
CIT	Compressed Intake Temperature
CL	Center Line
CMBT	Combat
CMPTR	Computer
COC	AOA Limiter System
COMP	Compass
CPI	Combined Pressure Indicator
CRIT	Critical
CRT	Cathode Ray Tube
CW	Clockwise

D

DASS	Defensive Aids Subsystem
DC	Direct Current
DI	Drag Index
DIM	Dimmer
DISCON	Disconnect
DLU	Acceleration Sensor
DME	Distance Measurement Equipment
DUSU	Angular Rate Sensor

E

E	East
EAS	Equivalent Airspeed
ECM	Electronic Counter Measures
ECP	Engine Control Pump
ECU	Engine Control Unit
EGT	Exhaust Gas Temperature
EMER	Emergency
EMERG	Emergency
ENG	Engine
ENG GBX	Engine Gearbox
EPM	Electronic Protection Measures
EXT	External, Extinguisher
ext	Extension

F

F/C	Front Cockpit
FAF	Final Approach Fix
FCS	Fire Control System
FDR	Flight Data Recorder
FHS	Front Hemisphere
FM	Frequency Modulation
FT, ft	Feet
FO	Foldout
FOD	Foreign Object Damage
FSP	Failure Simulation Panel

G

G	German
g	(Unit of) Gravity
GAF	German Air Force
GCA	Ground Controlled Approach
GEN	Generator
GENER	Generator
GBX	Accessory Gearbox
GND	Ground
GT	German Trainer

H

HDD	Head Down Display
HDG	Heading
HF	High Frequency
HMS	Helmet-Mounted Sight
HP	High-Pressure
HSI	Horizontal Situation Indicator
HUD	Head Up Display
HYD	Hydraulic
Hz	Hertz (Cycles per second)

I

I/C	Intercom
I/P	Identification of Position
IAS	Indicated Airspeed
ICAO	International Civil Aviation Organization
IFF	Identification Friend or Foe
IFR	Instrument Flight Rules
IGV	Inlet Guide Vane
ILS	Instrument Landing System
ILLUM	Illumination
IMC	Instrument Meteorological Conditions
IN	Inertial Navigation
in	Inch
INBD	Inboard
IP	Instructor Pilot
IR	Infrared
IRSTS	Infrared Search and Track System

J

JETT	Jettison

K

KG, kg	Kilogram
kHz	Kilohertz
KIAS	Knots Indicated Airspeed
KM, Km	Kilometer
KTAS	Knots True Airspeed
KTS, kts	Knots
kPa	Kilopascal
kp	Kilopond
kVA	Kilovolt-Ampere
kW	Kilowatt

L

L	Litre
LCN	Load Classification Number
LDR	Light Dependent Resistor
LG	Landing Gear
LDG, ldg	Landing
LED	Light Emitting Diode
LEF	Leading Edge Flaps
LH	Left Hand
LP	Low-Pressure
LPM	Limited Power Mode
LRF	Laser Range Finder

M

M	Mach
m, mtr	Meter
MAC	Mean Aerodynamic Cord
Mag	Magnetic
MAN	Manuell
MAX, max	Maximum
MDA	Minimum Descent Altitude
MHz	Megahertz
MIC	Microphone
MID	Middle
MIN, min	Minimum
min	Minutes
MIL	Military
MLG	Main Landing Gear
MPa	Megapascal
MRK	Marker
MSL	Mean Sea Level, Missile

N

N	North
NA	Not applicable
NAV	Navigation
NAVIG	Navigation
NDB	Non Directional Beacon
NE	Not established
NH	High-Pressure Compressor Speed
NL	Low-Pressure Compressor Speed
NLG	Nose Landing Gear
NM	Nautical Miles
NORM	Normal
NPM	Normal Power Mode
NWS	Nose Wheel Steering

O

OAT	Outside Air Temperature
OPT	Optical, Optimum
OUTBD	Outboard

P

Pa	Pascal
PAR	Precisson Approach Radar
PCN	Pavement Classification Number
PEC	Personal Equipment Connector
PH	Phase
PIO	Pilot Induced Oscillation
Pos	Position
PTO	DC/AC Converter
PTT	Press to Transmit
PWR, pwr	Power

Q

QFE	Barometric Pressure at Airfield Level
QNH	Barometric Pressure at Sea Level

R

R/C	Rear Cockpit
RCVR	Receiver
RDR	Radar
REC	Receive
RH	Right Hand
RHAW	Radar Homing and Warning
RHS	Rear Hemisphere
RNG	Range
RPM	Revolutions per Minute
RUD	Rudder
RWY, rwy	Runway

S

S	South
SAS	Stability Augmentation System
sec	Seconds
SIF	Selective Identification Feature
SL	Sea Level
SP	Simulation Panel
SPO	RHAW Receiver
SQLCH	Squelch
STBY	Standby
sw	Switch
SWL	Single Wheel Load
SYS	System

T

T/O	Takeoff
T/R	Transmit/Receive
TAC	Tactical
TACAN, TCN	Tactical Air Navigation
TAS	True Airspeed
Temp	Temperature
TGT	Target
TLP	Telelight Panel
TO/LD	Takeoff/Landing
TR	Transmit
TFU	Trim Feel Unit
TURB	Turbine
TWF	Track-While-Scan Feature

U

UHF	Ultra High Frequency

V

V	Volt
VENT	Ventilation
VFR	Visual Flight Rules
VHF	Very High Frequency
VIBR	Vibration
VIWAS	Voice Information and Warning System
VMC	Visual Meteorological Condition
VOL	Volume
VSI	Vertical Speed Indicator
VVI	Vertical Velocity Indicator

W

W	West
WCS	Weapon Control System
WDT	Wing Drop Tank
WP	Way Point

X, Y, Z

SECTION 1

DESCRIPTION AND OPERATION

TABLE OF CONTENTS

	Page
The Aircraft	1-3
Engines	1-5
Bleed Air System	1-6
Engine Oil System	1-6
Engine Fuel System	1-8
Engine Control System	1-8
Engine Anti-Surge System	1-17
Engine Starting System	1-28
Throttles	1-30
Engine Fire Detection System	1-33
Engine Operation	1-36
Auxiliary Power System	1-37
Aircraft Fuel System	1-40
Electrical Power Supply System	1-47
Hydraulic Power Supply System	1-50
Pneumatic Power Supply System	1-52
Landing Gear System	1-54
Brake System	1-57
Drag Chute System	1-59
Wing Flap System	1-59
Speedbrake System	1-61
Flight Controls	1-61
AOA / G Control System	1-67
Automatic Flight Control System	1-68
Pitot Static System	1-73
Air Data Computer	1-75
Instruments	1-76
HUD / HDD	1-82
Canopy	1-84
Ejection Seat System	1-86
Air Conditioning and Pressurization System	1-90A
Lighting System	1-93
Oxygen System	1-95
Communication and Avionic Equipment	1-97
Recorders	1-101
Navigation System	1-103

Page

Armament System 1-118
Defensive Aids Subsystem 1-118
External Stores 1-118
Warning and Information Equipment 1-118
Servicing Diagram 1-123

THE AIRCRAFT

The MiG-29 flown in the single-seat and double-seat (tandem) trainer version is a light-weight, high-performance, all-weather fighter interceptor, designed by the Mikojan company, with look-down / shoot-down and ground-attack capability.

Mission capability includes air defense with radar and infrared guided missiles and a 30 mm gun.

The aircraft is equipped with two Tumansky RD-33 dual-shaft, axial-flow turbofan engines with variable air intake ducts and variable exhaust nozzle sections.

Two air intakes are installed in nacelles below the wing roots. For foreign object damage (FOD) prevention, the air intakes are closed after landing and generally on the ground. With the intake ramps closed, engine air is taken in through a series of louvers in the upper surface of the wing root.

Each engine drives an associated engine gearbox (ENG GBX). Both ENG GBX are interconnected to the aircraft accessory gearbox (GBX). For engine start, an auxiliary power unit (APU) provides torque to the GBX which drives all accessories.

Normally, the thrust-to-weight ratio is greater than 1 (depending on the aircraft load and configuration). It enables high velocities, high rates of acceleration and high turn rates.

The aircraft shape is characterized by an integrated fuselage-to-wing design which forms an overall airfoil.

The almost flat bottom of the fuselage is an integrated part of the lower surface of the airfoil.

The aircraft structure comprises cantilever low-wing monoplane wings with leading edge flaps (LEF), trailing edge slotted flaps and ailerons. The tail of the cantilever structure includes two vertical stabilizers with small inset rudders and two tailerons. Dual irreversible hydraulic actuators position the control surfaces.

Electrical power is provided by an AC and a DC generator driven by a gearbox. Two batteries supply emergency power.

The fuel supply system incorporates internal fuselage and wing tanks, single point refueling and a fuel tank vent system. An external centerline tank (CL tank) and two wing drop tanks (WDT) can be installed.

The hydraulic power supply system provides pressure to the hydraulic actuators. Two separate and independent systems supply hydraulic pressure to the main and to the boost system. An emergency pump supplies pressure in the event of a main pump malfunction.

The pneumatic pressure supply consists of a main and an emergency system to control and pressurize aircraft systems.

The landing gear is hydraulically operated. It includes pneumatically powered brakes, anti-skid for all wheels and nose wheel steering.

A drag chute contained in the aft section of the fuselage significantly reduces landing roll distance.

A rocket-assisted ejection seat is designed to provide safe escape under minimum speed / zero altitude conditions. It is fully automatic throughout the ejection sequence.

The oxygen system is divided into a main and an emergency system. The main system supplies oxygen to the pilot during normal flight conditions and supports APU start and engine relight.

An emergency oxygen bottle is installed in the ejection seat to provide the pilot with emergency oxygen.

The pitot system includes a main and an emergency pitot boom. To prevent icing, both booms are electrically heated.

An angle of attack (AOA) limiter system and an automatic flight control system (AFCS) with automatic pitch control is incorporated.

The weapon delivery system comprises fire control, missile launchers and 30 mm gun.

The fire control system includes the pulse Doppler radar, an infrared search and track system (IRSTS) and a weapon computer.

Two digital computers process armament control data to provide displays of navigation, steering information and weapon aiming data to the head up display (HUD) and head down display (HDD).

A helmet mounted sight (HMS) system can be used to designate visually acquired targets to the radar, the infrared search and track system and to the infrared (IR) seekers of the missiles.

Target range information is provided by an integrated laser range finder (LRF) in conjunction with IRSTS operation.

Navigation equipment such as tactical air navigation (TACAN) is incorporated.

The aircraft has electronic protection measures (EPM) capabilities and a radar homing and warning receiver (RHAW).

A flare dispenser system is installed for protection against IR missiles.

Information and warning equipment is installed to attract the pilot's attention to failures in aircraft systems by audio and visual means i.e. telelight panel (TLP), voice information and warning system (VIWAS) and AEKRAN.

Flight data are continuously recorded for further processing after the mission.

A HUD camera is installed to record display and visual target information.

MIG-29 GT Trainer Version

The tandem-seat trainer version has a continuous framed canopy.

The GT has no radar but is capable of employing IR missiles and the 30 mm gun.

A radar simulation control panel is installed in the rear cockpit to display simulated targets into the HUD and the HDD. The emergency simulation control panels are deactivated.

For safe ground operation, a periscope system enables the rear occupant to have visual contact with the area in front of the aircraft.

AIRCRAFT GROSS WEIGHT

The approx. average gross weights are as follows:

	G	GT
Operating weight	11 001 kg	10 856 kg
Operating weight plus full internal fuel load	14 454 kg	14 409 kg
Operating weight plus full internal fuel load and full external centerline tank	15 775 kg	15 730 kg

AFTER MODIFICATION WITH WING DROP TANKS

Operating weight plus full internal fuel load, full centerline tank and two full wing drop tanks	17 906 kg	

NOTE

The operating weight includes the crew member (for GT two crew members) unusable fuel, oil and the gun without ammunition.

For detailed information, refer to GAF T.O. 1F-MIG29-5.

AIRCRAFT DIMENSIONS MIG-29 G

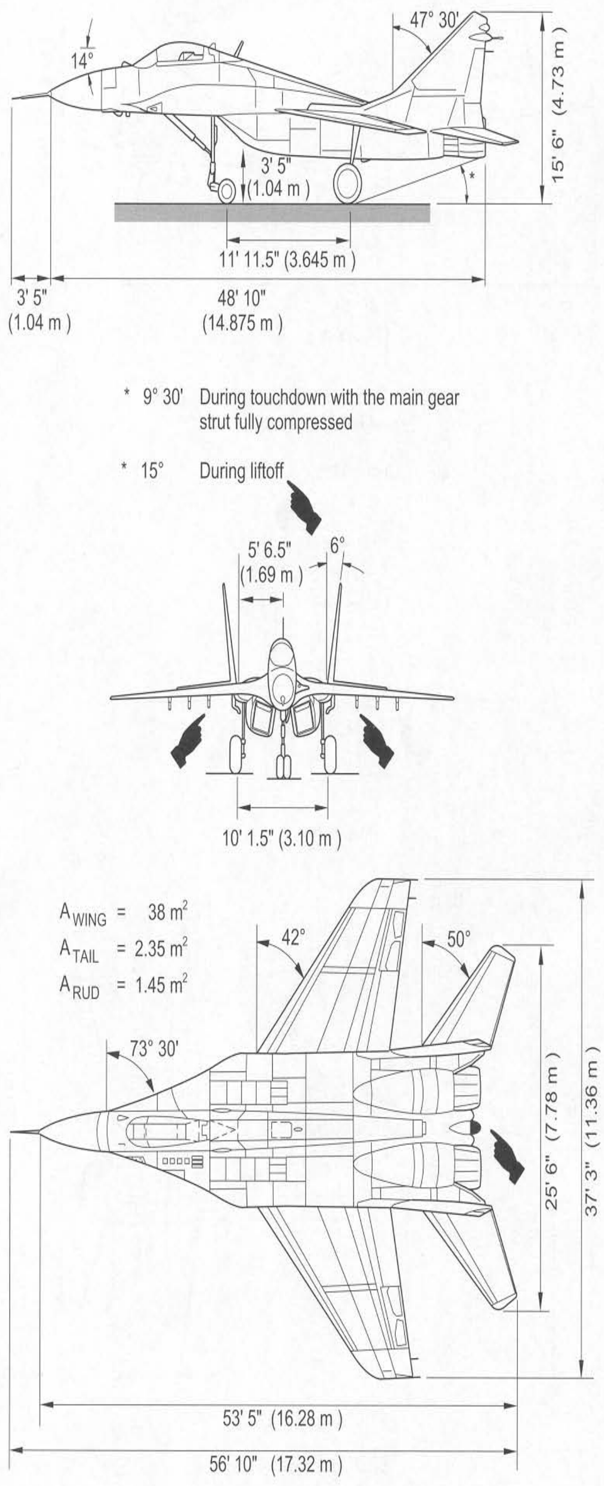


Figure 1-0

AIRCRAFT DIMENSIONS MIG-29 GT

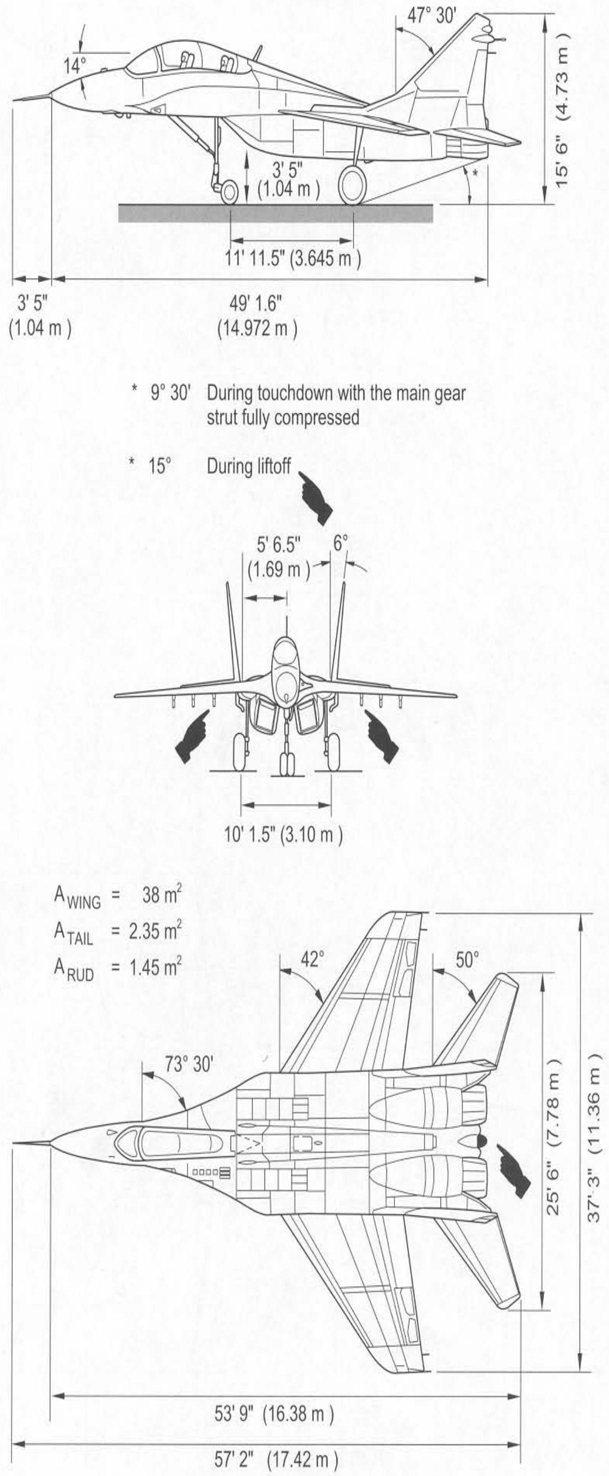


Figure 1-0A

ENGINES

The aircraft is powered by two Tumansky RD-33 thirteen-compressor-stage, dual-shaft, axial-flow turbofan engines. They are equipped with ring combustion chambers and afterburners, variable air intake systems and variable exhaust nozzles. Refer to figure FO 1-5.

For standard day / sea level conditions, the approximate static thrust ratings are as follows:

- NPM = Normal Power Mode
- LPM = Limited Power Mode

G / GT	NPM	LPM
Maximum AB thrust	8 300 kp	7 520 kp
Minimum AB thrust	5 600 kp	5 280 kp
MILITARY thrust	5 040 kp	4 680 kp
IDLE thrust	180 kp	180 kp

The two engines are mounted side by side in the aft section of the fuselage.

An APU gas turbine engine started by an electric motor is used to crank the engines for starting. Either the batteries or an external electrical power source can be used to provide electrical power during engine start.

The engines are supplied with separate intakes located below the wing roots. On the ground, air is provided through louvers in the upper surface of the wing roots since the variable ramps of the intakes are closed to prevent FOD.

In flight, engine air flow is controlled by variable ramps and variable stator vanes of the first two stages of the high-pressure (HP) compressor. It allows optimum engine performance over a wide range of aircraft operating conditions.

Engine air is routed through the four stages of the low-pressure (LP) compressor. After the LP compressor the airflow is divided into two streams, a hot main stream and a cold bypass flow.

The bypass air flows through an annular duct surrounding the HP compressor, the combustion chamber and the turbine section to rejoin the main flow in the air mixer of the afterburner (AB) section. The main stream flows through the nine stages of the HP compressor to the annular combustion chamber, where a controlled quantity of fuel is injected and ignited during start by ignitor plugs.

The hot high-pressure gas from the combustion chamber expands through the turbine section and mixes with the cold bypass stream for further expansion.

The turbine section of the engine consists of two single-stage turbines driving the HP compressor and the LP compressor. The two rotor shafts are mechanically independent of each other.

Engine speeds are indicated by a tachometer showing the HP compressor speed of both engines as a percentage of nominal maximum RPM.

During AB operation, additional fuel is injected into the hot gas stream by AB spray bars located in the AB chamber behind the turbine section, producing a substantial gain in thrust.

The exhaust nozzle area is fully variable and automatically controlled to obtain the desired thrust within engine operating limits.

The engine control unit (ECU) controls the hydro-mechanical equipment of the engine control system and supplies discrete fail signals to the warning equipment.

The engine system is described in the following paragraphs:

- Bleed air system
- Engine oil system
- Engine fuel system
- Engine control system
- Engine anti-surge system
- AB fuel system
- Exhaust nozzle system
- Engine air intake system
- Variable stator system
- Engine ignition system
- Engine starting system
- Engine AB system
- Throttles
- Engine controls and indicators
- Engine fire detection system
- Engine fire extinguisher system
- Engine operation

BLEED AIR SYSTEM

Engine compressor bleed air taken from the LP and HP compressors (refer to figure FO-5) at three locations is utilized for the following functions:

LP compressor:

- Fuel accumulator tank pressurization.
- External tank pressurization and fuel transfer.
- Internal tank pressurization.

HP compressor 5th stage:

- HP and LP turbine rotor and stator cooling.

HP compressor 7th stage:

- Air-conditioning and pressurization system.
- Anti-ice system of the LP compressor intake.

ENGINE OIL SYSTEM

Each engine is equipped with a self-contained, dry-sump full pressure oil system to provide circulation of oil for lubrication and cooling of the engine main bearings and of the ENG GBX. Venting of the bearings and of the oil tank is provided to prevent excessive pressure build-up. Refer to figure FO-4.

Oil is drawn from the oil supply tank by a main lube pump and delivered through a pressure filter to the accumulator and the oil pressure sensor. Tappings are provided to feed the three main engine bearings and the ENG GBX.

Oil from the engine main bearings is returned by scavenge pumps to the oil tank via two separate fuel-cooled oil coolers (engine and AB fuel systems) to cool the engine oil. Filters are fitted in the oil return lines in front of the scavenge pumps.

A magnetic chip detector to provide an indication of engine wear and warning of engine components breakdown and an oil temperature sensor are provided downstream in the return line. Two suction pumps draw return oil from the ENG GBX and feed it to the output side of the main lube pump.

When the engine is shut down, oil from the forward main bearing is drained to a separate return tank which is connected to a scavenge pump.

The three engine bearing chambers, the oil tank and the oil-air separator are vented to the ENG GBX which in turn is vented overboard via a centrifugal breather.

For negative g flights a pendulum-like suction pipe inside the oil supply tank ensures oil supply to the main lube pump.

INDICATIONS AND WARNINGS

The equivalent information will be recorded by the flight data recorder.

Engine Oil Temperature

Engine oil temperature is sensed by a temperature probe in the oil return line. The engine fault detection unit will illuminate a red warning caption on the telelight panel (TLP).

	INDICATION	FAULT / EFFECT
MASTER CAUTION	LIGHT FLASHING	
TLP	OIL PRESS LEFT	Oil temperature above 195° C.
AEKRAN	OIL TEMP LEFT	
VIWAS	"SCHMIERSTOFFTEMPERATUR IM LINKEN TRIEBWERK ZU HOCH" "DREHZAHL VERRINGERN"	

Engine Oil Pressure Low

A pressure sensor in the pressure line illuminates a red warning caption via the engine fault detection unit.

	INDICATION	FAULT/EFFECT
MASTER CAUTION	LIGHT FLASHING	
TLP	OIL PRESS LEFT	Oil pressure LH engine low for more than 20 sec: If the actual pressure falls below 1.8 ±0.18 kp/cm^2 at 50 % to 89 % RPM or below 2.7 ±0.27 kp/cm^2 at RPM > 89 % for more than 20 sec.
AEKRAN	OIL PRESS LEFT	
VIWAS	"SCHMIERSTOFFDRUCK IM LINKEN TRIEBWERK ZU GERING" "DREHZAHL VERRINGERN"	

Engine Chip

Metal chips are sensed by a chip detector in the oil return line. The engine fault detection unit will illuminate a red warning caption on the TLP.

	INDICATION	FAULT/EFFECT
MASTER CAUTION	LIGHT FLASHING	
TLP	OIL PRESS LEFT	The system remains operational for 17 sec when oil pressure is low. It is assumed that abrasion will start after 20 sec.
AEKRAN	CHIP LEFT	
VIWAS	"SPÄNE IM SCHMIERSTOFF DES LINKEN TRIEBWERKS" "DREHZAHL VERRINGERN"	

ENGINE FUEL SYSTEM

The engine fuel system pressurizes, meters, atomizes and injects fuel into the HP compressor discharge airstream, refer to figure FO-5.

The system is controlled by the engine fuel control as a function of various internal operating signals.

The engine fuel system consists of a low pressure and a high pressure system. Fuel is supplied to the low pressure fuel pump of the low pressure system by two fuel booster pumps located inside the engine supply tank. The pressurized fuel passes through a filter and is distributed to the engine control pump (ECP), the AB fuel pump and the nozzle HP pump of the HP system.

The ECP meters the fuel according to throttle position and various engine parameters.

The engine fuel is routed via the drain and cut-off valve, the fuel-cooled oil coolers and the engine fuel flow divider valve to the nozzles of the first and second manifold of the engine combustion chamber, where injection into the airstream occurs.

The ECP supplies fuel to position the actuators of:

- Variable stator vanes of the HP compressor inlet
- AB ignition control
- Automatic engine and AB control equipment.

ENGINE CONTROL SYSTEM

The engine control system is a hydro-mechanical system manually controlled by throttle inputs and operated by an electronic engine control unit (ECU), refer to figure 1-1A.

Main system components of the engine control system include:

- ECU
- ECP
- AB and nozzle control unit
- Engine starter unit.

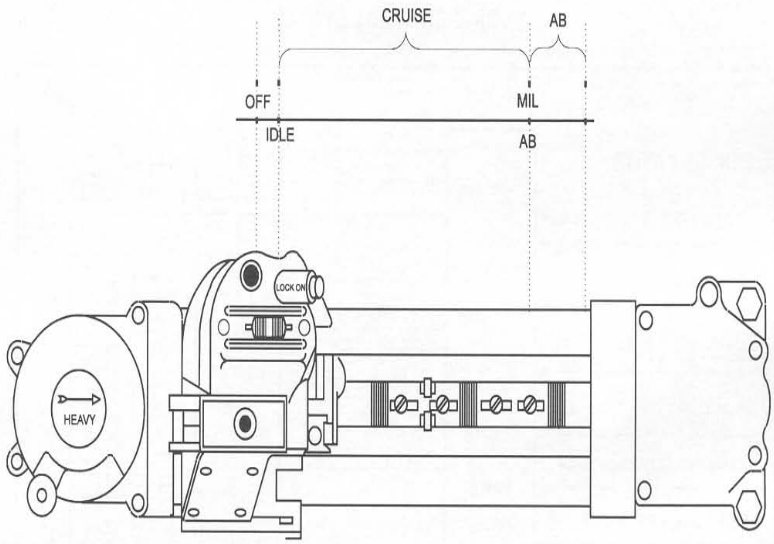
The throttle produces an engine speed demand signal which is routed mechanically to the ECP and to the AB and nozzle control unit. The ECU supplies electrical control signals to solenoids in the ECP, the AB and nozzle control unit and to the engine starter unit in order to modify engine performance within safe operation limits.

The entire performance range of the engine may be divided into four distinct operation regions:

- IDLE
- Cruise
- MIL
- AB

Which system(s) or system components are active to control the engine depend on in which region the throttle is positioned, refer to figure 1-1.

In the column throttle position, the four regions of the engine performance range are listed. In the same row as the throttle position, to the right, the control systems or units are listed which are active for that particular throttle position, while in the columns underneath, the parameters being adjusted or modulated to control the engine.



Throttle position	ECU	ECP	AB and Nozzle Control Unit
IDLE	-	NH	NL
Cruise	NL Correction depending on air mass flow	NH	NL
MIL	NH, NL, T4	-	Nozzle area
AB	T4	-	-

Figure 1-1

In addition to the normal ECS the following functions are provided:

- Automatic engine start sequence on the ground and in flight.
- Control of the variable air intake guide vanes (IGV) of the HP compressor.
- Providing a fuel pressure signal (servo fuel) to control the AB ignition system.
- Supply of servo fuel to the control valve of the engine anti-ice system.
- Control of air intake flow during weapon deployment to prevent stall.

ENGINE CONTROL SYSTEM

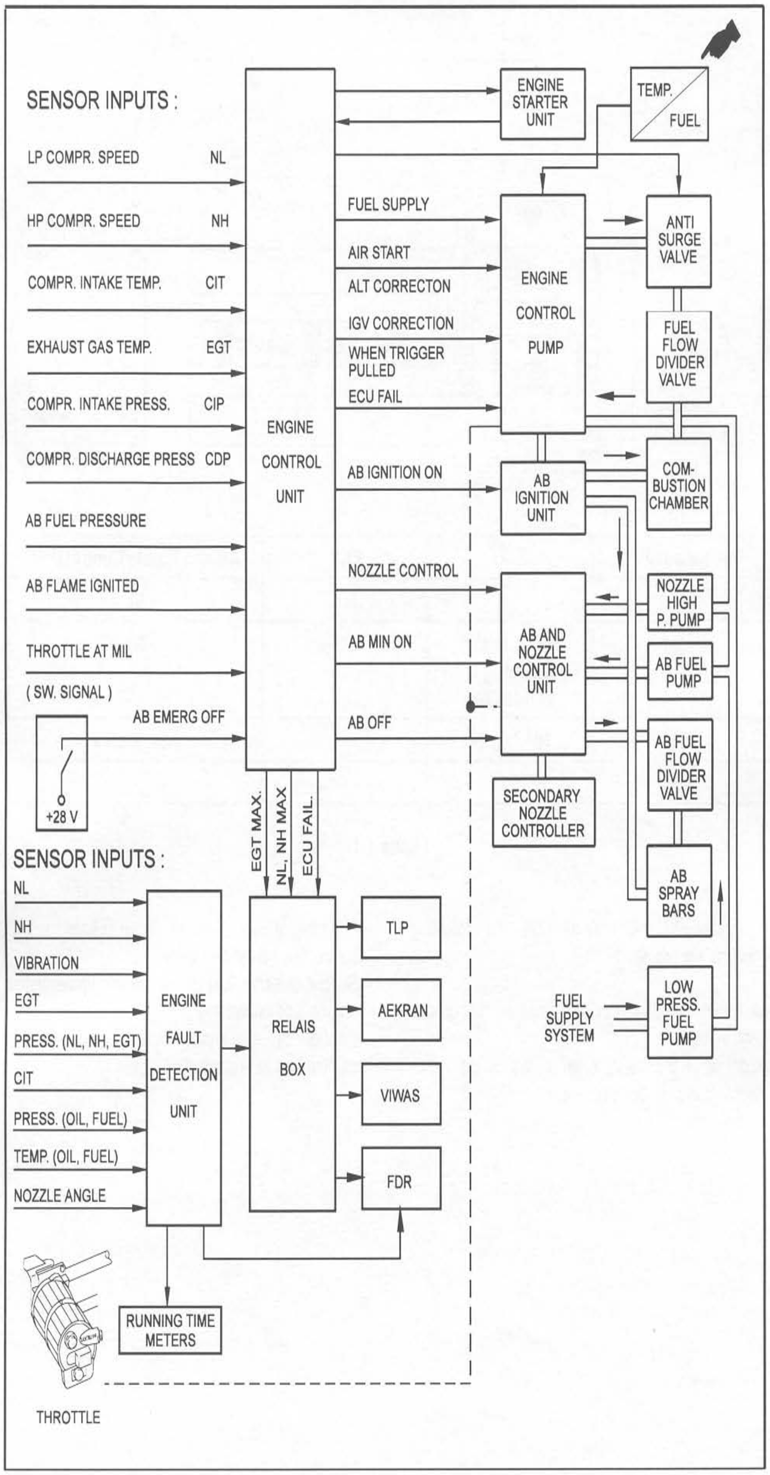


Figure 1-1A

ENGINE CONTROL UNIT

The ECU optimizes the fuel flow for thrust demand, which is controlled by the throttle, by consideration of environmental and engine-specific parameters.

The parallel electronic function lanes of the ECU continuously receive speed signals from the shafts of the HP and LP compressor, LP compressor inlet temperature (CIT), LP turbine outlet and exhaust gas temperature (EGT). They also receive signals from CIT and from the exhaust nozzle outlet by sensors in the engine.

The speed of the high-pressure compressor is abbreviated NH and the speed of the low-pressure compressor as NL. NH is indicated on the engine RPM indicator.

The ECU compares these parameters against preset guiding schedules and limit values and responds with electrical control signals to solenoids in control units of the engine fuel, AB, IGV, exhaust nozzle and air intake.

The ECU, together with the hydro-mechanical control devices provides at

Engine start:

- Control of start sequence as a function of throttle setting, engine fuel pressure, and of air pressure ratio between compressor discharge and ambient air.

Engine run-up to IDLE:

- Limiting of EGT as a function of CIT

Cruising operation:

- Limiting of NL as functions of CIT and throttle setting.

- Maintaining the relation between NH and NL by modulation of the primary exhaust nozzle area.

MIL power and AB operation:

- Limiting of NH and EGT as a function of CIT by modulation of engine fuel flow.
- Scheduling of NL as a function of CIT by modulation of the primary exhaust nozzle area.
- Limiting of NL as a function of CIT by modulation of engine fuel pressure.

AB selection:

- Control of the AB ignition logic.

Engine operation boundaries:

- Protection against compressor surge.

FUNCTION OF THE ENGINE CONTROL UNIT (ECU)
NORMAL POWER MODE

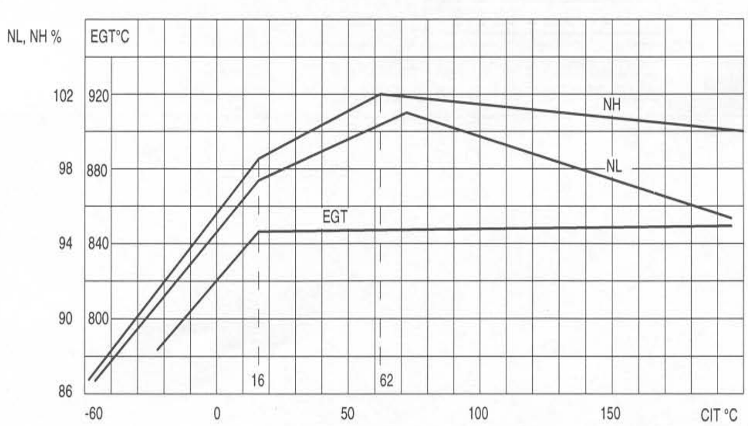


Figure 1-2

FUNCTION OF THE ENGINE CONTROL UNIT (ECU)
(LIMITED POWER MODE)

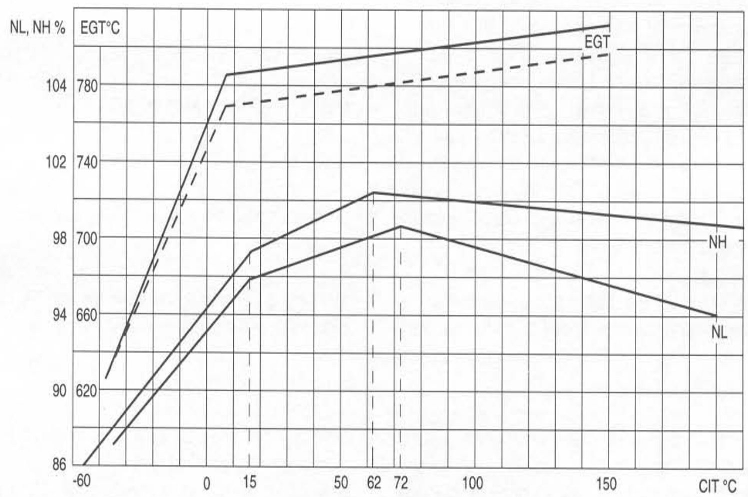


Figure 1-3

INDICATIONS AND WARNINGS

Built-In Test Equipment

The Built-In Test Equipment (BITE) of the ECU provides self-test of limitation lanes and selects a reversionary lane in case of failure. This reversionary lane controls the NH speed controller to reduce the scheduled NH by 6 % to 7 % and issues information to the warning equipment which responds as follows:

	INDICATION	FAULT/EFFECT
AEKRAN	LEFT ENG STBY SYS	Automatic reduction of the scheduled NH by 6 % to 7 %.
VIWAS	"LINKES TRIEBWERK IM RESERVEREGIME" "BEACHTE TEMPERATUR UND DREHZAHL"	

NH SPEED CONTROLLER

The NH speed controller, as part of the engine control pump, adjusts the HP compressor RPM as a function of the throttle position and CIT.

The controller consists of a centrifugal governor which is driven at a speed which is a function of NH and controlled by throttle angle via a mechanical linkage. The set position is continuously modified by a hydraulic actuator which receives a fuel pressure signal representing CIT.

The output actuator of the NH speed controller represents corrected RPM demand and operates the fuel metering valve to set up the required engine fuel flow. At a selected throttle setting, the engine thrust remains constant, regardless of aircraft speed or altitude, except when overridden by any limiters.

The engine maximum speed is controlled by the scheduled limits of the engine control unit which receives actual NH from a pulse probe. The electrical signal is converted to a positioning signal for an electrical pressure control solenoid which modifies the fuel flow.

To avoid conflicts between the corrected RPM demand signal and the limit signal during maximum engine speed, the ECU generates an offset speed signal to set the corrected RPM signal about 3 % above the limit signal.

FUNCTION OF THE NH SPEED CONTROLLER

(NORMAL POWER MODE)

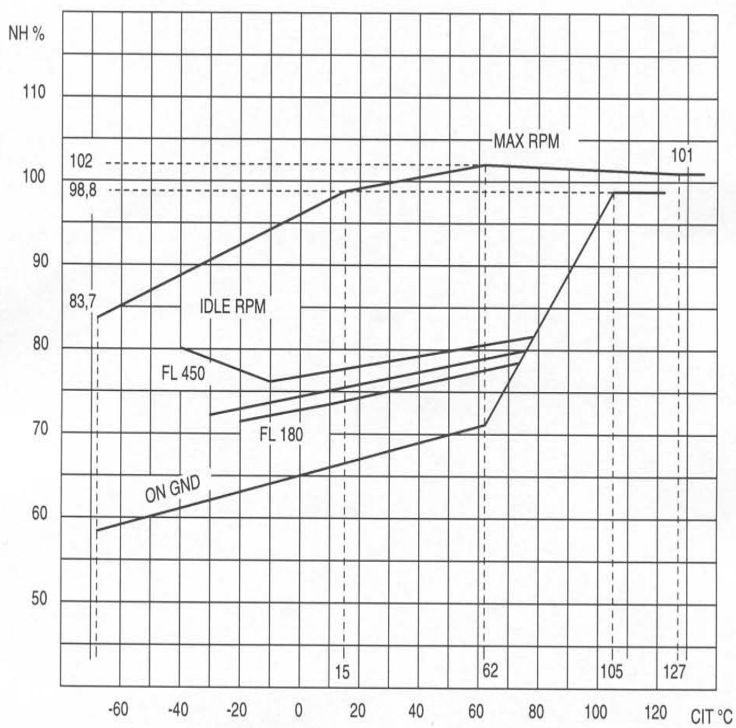


Figure 1-4

FUNCTION OF THE NH SPEED CONTROLLER
(LIMITED POWER MODE)

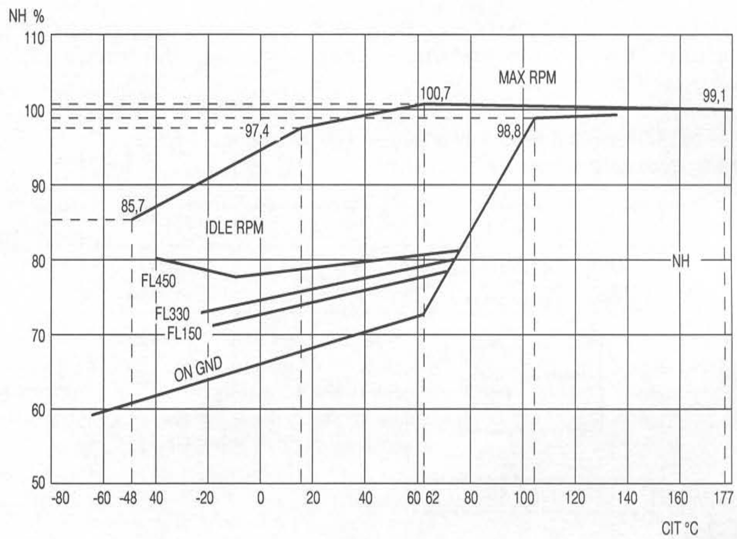


Figure 1-5

INDICATIONS AND WARNINGS

NH Overspeed

Should the ECU detect an NH overspeed by the input from the NH pulse probe, then it assumes a failure of the NH speed controller.

When the throttle setting is reduced, the primary exhaust nozzle controller reduces the primary nozzle area. As a result, the compressor discharge pressure increases and NL, is reduced as well.

The equivalent information will be recorded by the flight data recorder.

	INDICATION	FAULT/EFFECT
MASTER CAUTION	LIGHT FLASHING	
TLP	REDUCE RPM LH ENG	When NH increases by more than 2 % above the scheduled value the ECU issues signals to the warning system after a time delay of 2 sec. The same warnings are initiated by the engine fault detection unit if NH accelerates to 103.5 % RPM within 2 to 3 sec.
AEKRAN	LEFT OVER SPEED	
VIWAS	"DREHZAHL LINKES TRIEBWERK ZU HOCH" "DREHZAHL VERRINGERN"	

STEADY STATE CONTROL

At IDLE and cruise steady state operation, NH is controlled only by the corrected RPM function of the NH speed controller and by primary nozzle modulation for NL guidance. RPM fluctuations of compressor speed are kept within ± 1.5 % RPM at IDLE and ± 1.2 % RPM at cruise speeds.

At MIL and AB steady state operation, maximum engine speed is controlled by the schedules of the ECU, the corrected RPM function of the NH speed controller and the AB nozzle control unit for thrust and NL guidance. RPM fluctuations of compressor speed are kept within ± 0.6 %.

TRANSIENTS CONTROL

Engine acceleration and deceleration between IDLE and MIL power is accomplished by repositioning of the NH speed controller by throttle setting.

The ECU receives values of compressor intake pressure and compressor discharge pressure and controls air flow through the compressor by regulating the necessary fuel. The correct fuel-to-air ratio is monitored by the ECU to ensure combustion.

The air flow is also controlled by air inlet ramps and two-stage inlet guide vanes of the HP compressor on demand of the ECU.

NL SPEED CONTROL

The LP compressor provides an air flow to the HP compressor and a secondary airstream to cool the hot section of the engine.
Further, the LP compressor provides a high increase of thrust due to increase of air flow by mixing the cold secondary air with the hot gases from the turbine section.

The gas pressure in the air mixer must be kept lower than the turbine exhaust pressure to ensure laminar gas flow through the two turbine sections to prevent turbine stall.

When the pressure in the gas mixer decreases and the difference of pressure across the turbines increases, the turbines can extract more energy from the mass flow and NH and NL will increase. The ECU will control the increase of NH by reducing the engine fuel flow, whereas the increase of NL is controlled by increasing the mixer pressure, thus decreasing the pressure difference across the turbine section.

The mixer pressure is controlled by modulation of the primary exhaust nozzle area. The relation of NL to NH is scheduled and limited by the engine control unit by affecting the nozzle jet area at cruising, MIL and AB power. Both parameters NL and NH are corrected for CIT.

INDICATIONS AND WARNINGS

NL Overspeed

To prevent NL overspeed when the primary exhaust nozzle controller fails, a NL maximum speed limiter lane within the ECU is incorporated. This lane prevents an increase of NL of more than 2 % RPM above the scheduled value by reduction of the engine fuel flow, i.e. affecting the NH speed control setting.

The equivalent information will be recorded by the flight data recorder.

	INDICATION	FAULT/EFFECT
MASTER CAUTION	LIGHT FLASHING	
TLP	REDUCE RPM LH ENG	When NL overspeeds by 2 % RPM, the ECU issues signals to the warning system after a time delay of 2 sec. The same warnings are triggered by the engine fault detection unit if the NL accelerates to 103.5 % RPM within 2 to 3 sec.
AEKRAN	LEFT OVER SPEED	
VIWAS	"DREHZAHL LINKES TRIEBWERK ZU HOCH" "DREHZAHL VERRINGERN"	

ENGINE FAULT DETECTION UNIT

The engine fault detection unit compares actual engine parameters to preset schedules and generates discrete signals for the warning system if parameters exceed the limits.

In addition, the unit issues a signal to engage the AC electrical power generator and activates the nitrogen system to pressurize the fuel system when NH exceeds 55 % RPM.

The engine fault detection unit is connected to the ENG SYS switch on the system power control panel at the RH console.

INDICATIONS AND WARNINGS

Engine Overtemperature

When the throttle is retarded, NH and compressor discharge pressure are decreased to normal values. The limiter of the ECP is activated to reduce the engine fuel flow. NH and EGT are stabilized.

The equivalent information will be recorded by the flight data recorder.

	INDICATION	FAULT/EFFECT
MASTER CAUTION	LIGHT FLASHING	
TLP	REDUCE RPM LH ENG	When the sensed EGT exceeds the scheduled value by 40° to 60° C for 0.2 sec.
AEKRAN	OVERHEAT LEFT	
VIWAS	"ÜBERHITZUNG LINKES TRIEBWERK" "DREHZAHL VERRINGERN"	

Engine Vibration

In the immediate vicinity of vital engine components, e.g. bearings and gears, vibration sensors are installed which convert mechanical oscillations and vibrations into an electrical signal. The amplitude of this signal is proportional to the magnitude of the vibration.

As soon as the amplitude of the signal exceeds a scheduled value, the engine fault detection unit issues a warning signal to the various warning systems.

	INDICATION	FAULT/EFFECT
MASTER CAUTION	LIGHT FLASHING	
TLP	REDUCE RPM LH ENG	Excessive vibration in left engine. The vibration level exceeds a present limit for NH greater than 35 % RPM.
AEKRAN	VIBR LEFT	
VIWAS	"VIBRATION IM LINKEN TRIEBWERK" "DREHZAHL VERRINGERN"	

Engine Fuel Pressure

	INDICATION	FAULT/EFFECT
MASTER CAUTION	LIGHT FLASHING	
TLP	REDUCE RPM LH ENG	Engine fuel pressure exceeds 7.35 ±0.49 MPa for 2 to 3 sec.
AEKRAN	FUEL PRESSURE LEFT	
VIWAS	"KRAFTSTOFFDRUCK LINKES TRIEBWERK ZU HOCH" "DREHZAHL VERRINGERN"	

ENGINE ANTI-SURGE SYSTEM

The engine anti-surge system is selected with the ANTI SURGE switch on the system power panel. The activated system automatically detects and counteracts engine surge. A sensor detects fluctuations of HP compressor discharge pressure.

When fluctuations occur, the ECU issues control signals. After fluctuations have ceased, the signals will persist for additional 0.5 sec, however they will not exceed a total of 2.4 sec. The control signals are:

- Signal to close the inlet guide vanes (IGV) by 25 degrees.
- Close signal to the drain and shut-off valve to interrupt the engine fuel flow to the combustion chamber for up to 3 sec.
- Close signal to the ECP to close the IGV of the HP compressor.
- Open signal to the NL control lane of the ECU to shift the program schedule for 5 % NL. As a result, the primary nozzle area will open for a corrected value.
- Signal to close the intake ramp for an additional 10 % maximum, limited by the applicable ramp travel schedule. Refer to variable duct ramp system in this section.
- Start signal to the engine starter unit to actuate a preventive engine start cycle for 8 sec. This activates the green caption LH / RH ENG START on the TLP.

If the discharge pressure sensor of the HP compressor fails, the control signals from the ECU are automatically switched off after 2.5 sec.

When the anti-surge lane is activated and an additional fault signal from the engine high temperature lane is present, anti-surge actions are operative for the time of the high temperature condition plus 0.5 sec.

Total time of extended system operation is limited to a maximum of 8 sec. If the high temperature condition persists for more than 2.4 sec, engine fuel flow will be alternately interrupted by the drain and shut-off valve for 2.4 sec and permitted for 1.2 sec.

The engine anti-surge system is deactivated at altitudes below 9 000 ft MSL with airspeeds below M 1.15.

Exception:

If the 30 mm gun or a missile is fired, or if an overheat condition exists, the system is activated and a preventive engine relight cycle is initiated.

INDICATIONS AND WARNINGS

The equivalent information will be recorded by the flight data recorder.

	INDICATION	FAULT / EFFECT
MASTER CAUTION	○ LIGHT FLASHING	
TLP	REDUCE RPM LH ENG	Engine in surge condition and overheat left / right.
AEKRAN	OVERHEAT LEFT	
VIWAS	"ÜBERHITZUNG LINKES TRIEBWERK" "DREHZAHL VERRINGERN"	

AFTERBURNER FUEL SYSTEM

The AB fuel system supplies and regulates fuel flow into the engine tailpipe for AB combustion. The ignited fuel-air mixture increases engine thrust. Refer to figure FO-5.

The AB system consists of an annular casing which contains the air mixing chamber, and a diffusor type of AB combustion chamber. The diffusor ensures reduction of air flow velocity which results in a gain of time for hot and cold air mixing, AB fuel injection and ignition. The injection system consists of flame holders and three spraybars with injection nozzles for radial fuel injection.

The required fuel flow for AB ignition will be controlled by the ECU. It also sets the exhaust nozzle to a position for minimum AB power. Simultaneously the AB ignition unit is activated.

The system ensures ignition in the AB combustion chamber, stable burning at minimum AB thrust, modulation of AB fuel flow at different power settings, AB thrust transients control and AB ignition timing.

AB fuel is controlled by throttle and CIT inputs to the AB and nozzle control unit and is limited to safe operating ranges by the ECU.

AFTERBURNER IGNITION

To initiate AB operation, the throttle must be advanced into AB range. AB ignition is possible at engine speeds of at least 72 % to 76 % RPM.

The fuel from the LP fuel pump of the LP system is supplied to the AB fuel pump.

When the throttle is advanced into AB range, the AB fuel pump increases the fuel pressure and supplies it to the AB and nozzle control unit. The pressurized fuel is applied via the AB fuel-cooled oil cooler to the AB pressurizing valve and to the nozzles of the first of three spraybars. A fuel pressure sensor detects the system pressure and issues an appropriate signal to the ECU.

The required fuel flow for AB ignition will be controlled by the ECU. It also sets the exhaust nozzle to a position for minimum AB power. Simultaneously the AB ignition unit is activated.

The ignition unit controls the internal pressure and fuel flow to the ejector nozzle and spin nozzle of the AB torch ignitor.

Starter jet fuel is supplied to the ejector nozzle inside the combustion chamber and to the spin nozzle. Starter jet fuel from the ejector nozzle ignites inside the combustion chamber. This torch will ignite the starter jet fuel supplied to the spin nozzle. This will extend the torch to the AB combustion area to ignite the limited, minimum AB fuel from the first spraybar.

Two flame sensors are installed behind the AB flame holder to detect the ignited AB fuel and to initialize the shut-off of the AB ignition by the ECU. Simultaneously, the ECU establishes the normal fuel flow for minimum AB.

INDICATIONS AND WARNINGS

When the AB flame sensors detect a flame, the ECU issues a status signal to the warning equipment which responds as follows:

The equivalent information will be recorded by the flight data recorder.

	INDICATION	FAULT / EFFECT
TLP	LH ENG AB	Left engine AB on.

AFTERBURNER CONTROL SYSTEM

The AB control system is a hydro-mechanical system using fuel as actuating fluid. It is manually controlled by throttle inputs and automatically operated by the ECU.

The main system components are the ECU and the AB and nozzle control unit.

The AB and nozzle control unit regulates the fuel to spraybars according to throttle setting.

Since throttle position in AB is beyond MIL, the basic ECP senses a demand for 100 % RPM for all AB throttle settings.

As soon as AB is selected, the ECU, the AB and nozzle control unit, and the AB ignition unit control will regulate:

- AB ignition sequence as a function of throttle setting and of compressor discharge pressure corrected for CIT.
- Time of torch ignition as a function of fuel pressure.
- Primary exhaust nozzle setting to minimum cross section.

During AB operation:

- AB operation as a function of throttle setting and of compressor discharge pressure corrected for CIT.
- Primary exhaust nozzle cross section according to throttle settings.

The AB fuel pressurizing valve delivers the fuel to the first spraybar for AB start, to the second and third spraybar as a function of fuel pressure.

AB acceleration according to a throttle burst is limited only by constructional drag inside the control units.

During throttle burst from IDLE to AB MAX, the AB will not ignite below 72 % to 76 % RPM.

When AB blow-out occurs during AB operation, the ECU will limit the AB fuel flow to the quantity required for minimum AB operation after 0.5 sec.

For an emergency AB shut-down, the AB EMERG OFF switch on the engine emergency panel has to be set to OFF. The ECU together with the AB and nozzle control unit and AB fuel divider valve will reduce the fuel pressure so that the spraybars close in sequence.

EXHAUST NOZZLE SYSTEM

Since thrust is directly proportional to gas velocity at the exhaust, pressure and temperature in the AB area have to be as high as possible to obtain a high nozzle pressure ratio at the Laval nozzle. Refer to figure FO-5.

Two sets of cylindrical nozzles, operating together, make up the variable exhaust nozzle system. The primary nozzle (inner nozzle) controls the convergent portion of the nozzle, while the secondary nozzle (outer nozzle) controls the divergent portion of the nozzle.

Both nozzles are mechanically linked for common operation by the synchronization unit, using fuel as actuating fluid. The exhaust gas leaves the primary nozzle at subsonic velocity and is accelerated to supersonic velocity by controlled expansion of the gas. The pressure of the gas, before leaving the secondary nozzle, equals ambient air pressure.

NOZZLE AREA CONTROL

Pressurized fuel as a control medium is supplied from the HP nozzle pump to the nozzle control section of the AB and nozzle control unit. Depending on the inputs, the AB nozzle control unit modifies fuel pressure to the synchronization unit for nozzle area adjustment.

Throttle setting and corrected NL as a function of corrected NH are utilized to schedule the correct primary nozzle area (Aj1). During engine operation below MIL, the nozzle is scheduled to open fully at IDLE and the area is decreased as the throttle is advanced toward the MIL position.

For AB ignition, the area is closed to minimum AB operation.
During engine operation in the MIL and AB range the nozzle control system modulates the primary nozzle area (Aj1) to maintain NL according to the preset schedule of the ECU. The secondary nozzle area (Aj2) is adjusted synchronously to achieve a complete pressure drop within the Laval nozzle to ambient atmosphere pressure.

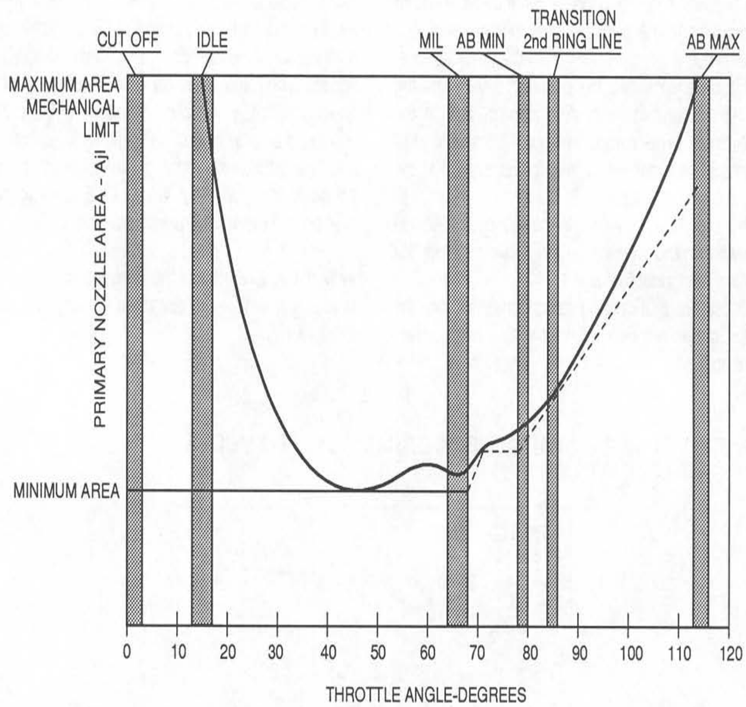
When the nozzle control lane of the ECU fails, the primary nozzle area is modulated by the AB and nozzle control unit as a function of throttle setting and CIT.

INDICATIONS AND WARNINGS

The equivalent information will be recorded by the flight data recorder.

	INDICATION	FAULT / EFFECT
AEKRAN	**LEFT ENG STBY SYS**	Nozzle control lane of LH engine failed.
VIWAS	"LINKES TRIEBWERK IM RESERVEREGIME" "BEACHTE TEMPERATUR UND DREHZAHL "	

VARIATION OF THE NOZZLE AREA WITH THROTTLE POSITION



PRIMARY NOZZLE SCHEDULE GENERATED BY THE ECU AS FUNCTION OF CORRECTED RPM OF HP COMPRESSOR TO CONTROL THE LP COMPRESSOR SPEED.

MINIMUM AREA AS LIMITED BY THE AB AND NOZZLE CONTROL UNIT.

MECHANICAL SCHEDULE AS FUNCTION OF THROTTLE; AB AND NOZZLE CONTROL UNIT WHEN ECU FAILS.

Figure 1-6

ENGINE AIR INTAKE SYSTEM

There are two independent air intakes, one for each engine. Each inlet duct is located below the wing root, 2.5 inches apart from the lower surface. This distance allows the boundary layer from the wing root and the inlet duct to pass outside the bellmouth. The components are a variable duct ramp system and an air inlet louver system at the upper wing root surface.

The inlet louver system is interconnected to the forward ramp system by an internal upper air intake duct, refer to figure 1-7.

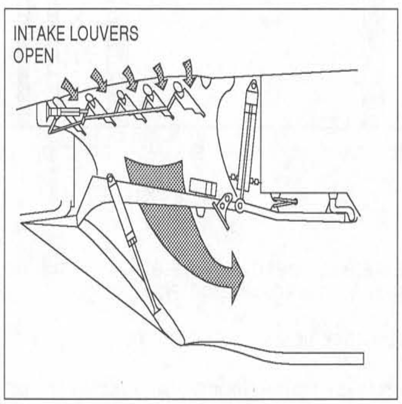
To prevent FOD during takeoff and landing, the duct ramps are closed and the air intake louvers are opened.

VARIABLE DUCT RAMP SYSTEM

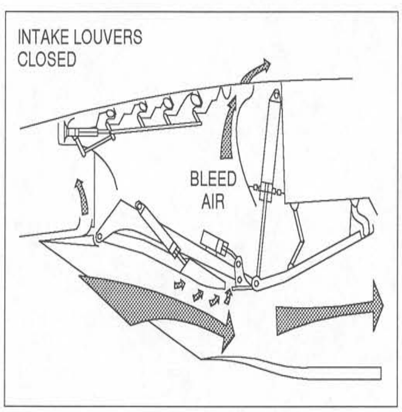
The variable forward ramp system provides engine air at optimum subsonic airflow to the low-pressure compressor face throughout a wide range of speeds. The ramp assembly consists of a variable forward ramp, a variable aft ramp, a bleed-off valve and a ramp control unit. The bleed-off valve and perforated sections of the ramps allow boundary layer air from the forward ramp to be bled-off and exhausted overboard.

In flight the forward and the aft ramp are variable to modify the intake air stream to the engine, refer to figure 1-7.

VARIABLE DUCT RAMP SYSTEM MODES



TAKEOFF/LANDING MODE



IN-FLIGHT MODES

Figure 1-7

AIR INTAKE LOUVERS

The supplementary air intake duct at each upper wing root surface is equipped with five narrow hinged shutters, air intake louvers, allowing the duct to be open or closed. The louvers are spring loaded closed. During takeoff and landing roll, the louvers are opened by vacuum generated by the engine compressor, since the forward ramp is closed. When the forward ramp is retracted at about 108 KIAS, the louvers close. During flight, however, depending on engine RPM, they may open intermittently at Mach numbers ≤ 0.3 in IDLE and ≤ 0.6 in MIL. During engine shut-down, the louvers are locked in the close position when the main hydraulic system pressure subsides.

AIR INTAKE CONTROL

During supersonic flight, the intake airstream has to be decelerated to subsonic speed. Deceleration is attained by four slanting and one straight shock wave. The number of slanting shock waves, their slope angles and the position of the final straight shock wave depend on airspeed, AOA and inclination of the ramps.

The forward and aft ramp are controlled separately by a control unit and hydraulically positioned. The three control schedules are functions of corrected NL, altitude and Mach number. Refer to figure FO-6.

VARIABLE RAMPS SYSTEM OPERATION

On the ground and with engines shut down, no hydraulic pressure is available, and the forward and aft ramp moves to maximum duct opening to provide free access for interior inspection. Refer to figure 1-8.

During engine start, the forward ramp is moved to maximum extended position closing the intake duct.

NOTE

Depending on the setting of the ramp control unit, either both ramps close as soon as hydraulic pressure is available, or the ramp of the starting engine closes when 35 % RPM are reached.

During takeoff, at about 108 KIAS, the forward ramp is retracted to fully open.
In flight, gear retracted, the third travel schedule controls the wedge angle between 0 % and 35 % extension. Refer to figure 1-8.

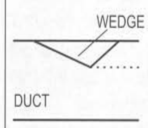
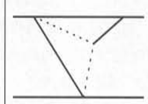
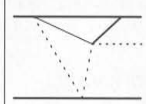
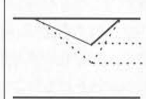
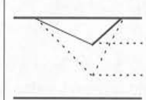
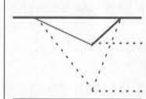
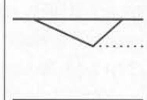
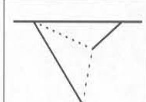
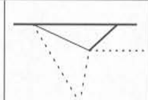
The second travel schedule controls the wedge angle between 0 % and 60 % extension.

The first travel schedule controls the wedge angle between 0 % and 100 % extension.

During landing, with gear extended, the wedge is completely retracted for full duct opening.

After landing, when the speed is reduced below 108 KIAS, the forward ramp is extended to close the air intake.

ENGINE AIR INTAKE SYSTEM

NO.	CONDITION	DESCRIPTION	FWD RAMP POSITION	WEDGE EXTENSION	PRO-GRAM	MECHANICAL CONDITION	INDICA-TION
1	ON GND	ENG SHUT-DOWN NO HYDRAULIC PRESSURE AVAILABLE	FWD PART OF WEDGE	MINIMUM 0 %	-		0 %
2	ON GND	ENG RUNNING HYDRAULIC PRESSURE AVAILABLE	SEPARATES FROM WEDGE AND CLOSES DUCT	AFT RAMP MINIMUM	-		ВП
3	TAKEOFF	SPEED ABOVE 108 KIAS	FWD PART OF WEDGE	MINIMUM 0 %	-		0 %
4	IN FLIGHT	GEAR RETRACTED PROGRAM RANGE: BELOW 10 000 ft ABOVE M 1.15 OR ABOVE 10 000 ft BELOW M 1.15	FWD PART OF WEDGE	0 TO 35 %	3		0 % 35 %
5	IN FLIGHT	ABOVE 10 000 ft M 1.15 TO M 1.5	FWD PART OF WEDGE	0 TO 60 %	2		0 % 60 %
6	IN FLIGHT	ABOVE M 1.5	FWD PART OF WEDGE	0 TO 100 %	1		0 % 100 %
7	LANDING	GEAR EXTENDED	FWD PART OF WEDGE	MINIMUM 0 %	-		0 %
8	AFTER LANDING	SPEED BELOW 108 KIAS	SEPARATES FROM WEDGE AND CLOSES DUCT	AFT RAMP MINIMUM	-		ВП
9	ON GND	ENG SHUT-DOWN NO HYDRAULIC PRESSURE AVAILABLE	FWD PART OF WEDGE	MINIMUM 0 %	-		0 %

NOTE: The wedge extension within a program is a function of corrected NL. A high corrected NL corresponds to minimum extension. Refer to figure FO-6.

Figure 1-8

Built-In Test Equipment

After start of both engines, the two ramp control units are tested automatically when engine RPM is increased to 80 % to 90 % RPM.

Check for illumination of two green captions LH INLET CHECK or RH INLET CHECK on the control and test panel at the aft section of the RH console.

No warning should be issued by the warning equipment.

The ramp control unit consists of two control lanes. In case of a malfunction of one lane, the BITE selects the second lane automatically.

RAMP CONTROL UNIT BITE INDICATION

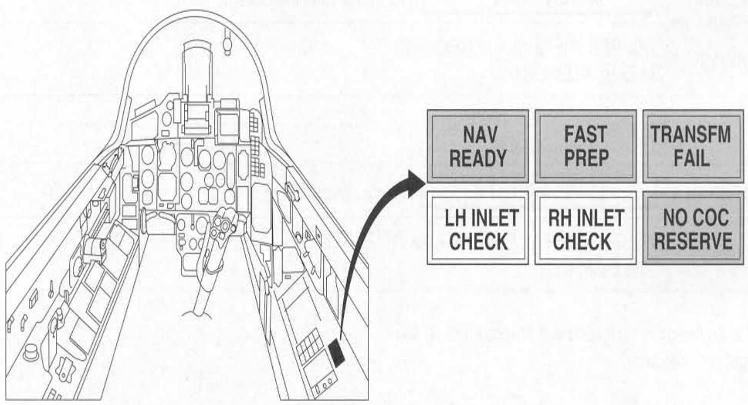


Figure 1-9

PREVENTIVE RAMP EXTENSION

When the ECU receives a signal from the anti-surge system, i.e. surge detection lane of the ECU, an additional 10 % extension demand signal is issued by the ramp control unit. This additional extension is limited by the maximum extension value of the actual variable duct travel schedule.

INDICATIONS AND WARNINGS

- If the gear is retracted, and the forward ramp is not retracted to full duct opening, i.e. the air intake louvers are still open.
- If after takeoff the ramp control is inoperative with main hydraulic system pressure available, the wedge may extend only to 55 % which results in a significant power loss.
- If main hydraulic system pressure is not available and the ramp control system fails, the wedge remains in its last position.

In these cases the warning equipment will issue the warnings listed below:

	INDICATION	FAULT / EFFECT
AEKRAN	UPPER INLET	Air intake remains closed.
VIWAS	"OBERER LUFTEINLAUF GEÖFFNET" "M-ZAHL KLEINER 0,8"	

	INDICATION	FAULT / EFFECT
AEKRAN	LEFT AIR INTK	Ramp control failure.
VIWAS	"AUSFALL DER AUTOMATIK LINKER LUFTEINLAUF" "KEILE ÖFFNEN"	

The equivalent information will be recorded by the flight data recorder.

Manual Wedge Retraction

In case of an intake ramp controller malfunction or a main hydraulic system failure, the wedges are locked in the position at time of failure. To retract the wedges during flight or before landing, thus fully opening the air intake duct, the springloaded and guarded RAMP EMERG RETRACTION LH or RH switch at the engine emergency panel has to be held to RETRACTION for wedge retraction.

If the malfunction is a faulty intake ramps controller, an emergency hydraulic unit powered by the main hydraulic system will retract the wedge upon switch operation. If the main hydraulic system fails as well, both wedges will be retracted by engine intake ram air upon actuation of one or both switches.

After emergency wedge retraction the wedge can extend to the 8 % position when the switch is released.

Ramp Position Indicator

The indicator shows wedge / ramp positions of both air intake systems as a percentage of nominal maximum extension. The 0 % mark represents minimum extension, which corresponds to fully-open air intake duct. For takeoff and landing, when the forward ramp closes the intake duct, the indication will be at the takeoff / landing position ВП.

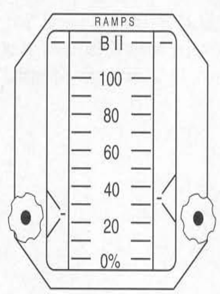


Figure 1-10

Wedge Travel Programs

This diagram shows the three wedge travel programs as a function of corrected NL. The extra travel of the forward ramp and it's function is shown also. Refer to figure FO-6. The wedge travel programs, as function of altitude and Mach number, are shown in figure FO-6 as well.

VARIABLE STATOR SYSTEM

The variable stator system consists of intake guide vanes and stator vanes of the first three stages of the HP compressor. Its function is to prevent compressor surge by limiting the intake air flow angle.

Squeezing either gun or missile trigger will activate the engine anti-surge cycle, thus closing the vanes by 25 degrees. This minimizes adverse effects on the engine caused by gun or missile exhaust gas ingestion. Upon signals from the ECU, the system uses fuel from the ECP as the actuating medium.

ENGINE IGNITION SYSTEM

The engine ignition system initiates ignition of the fuel in the combustion chamber during the starting cycle, and provides an automatic engine ignition source when the weapon release trigger is pressed.

The engine starter unit provides power to each ignitor plug and controls the ignition sequence. The ignition sequence is initiated by pressing the GND START button. When 35 % RPM are reached, the ignition system is switched off.

For air relight, the ignition system is activated for 20 sec for automatic and semi-automatic relight. The ignition system can also be activated manually by operating the AIR RELIGHT LH / RH switch. In this case the ignition system will be active as long as the switch is held in the ON position, but should not exceed 100 sec to prevent damage to the ignition coils.

When either trigger is squeezed, the preventive air relight mode activates the ignition system for 8 sec.

For air relight, electrical power is supplied to the ignitor plugs. At the same time oxygen is guided into the ignition area.

INDICATIONS AND WARNINGS

For the time of ignition the engine fault detection unit issues a signal to the warning system as shown as follows:

	INDICATION	FAULT / EFFECT
TLP	LH ENG START	Left engine ignition system active.

ENGINE STARTING SYSTEM

Ground starting of both engines is achieved by the APU via an ENG GBX for each engine. Electrical start-up power is supplied by an external power unit or by two internal batteries.

The HP compressor shafts of the left and right engines are connected to two ENG GBX which are connected to a common GBX by two angular drives. Refer to figure FO-7.

An APU is flanged to the GBX and drives it through a gas-coupled turbine. The two ENG GBX can be interconnected by friction clutches within the GBX, allowing each ENG GBX to be driven by the APU. For engine start, a friction clutch is installed in the GBX. Selecting the appropriate engine with the APU running will cause the clutch controller to pressurize the appropriate clutch section with hydraulic oil and the selected engine to rotate.

At the same time engine ignition will be initiated. As soon as 35 % RPM is reached, ignition will be switched off. When engine speed reaches 50 % RPM the APU and the starting system automatically shut-down under control of the engine fault detection unit. Now the engine winds up to IDLE by itself.

The second engine is started accordingly. If the second engine does not light up, or if an RPM hang-up occurs, this engine can be cold cranked by the APU.

If 50 % RPM are not reached within 50 sec, or if the throttle is retarded to STOP within this period, the engine starter unit will automatically shut-down.

STARTING / RELIGHT MODES

The engine starting system allows two ground start modes and four relight modes:

- manual start in any order,
- automatic start,
- automatic relight,
- semi-automatic rilight,
- manual relight and preventive relight.

AUTOMATIC START OF BOTH ENGINES

An automatic start procedure for both engines is provided when the start-up mode switch is set to START BOTH engines. Check for APU switch in the guarded position START NORM. Set both throttles to IDLE and depress the GND START button.

The APU will drive the RH engine first. When APU shut-off speed is reached, the APU will be shut-off and restart for LH engine start after a break of 10 sec. This break provides speed synchronization between APU, GBX and mechanical drives.

MANUAL START

During the manual starting procedure, the left engine should be started first.

Check that the APU switch on the engine start panel is in the guarded position START NORM. To select the LH engine set start-up mode switch to LH and the LH throttle to IDLE.

Depressing the GND START button activates the APU system, engine ignition system, and the friction clutch control unit.

Accordingly the RH engine is started by selecting start-up mode switch to RH and the RH throttle to IDLE. The GND START button activates the APU ignition and the clutch systems to start the RH engine.

NOTE

Before the start sequence of the RH engine is initiated by pressing the GND START button, the LH engine has to run in IDLE for at least 40 sec.

CAUTION

Activation of the GND START button during engine run-up and engine operation is prohibited.

RELIGHT MODES

In the event of an impending failure, counteractive measures are taken automatically by the engine starting system. However, depending on circumstances, use of the semi-automatic relight or manual relight may be required. During all relight modes, pure oxygen is injected into the combustion chamber of the engine.

The relight controller of the ECP receives an altitude correction signal when above 18 000 ft MSL to lean the mixture. The controller is shut-off when 85 % RPM or more is sensed.

NOTE

- At altitudes below 40 000 ft MSL, airspeed required for engine relight is 220 to 540 KIAS with a minimum windmilling RPM of 12 %.
- At altitudes between 40 000 ft MSL and 56 000 ft MSL, a successful relight may be expected between 300 KIAS and M 1.8 if relight is initiated during engine wind-down, however, a minimum windmilling RPM of 50 % may be required.
- At altitudes above 56 000 ft MSL, a normal relight and acceleration should not be expected.
- To assure a reliable airstart, the upper limits of the speed ranges should be preferred.
- If the engine is not controllable over the entire RPM range, retard the throttle to off and repeat engine relight at higher speed.

AUTOMATIC RELIGHT

In the event that RPM drops below 50 % and throttle setting is between IDLE and MIL, the engine starter unit will activate the ignition system while the oxygen system will inject oxygen into the combustion chamber. Oxygen is supplied until 75 % RPM are reached, however, the duration of injection is limited to 20 sec. The warning system illuminates the green captions LH or RH ENG START on the TLP.

SEMI-AUTOMATIC RELIGHT

If the automatic relight fails or an engine RPM hang-up above 50 % occurs, a semi-automatic relight has to be initiated.

This is done by retarding the throttle of the failed engine to OFF for 2 to 3 sec and then advancing the throttle to IDLE. As soon as the throttle is advanced out of the OFF position, ignition is provided and oxygen is injected into the combustion chamber until an RPM of 75 % is reached, however, the injection duration is limited to 20 sec. The warning system illuminates the appropriate ENG START caption on the TLP.

MANUAL RELIGHT

When the engine does not start with the semi-automatic relight procedure, a manual air relight must be attempted.

To perform a manual relight, retard the throttle of the failed engine to OFF. Position the safety wired LH AIR RELIGHT or RH AIR RELIGHT switch as required. The green LH / RH ENG START caption illuminates. Advancing the throttle between IDLE and MIL will initiate the engine ignition system. Run-up time of the engine may last up to 70 sec.

Oxygen is injected into the combustion chamber as long as the AIR RELIGHT switch is actuated.

When the relighted engine reaches 50 % RPM, position the LH / RH AIR RELIGHT switch to OFF. To prevent damage to the ignition coils, the LH / RH AIR RELIGHT switch must be switched OFF after 100 sec. The oxygen supply allows approximately five air relight cycles.

PREVENTIVE RELIGHT

The preventive relight mode is activated automatically for 8 sec when:

- either trigger is squeezed,
- an overheat condition is sensed, or
- a surge is encountered.

As during the other relight modes, oxygen is supplied to the engines and the ignition system is activated.

THROTTLES

Two throttles (refer to figure 1-11) are located at the LH side wall. A throttle lever controls each engine from OFF to MAX AB passing through IDLE and MIL power settings. In the OFF position, the throttles are mechanically locked. To position the throttles from OFF to IDLE or IDLE to OFF the locks must be disengaged by squeezing latches which are integrated at the back side of the throttle grips.

When advancing the throttles from IDLE into the AB range or vice versa, locks engage at position MIL. These locks can be disengaged by squeezing latches which are integrated at the front side of the throttle grips. They will lock again in the MAX AB position. To move the throttles out of MAX AB or from MIN AB to MIL, the front latches must be disengaged.

Positioning a throttle from OFF to MAX AB actuates two different micro switches in the ECU. The first one is actuated in IDLE to enable the starter unit. The second switch is actuated at MIL to select the appropriate ECU schedules for MIL and AB.

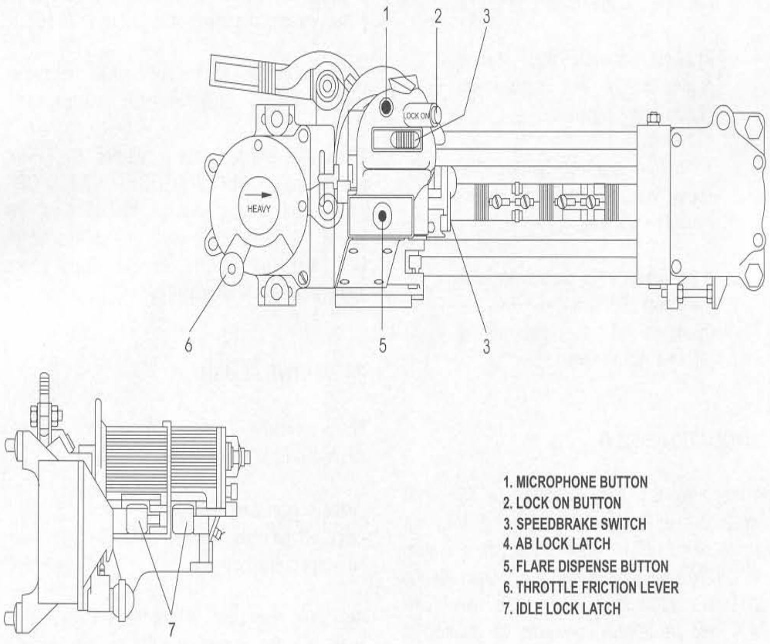
The throttles are not interconnected.

A friction adjustment lever is mounted aft of the throttles to permit adjustment of throttle friction to suit individual requirements.

GT:

Two interconnected throttle control levers are located in each cockpit. Full throttle control from OFF through MAX AB is selectable in either cockpit by a throttle stroke lever on the left cockpit side wall behind the throttles. Refer to figures FO-2 / FO-3. It allows to switch full throttle control from the front cockpit to the rear cockpit and vice versa, but is available in one cockpit at a time only. With the lever in the front cockpit position the squeeze latches on the rear cockpit throttles are disabled.

THROTTLE ASSEMBLY



1. MICROPHONE BUTTON
2. LOCK ON BUTTON
3. SPEEDBRAKE SWITCH
4. AB LOCK LATCH
5. FLARE DISPENSE BUTTON
6. THROTTLE FRICTION LEVER
7. IDLE LOCK LATCH

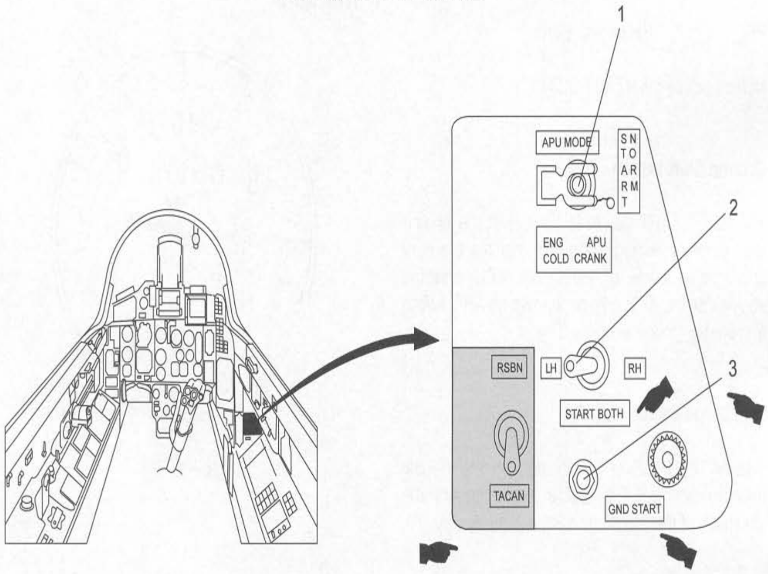
Figure 1-11

ENGINE CONTROLS AND INDICATORS

Engine System Switch

Engaging the ENG SYS switch located on the electric power panel supplies power to the ECU and the APU. Refer to figure 1-22.

ENGINE START PANEL



1. APU SWITCH
2. START-UP MODE SWITCH
3. GND START BUTTON

Figure 1-12

APU Switch

The APU switch located at the engine start panel (refer to figure 1-12) controls the GBX clutch controller and the engine starter unit.

APU MODE — GBX and associated equipment connected.

START NORM — Normal engine start.

ENG COLD CRANK — Engines connected; ignition deactivated. Fuel and oxygen are not supplied.

APU COLD CRANK — APU cranked by the electro starter. Fuel and oxygen are not supplied. Ignition deactivated.

In APU MODE, the various clutches will be engaged and disengaged in such a way that the engines are not connected with the GBX whereas the APU and all the accessories are.

NOTE

Since this mode is used for maintenance purposes only, it should not be selected by the pilot.

The START NORM mode is guarded and safety wired.

Start-Up Mode Switch

The start-up mode switch is located on the engine start panel. It allows selection of individual engine start or start in automatic sequence.

LH	LH engine start
START BOTH	Start both engines sequence RH / LH
RH	RH engine start

Normal position is START BOTH.

Ground Start Button

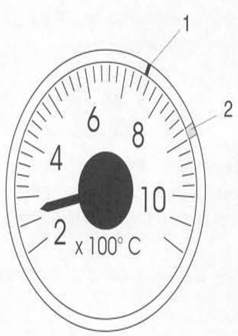
The GND START button is located at the engine start panel. Pressing the button initiates the start and ignition cycle of either the APU and the engines or the APU only depending on APU switch and start-up mode switch setting.

Anti Surge Switch

The ANTI SURGE switch located on the electric power panel (refer to figure 1-22) triggers the activation of the anti-surge system if necessary.

EXHAUST GAS TEMPERATURE INDICATOR

Two indicators provide a rotary pointer display of the EGT from 200° C to 1 100° C in increments of 20° C from 300° C to 1 000° C and 50° C below and above these values. The EGT sensors driving the instruments are located behind the LP turbine outlets. Refer to figure 1-13. The yellow marker and the red sector are adjusted for each individual engine.



1. YELLOW MARKER
2. RED SECTOR

Figure 1-13

ENGINE RPM INDICATOR

A dual pointer RPM indicator displays the RPM of both engines. Refer to figure 1-14.

The scale of the instrument runs from 0 to 110 % at increments of 1 %. Markings on the pointers make reference to the corresponding engine. Metering accuracy is ±1 % below 60 % RPM and above 100 % RPM, and ±0.5 % between 60 % RPM and 100 % RPM.

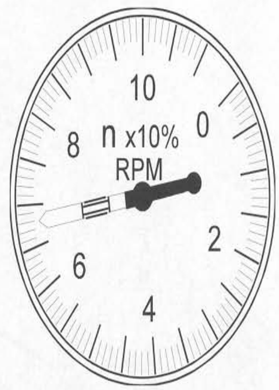


Figure 1-14

Figure 1-15, deleted

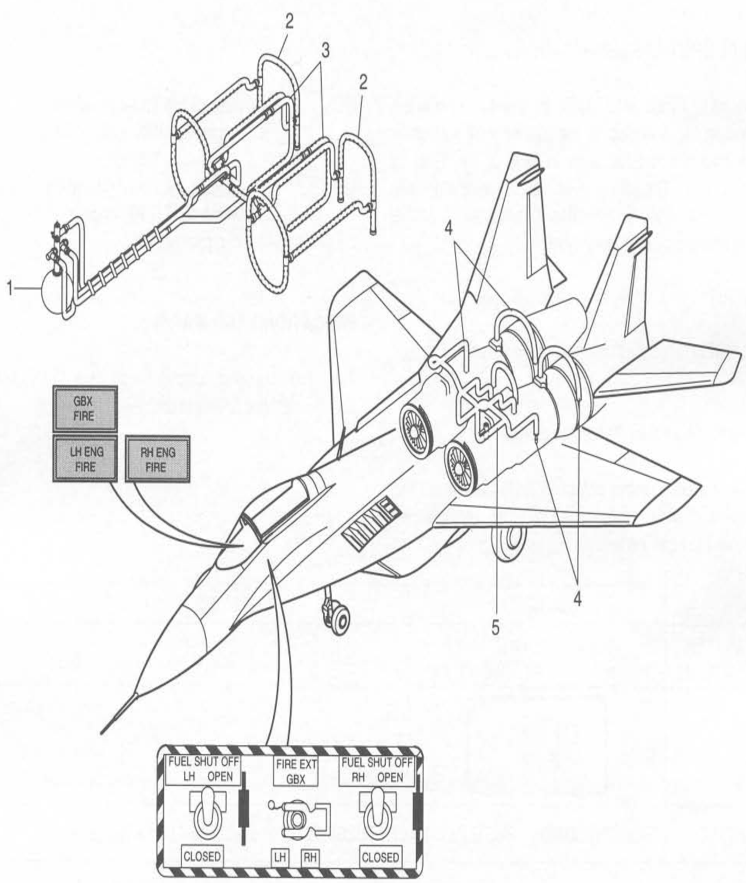
ENGINE FIRE DETECTION SYSTEM

A fire detection system is installed near the GBX and the LH and RH engine. It's function is based on the electrical conductivity of flames. A heat resistant conductor loop is routed through these areas, the distance to the airframe is fixed by high voltage stand-off isolators. In the event of a fire, the high voltage on this conductor loop discharges to the airframe which is electronically detected and initiates a warning signal.

The fire detection system is completely insensitive to high temperatures and will not be triggered by insulation breakdowns as a result of humidity or other electrical short circuits.

The fire detection system will be activated within 3 sec after the appearance of flames.

The extinguisher system consists of a spherical pressure bottle containing an extinguishant foam, three pyro cartridge operated valves and the extinguishing manifolds towards the GBX and the engines, refer to figure 1-16 and 1-17.



1. FIRE EXTINGUISHANT PRESSURE BOTTLE
2. FIRE EXTINGUISHANT SPRAY MANIFOLDS OF ENG COMPARTMENTS
3. FIRE EXTINGUISHANT SPRAY MANIFOLDS OF GBX COMPARTMENTS
4. FIRE WARNING SENSORS IN ENG COMPARTMENTS
5. FIRE WARNING SENSORS IN COMPARTMENTS

Figure 1-16

ENGINE EMERGENCY PANEL

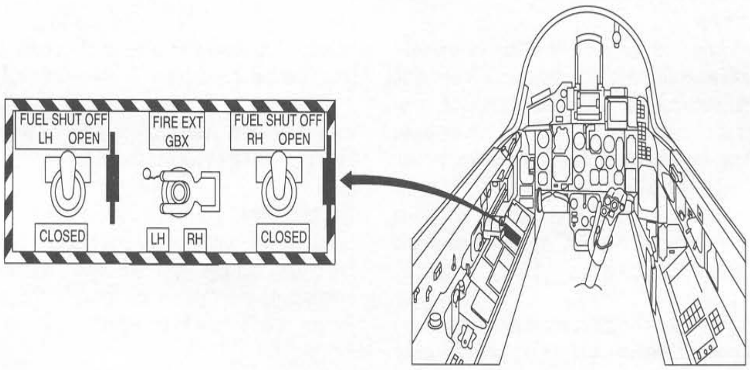


Figure 1-17

FUEL SHUT-OFF LH/RH Switches

Individual FUEL SHUT OFF switches are provided for opening and closing the fuel shut-off valves in the engine boost fuel lines in case of fire, refer to figure 1-17. The fuel shut-off valves are electrically controlled and pneumatically actuated by the pneumatic power supply system.

LH/RH	Fuel shut-off valve open
CLOSED	Fuel shut-off valve closed

Fire Extinguisher Selection Switch

The fire extinguisher selection switch activates the required spray manifolds of the extinguisher system to fight the fire.

GBX	Selects the spray manifolds within the GBX compartment
LH/RH	Selects the spray manifolds within the LH/RH engine compartments

INDICATIONS AND WARNINGS

The red warning captions on the TLP will extinguish if fire fighting has been successful.

	INDICATION	FAULT/EFFECT
MASTER CAUTION	LIGHT FLASHING	
TLP	LH ENG FIRE	Fire in LH engine
VIWAS	"BORDNUMMER, FEUER IM LINKEN TRIEBWERK" (message will be paged twice)	

	INDICATION	FAULT / EFFECT
MASTER CAUTION	LIGHT FLASHING	
TLP	GBX FIRE	GBX fire.
VIWAS	"BORDNUMMER, FEUER IM KSA" (message will be paged twice)	

WARNING

The extinguisher system can be activated only once and all foam will be consumed entirely. The pilot must exercise extreme caution selecting the correct position of the guarded fire extinguisher selection switch.

ENGINE OPERATION

The engine is controlled hydro-mechanically. Under various flight conditions the engine performance is governed electrically by the ECU.

The engine can be operated in three different modes:

- Normal power mode
- Combat mode
- Limited power mode

These modes can only be selected prior to flight by the ground crew.

Control of the engines by throttle bursts within 1 to 2 sec between IDLE and MAX AB is permissible. Time for ignition of AB is 2 to 3 sec. During flight, time for engine acceleration from IDLE to MAX AB is 3 to 7 sec.

NOTE

RPM hang-up is possible momentarily at altitudes above 30 000 ft and airspeeds below 300 KIAS during acceleration from IDLE to MIL.

G-forces can cause RPM changes up to 7 %. However, RPM must not exceed 103 %. A change in EGT is possible as well, but must not exceed the maximum value for MIL operation.

Selecting AB from the MIL power position is assured in the entire range of attitude and velocity. However, during throttle bursts from IDLE to AB at altitudes above 43 000 ft and close to minimum speed, AB ignition may not be available.

NOTE

If AB does not light, the throttle must be retarded to the MIL position. After the engine has stabilized, AB may be reselected.

AB ignition can be verified by observing the green caption LH / RH ENG AB.

NOTE

If the AB does not shut down when deselected, it can be shut down by use of the safety wired AB EMERG OFF switch located on the engine emergency panel. This switch shuts down the AB of both engines.

NORMAL POWER MODE

The performance data throughout the manual, refer to a normal tuned engine, i.e. engine in normal power mode (NPM), except mentioned otherwise.

COMBAT MODE

The combat mode provides additional thrust to MAX AB and is operational under the following prerequisites:

- Combat selector switch МАКС РПТ (MAKS-RPT = normal - combat) located in the LH gear bay, has to be selected prior to flight to the position RPT to achieve the additional thrust. This causes a maximum EGT value of approximately 25° C above the value of normal operation.
- Throttle setting MAX AB.
- Airspeed $M \geq 1.5$.

NOTE

Engine operation in combat mode must not exceed 2 % of service life time.

LIMITED POWER MODE

In order to enhance the service life time, the engine is tuned to limited power mode (LPM). Refer to TA 9002.

Tuned to LPM, the ECU limits the maximum EGT about 20° C below the value of normal operation. As a result, NH and NL is reduced also.

RUNNING TIME METERS

Six running time meters located in the LH gear bay record engine operation times in combat and AB modes and total running time.

AUXILIARY POWER SYSTEM

The auxiliary power system (APS) provides facilities for starting the engines on ground and in the air, and transmits mechanical power to drive various accessories. Refer to figure FO-7.

The system consists of an APU, a GBX, and two ENG GBX. The GBX is mounted between the two ENG GBX.

The APU drives the GBX which itself drives the two ENG GBX through two angle drives.

The GBX drives the DC and the AC generator, two hydraulic pumps of the hydraulic system and an active fuel pump of the fuel system. Each ENG GBX drives four associated engine system fuel pumps, three oil pumps and two speed sensors to support its associated engine.

The GBX can be driven by either engine via its ENG GBX through the angle drives or it drives each ENG GBX and the associated engine for engine start.

AUXILIARY POWER UNIT

The APU is a gas turbine using aircraft fuel and oxygen injection to get started. It drives the GBX through an exhaust gas coupled turbine.

The APU is used for engine start and for cold cranking to checkout engine systems. It also provides internal power to drive the accessory equipment for aircraft systems checkout.

APU STARTING SYSTEM

To start the APU, a 28 VDC starter motor is used. The electrical power is indicated on the voltmeter located on the pedestal panel.

Pressing the GND START button activates the engine starter unit to supply oxygen and energizes the engine ignition unit. After 1 sec the starter motor is switched on to wind up the APU compressor shaft. Simultaneously engine fuel is injected into the oxygen atmosphere within the combustion chamber. At 35 % RPM, the starter motor, the ignition and the oxygen supply are switched off. At 100 % RPM, operating speed is controlled by a fuel flow regulating governor. Power output is 77.5 kW.

INDICATIONS AND WARNINGS

CAUTION

If the exhaust gas temperature of the APU exceeds a preset value, the engine fault detection unit will activate the information and warning equipment. In this case the APU has to be shut off immediately.

	INDICATION	FAULT / EFFECT
AEKRAN	**START TURB CRIT CONDITNS**	The exhaust gas temperature of the APU exceeds a preset value.

APU / ENGINE COLD-CRANKING

For ENG or APU system checkout, the engines and the APU can be cold-cranked. To cold-crank an engine the APU switch is set to ENG COLD CRANK, the throttle to OFF and the start-up mode switch to LH or RH. Upon depressing the GND START button, the HP shaft of the selected engine will be driven by the APU. Fuel will not be injected into the engine combustion chamber and the engine ignition system will not be activated.

For cold-cranking the APU, the APU switch has to be set to APU COLD CRANK and the GND START button has to be depressed. In this mode the electrical starter motor will drive the APU compressor shaft. Fuel, oxygen and ignition will not be supplied to the APU.

INTERNAL POWER SUPPLY MODE

On the ground, the APU can be used to generate electrical and hydraulic power. In this mode the two ENG GBX are disconnected from the GBX to prevent engine rotation.

For internal power supply, the ENG SYS switch on the system power panel is set to ON and the APU switch on the engine start panel is set to APU MODE. With this setup, only the APU is started when the GND START button is pressed. The APU will drive the GBX and the associated equipment at a speed equivalent to 70 % engine RPM. The APU is shut down with the ENG SYS switch located on the electric power panel.

NOTE

This function shall not be used.

ACCESSORY GEARBOX

The GBX drives aircraft accessories such as pumps, generators etc. Refer to figure FO-7.

The GBX also transfers torque generated by the APU to the selected engine and controls drive from an engine to the accessory units.

Torque is transferred between the GBX and the two ENG GBX by angle drives.

The lube oil unit and two hydraulic pumps provide cooling and lubrication for the GBX and APU.

Oil quantity is 4.5 l. Sensors for vibration and oil pressure are installed.

A cross drive shaft and three friction clutches are engaged by oil pressure from the hydraulic pumps. The clutches are controlled by an internal control unit depending on the mode of operation and engine selected for start.

Normally the GBX is driven by the RH engine. However, if the LH engine RPM exceeds the RH engine RPM by 7 % or more, a freewheel clutch will select the LH engine and drive the GBX instead.

All accessories except the AC generator are gear-driven by the GBX with a fixed transfer ratio. The AC generator is driven by a constant speed torque converter.

INDICATIONS AND WARNINGS

Malfunctions in the GBX detected by the engine fault detection unit are issued to the warning equipment.

	INDICATION	FAULT / EFFECT
MASTER CAUTION	LIGHT FLASHING	
TLP	GBX FIRE	Fire in GBX.
VIWAS	"BORDNUMMER, FEUER IM KSA" (message will be paged twice)	

	INDICATION	FAULT / EFFECT
MASTER CAUTION	LIGHT FLASHING	
TLP	OIL GBX	Oil pressure in the GBX is below the min value for at least 20 sec.
AEKRAN	OIL PRESS ACCRY GBX	
VIWAS	"SCHMIERSTOFFDRUCK IM KSA ZU GERING" "AUFGABE ABBRECHEN"	

	INDICATION	FAULT / EFFECT
MASTER CAUTION	LIGHT FLASHING	
AEKRAN	ACFT ACCRY GBX VIBR	Vibration level of the GBX exceeds a preset level by 35 % for at least 2 to 3 sec.
VIWAS	"VIBRATION IM KSA" "AUFGABE ABBRECHEN"	

ENGINE GEARBOX

Two ENG GBX are installed, one for each engine to drive engine accessories. Refer to figure FO-7.

For normal operation, torque is transferred to the GBX via an angle drive. The angle drive receives torque from the GBX to start-up the engine.

The following engine accessories are mounted on the ENG GBX:

A low pressure fuel pump, an ECP, a nozzle high-pressure pump, an AB fuel pump with NH sensor unit, a lube oil unit, an oil centrifugal breather, a fuel filter unit and an additional NH sensor unit.

AIRCRAFT FUEL SYSTEM

Fuel is carried internally in five interconnected internal fuselage tanks and two internal wing tanks.

External fuel is carried in a single 1 500 l fuselage-mounted centerline (CL) tank on station seven.

All internal tanks may be refueled on the ground through a single pressure refueling point, located in the left main gear well.

The CL tank must be refueled individually through a pressure refueling point, located in the front section of the tank.

The fuselage tanks are arranged so that tank 1 is behind the aft bulkhead of the cockpit. Tank 2, the engine feed tank, tank 3 and the two tanks 3A complete the fuselage tank group. A fuel accumulator is installed in tank 3 to supply engine fuel during near-zero-g flight. Tanks 1 and 2 are arranged so that fuel will gravity-flow into tank 2 if a transfer pump failure occurs. Flapper valves prevent reverse fuel flow. The two internal wing tanks are installed in the wing roots, one at each side. Refer to figure 1-18.

All fuel is transferred to the engine feed tank, tank 2, and from there fed to the engines. Check valves within the transfer lines prevent reverse fuel flow in all aircraft attitudes. If the transfer rate to tank 2 is higher than the fuel consumption, a pressure relief valve opens and fuel is dumped to tank 1. A safety relief valve between tank 2 and 3 permits dumping of fuel to tank 3.

Both tanks 3A and the internal wing tanks contain a jet pump to transfer fuel to tank 3. Tank 3 contains a jet pump to transfer fuel to tank 1 and additionally a turbo pump to transfer fuel to the engine feed tank 2. Tank 1 contains a turbo pump to transfer fuel to tank 2.

The fuel transfer sequence is automatically controlled by a hydro-mechanical system. Regulated engine bleed air is used to transfer fuel from the external tanks to the internal tanks. Internal fuel transfer is accomplished by transfer pumps.

Air pressure or nitrogen pressure is used to maintain positive pressurization in all internal tanks, air pressure only is used for pressurization of the centerline tank.

Fuel is also used as a cooling medium to cool hydraulic and lube oil as well as the cooling fluid for the radar equipment.

Level control valves control the fuel levels in the tanks during transfer operations. Fuel gaging units supply quantity and flow data to the indication system.

AFTER MODIFICATION WITH WING DROP TANKS

Additional external fuel is carried in two 1 150 l wing drop tanks. The wing drop tanks are suspended by pylons, mounted to the wing stations one and two. Refueling of the wing drop tanks is accomplished individually through external filler points.

Regulated engine bleed air is used for wing drop tank pressurization and fuel transfer.

FUEL TANKS ARRANGEMENT

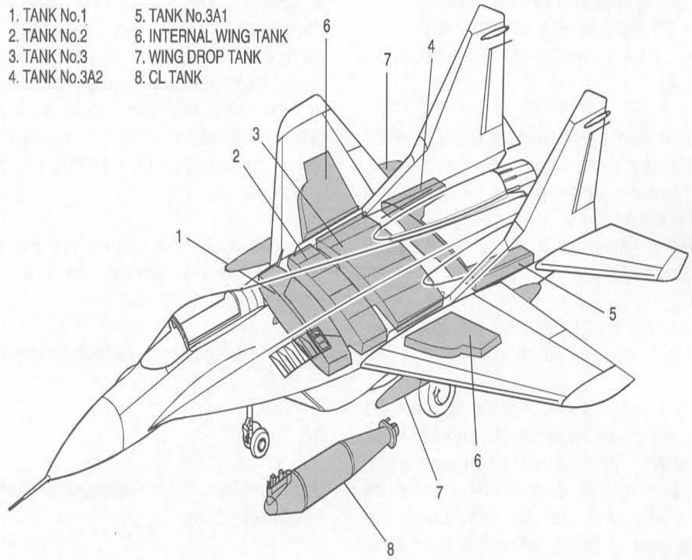


Figure 1-18

TRANSFER SYSTEM

The transfer system serves two purposes:

- transfer all fuel to the engine feed tank,
- maintain CG variation due to fuel consumption within limits.

The transfer system is a self-sustaining system. The accessory gearbox drives a centrifugal-type pump for active fuel. Active fuel is used to drive / control the associated components:

- level / pump control valves installed in tanks 1, 2, 3 and the internal wing tanks at certain levels,
- empty sensors in tanks 1 and 3 and the centerline tank,
- electromagnetic valves for control of external fuel transfer,
- turbo-type transfer pumps in tanks 1 and 3,
- jet-type transfer pumps in tanks 3, 3A and the internal wing tanks.

Upon switchover to internal power supply, the electromagnetic control valve for CL tank fuel transfer opens. After engine start, the turbo-type transfer pumps in tank 1 are running to transfer fuel to the engine feed tank, i.e. tank 2. The CL tank fuel shut-off valve and the transfer valve open, allowing fuel to transfer. However, CL tank fuel is not transferred at power settings below 80 % RPM. Above 80 % RPM, all CL tank fuel is transferred to tank 1. As soon as all fuel has been transferred, a sensor sends a tank empty signal to the fuel indicator and to an electromagnetic check valve. The check valve interrupts control pressure to the transfer valve, causing the valve to close. During negative g flight, an inertia switch associated with the check valve causes the transfer valve and the shut-off valve to close momentarily to prevent pressurized air from entering tank 1 and forcing fuel into the drain lines.

NOTE

At altitudes above 30 000 ft, centerline tank fuel may or may not transfer due to design limitations.

After transfer of a total of approximately 250 l fuel from tank 1, the transfer pumps in tank 3 start transferring fuel to tank 1 and to the engine feed tank.

Upon depletion of approximately 200 l from tank 3, the jet-type transfer pumps in tanks 3A and the internal wing tanks start transferring fuel to tank 3. Tanks 3A keep feeding until they are empty, however, there is no indication for the exhaustion of tanks 3A.

When the internal wing tanks are empty, a sensor sends a tank empty signal to the fuel indicator. When all fuel is transferred from the internal wing tanks and the tanks 3A, and approximately 600 l are depleted from tank 3, the transfer pumps of tank 3 are shut down.

Consecutively another 280 l are transferred from tank 1 to the engine feed tank.

Transfer from tank 3 is resumed and when tank 3 is empty, the empty sensor signals depletion to the fuel indicator. The turbo-type transfer pump in tank 3 and the transfer pumps in tank 3A as well as the internal wing tanks are shut down, the jet-type transfer pump in tank 3 continues to pump active fuel to tank 1, from where it is transferred to the engine feed tank.

When tank 1 is empty, the empty sensor causes the respective caption on the fuel indicator to illuminate.

When the amount of fuel in the engine feed tank has diminished to 550 kg, the caption 550 KG REMAIN on the TLP illuminates.

After complete depletion of the engine feed tank, fuel is forced from the fuel accumulator to the engine feed line. A pressure differential sensor causes the AEKRAN to indicate NO BOOST when the entire fuel has been consumed.

Figure 1-19 illustrates the fuel transfer sequence.

AFTER MODIFICATION WITH WING DROP TANKS

With wing drop tanks installed, the transfer sequence is essentially the same. However, since the pressurization system has been modified, CL tank fuel is transferred immediately, regardless of engine RPM.

When 70 l have been transferred from the internal wing tanks, the transfer valves of the wing drop tanks open and fuel is transferred to the internal wing tanks. Upon completion of fuel transfer from the wing drop tanks, an empty sensor signals fuel depletion to the fuel indicator and to an electromagnetic check valve. The check valve interrupts control pressure to the transfer valve causing the valve to close. During negative g flight, an inertia switch associated with the check valve causes the transfer valve to close momentarily to prevent pressurized air from entering the internal wing tanks.

After depletion of all fuel from the wing drop tanks, the transfer sequence continues the same way as with no wing drop tanks installed.

Figure 1-19A illustrates the fuel transfer sequence.

GT:

After engine start, fuel is transferred from tank 1 to the engine feed tank.

When approximately 50 l of fuel are transferred, the CL tank transfer valve opens, allowing fuel to transfer to tank 1 as soon as RPM is increased above 80 %. Upon completion of fuel transfer, an empty sensor signals fuel depletion to the fuel indicator, the transfer valve closes.

After depletion of another 500 l from tank 1, the transfer pumps in tank 3 start transferring fuel to tank 1 and to the engine feed tank.

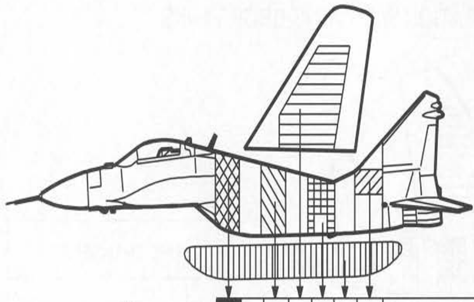
Upon depletion of approximately 50 l from tank 3, the jet-type transfer pumps in tanks 3A and the internal wing tanks start transferring fuel to tank 3. When the internal wing tanks are empty, an empty sensor signals fuel depletion to the fuel indicator.

Upon completion of fuel transfer from tanks 3 and 3A, an empty sensor signals fuel depletion to the fuel indicator, shuts off the jet-type transfer pumps in tanks 3, 3A and the internal wing tanks, and closes the transfer valves in tanks 3A and the internal wing tanks. The turbo-type transfer pumps in tank 3 continue running.

The transfer sequence is continued with tank 1, 2 and the accumulator tank with the respective indicator / warning captions illuminating at the appropriate fuel level.

Figure 1-19 illustrates the fuel transfer sequence.

FUEL TRANSFER SEQUENCE



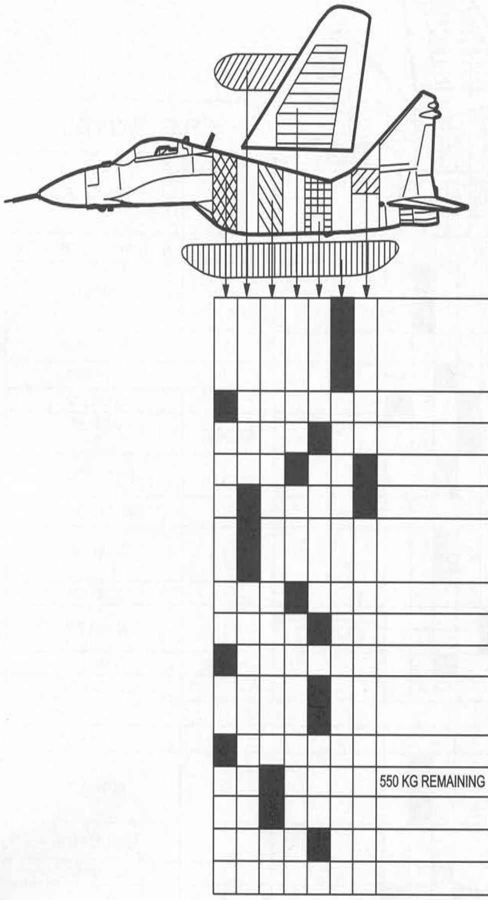
FUEL TRANSFER

	TANK NO.	TRANSFER
G:	1	50 L DURING GND OPERATION
	CL	COMPLETE
	1	250 L APPROX.
	3	200 L APPROX.
	3A	COMPLETE
	INT. WING	COMPLET E
	3	600 L APPROX.
	1	280 L APPROX.
	3	COMPLETE
	1	COMPLETE
550 KG REMAINING	2	COMPLETE
	ACCUM.	COMPLETE
		125 L UNUSABLE FUEL
GT:	1	50 L
	CL	COMPLETE
	1	500 L APPROX.
	3	50 L APPROX.
	3A	COMPLETE
	INT. WING	COMPLETE
	3	COMPLETE
	1	COMPLETE
550 KG REMAINING	2	COMPLETE
	ACCUM.	COMPLETE
		125 L UNUSABLE FUEL

Figure 1-19

FUEL TRANSFER SEQUENCE

AFTER MODIFICATION WITH WING DROP TANKS



FUEL TRANSFER	
TANK NO.	TRANSFER
CL	COMPLETE
1	250 L APPROX.
3	200 L APPROX.
INT. WING	70 L APPROX.
3A	COMPLETE
WING DROP TANKS	COMPLETE
INT. WING	COMPLETE
3	600 L APPROX.
1	280 L APPROX.
3	COMPLETE
1	COMPLETE
2	COMPLETE
ACCUM.	COMPLETE
	125 L UNUSABLE FUEL

Figure 1-19A

FUEL PRESSURIZATION AND VENTILATION SYSTEM

The pressurization and ventilation system uses air or nitrogen to pressurize the internal tanks. Regulated engine bleed air is used to pressurize the accumulator tank and all external tanks.

Both subsystems are interconnected by check valves to permit pressurization of the internal tanks by engine bleed air when the nitrogen supply is exhausted or when the electro-pneumatic nitrogen control valve is closed.

Four pressure bottles contain the nitrogen at a pressure of 32 MPa. During engine start, at 55 % RPM, the electro-pneumatic nitrogen control valve opens and nitrogen is supplied via a pressure reduction valve to the venting unit at a pressure of 0.8 MPa. The venting unit controls pressurization of the internal tanks between 3 kPa and 25 kPa, depending on aircraft altitude. It also provides pressure relief, whenever a predetermined value is exceeded.

The circuitry for the nitrogen control valve is routed through the left main gear scissors switch to prevent closure of the valve in case of an engine failure during flight.

As soon as engine bleed air from the low pressure compressor is available, the fuel accumulator and the external tanks are pressurized. Engine bleed air is delivered at a pressure of 50 Pa to 500 Pa and reduced by safety relief valves to deliver a constant pressure of 55 ±5 Pa to the fuel accumulator and 90 ±10 Pa to the external tanks for pressurization and fuel transfer purposes.

NOTE

At high altitudes and / or power settings below 80 % RPM, bleed air pressure may be insufficient to maintain fuel transfer from the CL tank, resulting in intermittent illumination of the AEKRAN indication DROP TANK NO USAGE.

If the nitrogen supply is exhausted or the nitrogen control valve closed, engine bleed air is supplied to the vent unit through the check valve for pressurization of the internal tanks.

AFTER MODIFICATION WITH WING DROP TANKS

Prior to the modification, pressure from the fuel pressurization and ventilation system may have been insufficient to transfer external fuel at low power settings and high altitude. To maintain positive pressurization for fuel transfer, the fuel pressurization and ventilation system has been modified to use compressed air from the cabin pressurization system during high altitude and low engine RPM conditions.

FUEL BOOST SYSTEM

The fuel boost system supplies fuel for the following purposes:

- Engine operation during positive and negative g flight,
- operation of the active fuel system,
- cooling of the radar cooling fluid and,
- cooling of engine oil.

Two turbo-type boost pumps are located in the engine feed tank 2. The pumps are arranged so that at least one pump remains submerged in fuel regardless of flight attitude to deliver fuel to the engine low pressure fuel pumps during positive and negative g flight.

A part of the fuel is pumped to the fuel accumulator in tank 3. The accumulator consists of two chambers, separated by a membrane. The upper chamber is pressurized by compressed air from the fuel pressurization and ventilation system. During positive or negative g flight, fuel is transferred to the lower chamber, the membrane is bent toward the upper chamber. The compressed air in the upper chamber forces the fuel from the lower chamber of the accumulator into the fuel supply lines in case pressure in these lines is insufficient during near-zero g flight conditions.

ACTIVE FUEL

A part of the fuel is routed to the active fuel pump. The centrifugal-type pump is mounted to the accessory gearbox. It increases fuel pressure depending on engine speed to drive the transfer pumps and the boost pumps.

The active fuel is also used to control the level control valves, the transfer pumps and the external tank pressurization valves and transfer valves.

COOLING FUEL

Fuel from the lower boost pump is used to cool the cooling fluid of the radar equipment cooling system. After passing the heat exchanger, the fuel is routed to the entrance of the upper boost pump.

Active fuel is routed to the oil cooler and returned to the fuel supply line.

Two temperature controlled valves open a return line to the engine feed tank when the fuel temperature after the engine low pressure fuel pump exceeds 105° C. The resulting increased fuel flow causes the temperature to decrease.

STARTER FUEL PUMP

The motor driven starter fuel pump supplies fuel to the APU and to the engine supply lines during engine start. The pump remains in operation as long as either engine is running. Therefore it provides a back-up for fuel supply in case of an active fuel system and a resulting boost pump failure.

FUEL PUMP Switch

The FUEL PUMP switch is located on the electric power panel on the RH console. Refer to figure 1-22. It is used to activate the starter fuel pump.

EXTERNAL TANK JETTISON SYSTEM

The CL tank jettison button is located on the control stick. The button is safety covered to prevent inadvertent actuation. Pressing the button causes an electromagnetic lock to open and releases the tank. The system is DC powered by an external source, the DC generator or the batteries.

WARNING

Jettison on the ground is possible with DC power available.

AFTER MODIFICATION WITH WING DROP TANKS

The EMERG RELEASE button located on the front panel is used to jettison the wing drop tanks. Refer to figure 1-19B. The button is safety covered and secured to prevent inadvertent actuation. Pressing the button causes the release cartridges to fire. A safety device automatically activates the firing circuit of the remaining wing drop tank upon separation of either tank to prevent jettisoning of a single wing drop tank which would result in a severe asymmetry.

WARNING

The jettison circuit will be hot as soon as DC power is available.

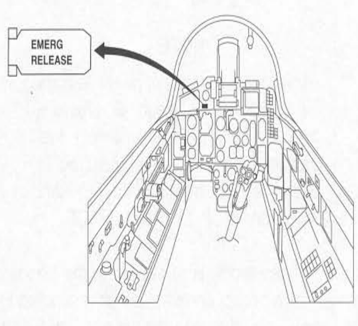


Figure 1-19B

GROUND REFUELLING / DEFUELLING

All internal tanks can be refueled via a single pressure refueling point or through external filler points.

The single point refueling receptacle is located in the left main wheel well. External filler points are installed on tanks 1 and 3. The CL tank will not be replenished during single point refueling and must be refueled individually.

The central refueling process is controlled from the refueling panel located in the left main gear bay. Following selections are available:

- 50 % Partial load, for refueling of tank 2 and partial refueling of tank 1 and 3;
- 100 % full load, for refueling of all internal tanks;
- 130 % full load plus centerline tank;
- CL centerline tank.

The refueling process automatically stops when the selected fuel load is reached and the caption REFUEL COMPLETE illuminates.

When refueling of internal tanks plus centerline tank is selected, the central refueling process automatically stops when the internal tanks are refueled completely, however, the caption REFUEL COMPLETE does not illuminate until the CL tank is full.

To refuel the CL tank, the respective position has to be selected. After completion of centerline tank refueling, selection of the position for full load plus centerline tank is mandatory for adjustment of the indication system.

If the refueling vehicle is equipped with two connectors for single point refueling, simultaneous refueling of the internal tanks and the centerline tank is permissible.

The internal tanks are defueled through a drain valve located near tank 3. The CL tank is defueled through its own drain valve. Remaining fuel can be drained by opening several drain plugs.

AFTER MODIFICATION WITH WING DROP TANKS

The wing drop tanks are always refueled last. They can only be refueled manually through filler caps. To obtain the correct fuel amount, the fuel indicator has to be adjusted manually for the amount of fuel in the wing drop tanks (approximately 1 800 kg) with the MAN adjustment knob on the fuel signals calibration panel in the rear of the cockpit.

The wing drop tanks are defueled through the filler caps.

FUEL QUANTITY DATA TABLE

	FULLY SERVICED			USABLE FUEL		
TANK	LITER	F-34 / kg *1)	TS-1 / kg *2)	LITER	F-34 / kg *1)	TS-1 / kg *2)
TANK 1	650	522	507			
TANK 2	900	723	702			
TANK 3	1 800	1 445	1 404			
TANKS 3A	300	241	234			
INTERNAL WING TANKS	650	522	507			
TOTAL INTERNAL FUEL	4 300	3 453	3 354	3 899	3 131	3 041
CL TANK	1 500	1 205	1 170	1 370	1 100	1 068
TOTAL INTERNAL FUEL PLUS CL TANK	5 800	4 658	4 524	5 269	4 231	4 110
WING DROP TANKS	2 300	1 847	1 794	2 129	1 709	1 661
TOTAL INTERNAL FUEL PLUS WING DROP TANKS	6 600	5 300	5 148	6 028	4 840	4 702
MAXIMUM FUEL LOAD TOTAL INTERNAL PLUS ALL EXTERNAL TANKS	8 100	6 505	6 318	7 398	5 940	5 770

*1) F-34 at 15° C, specific weight 0.803
*2) TS-1 at 20° C, specific weight 0.780

NOTE: Usable fuel is calculated by subtracting 7 % of fully serviced fuel, and additionally the fuel remaining trapped in the tanks: Internal 100 L, CL tank 25 L, WDTs 10 L.

Figure 1-19C

REFUELING PANEL

The refueling panel is located in the left main wheel well. Refer to figure 1-19D. It is used for refueling the aircraft, adjustment of the fuel indication, and verification of oil and hydraulic fluid quantities.

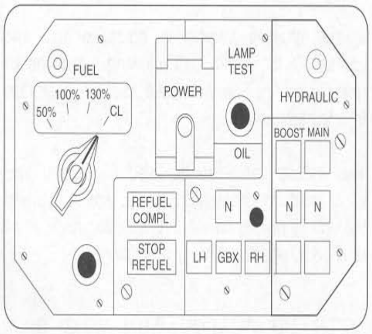


Figure 1-19D

POWER switch

The POWER switch is used to connect DC power to the refueling panel, provided the BAT GND SUPPLY switch is in the ON position.

LAMP TEST button

A LAMP TEST button is provided to check the light captions prior refueling.

FUEL selector

The FUEL selector is a rotary knob with the following functions:

- 50 % for refueling of tank 2 and partial refueling of tank 1 and 3;
- 100 % for refueling of all internal tanks;
- 130 % for refueling of all internal tanks plus centerline tank and;
- CL for refueling of centerline tank only.

NOTE

When the CL tank is refueled, the fuel selector knob has to be positioned to 130 % to obtain correct indications on the fuel indicator.

STOP REFUEL pushbutton

The STOP REFUEL pushbutton is used to stop the refueling procedure manually.

REFUEL COMPL caption

The caption illuminates when refueling is finished in accordance with the selection of the FUEL selector knob.

OIL captions

One green and three red captions indicate oil servicing requirements. The green caption illuminates when the oil level is within limits. Individual red captions indicate servicing requirements for the accessory gearbox, the LH and the RH engine.

HYDRAULIC captions

Three captions each indicate servicing requirements for the MAIN and the BOOST hydraulic system. The green caption marked N indicates no servicing required, the red caption indicates a servicing requirement and the yellow caption indicates that the system is overfilled.

FUEL SIGNALS CALIBRATION PANEL

The fuel signals calibration panel is located in the rear of the cockpit beneath the power distribution panel. Refer to figure 1-19E. It is used for adjustment, calibration and checkout of the fuel indication system. AC power must be available for operation.

NOTE

After refueling has been accomplished with battery power, the PTO switch must be set to ON before the indication system can be adjusted. Due to the limited capacity of the batteries, operation of the PTO is limited to 30 sec.

AFTER MODIFICATION WITH WING DROP TANKS

A rotary selector knob has been added to the panel, refer to figure 1-19F, to select a voice warning for bingo fuel. The fuel selector knob has been replaced by a three-position toggle switch.

GT:

The fuel signals calibration panel, refer to figure 1-19E, is located in the rear cockpit beneath the instrument panel in front of the control stick.

G / GT

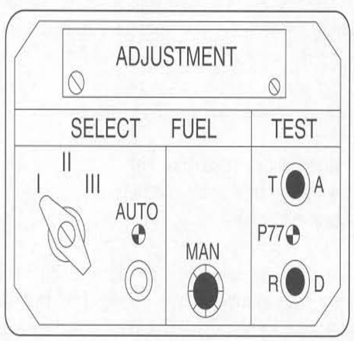


Figure 1-19E

AFTER MODIFICATION WITH WING DROP TANKS

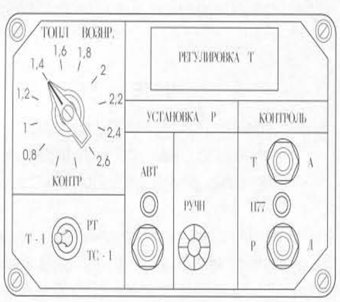


Figure 1-19F

Fuel Selector Knob

The fuel selector knob has three positions, labelled with Roman numerals, to select the type of fuel used. The fuel computer receives the specific weight data for calculation of the remaining fuel quantity and remaining flight distance.

AFTER MODIFICATION WITH WING DROP TANKS

The rotary knob has been replaced by a three-position toggle switch labelled T-1 (I) – TC-1 / PT(II).

РЕГУЛИРОВКА (ADJUSTMENT)

Covered adjustment screws are used for calibration of the fuel indicator.

АВТ (AUTO) button

Pressing the pushbutton inputs fuel quantity to the computer in accordance with the selection on the refuelling panel. The indicator light illuminates as soon as the quantity is displayed on the indicator.

РУЧН (MAN) adjustment knob

The manual adjustment knob can be used for random adjustment of the fuel quantity. Prior to adjustment, the FUEL COUNTER circuit breaker has to be pulled and the position P has to be selected with the T/P switch on the fuel indicator.

AFTER MODIFICATION WITH WING DROP TANKS

The button is used to add the fuel quantity of the wing drop tanks in kg to the fuel indication system.

Test buttons

Two test buttons and a LED are used for maintenance checkout. The buttons are labeled T-A and P(R)-Д(D), the LED is labeled П77(P77).

ТОПЛ ВОЗНР (FUEL RETURN) selector

The fuel return selector is used to select the desired bingo fuel. A VIWAS warning is issued when the selected fuel amount is reached.

CAUTION

Displaying of the VIWAS warning may differ from the adjusted value up to 190 kg.

CONTROL AND TEST PANEL

A new test button, labelled TEST WDT has been added on the control and test panel on the right console, replacing the FEEL UNIT OK caption, refer to figure 1-19G. Illumination of the TEST WDT caption on the telelight panel indicates a valid system check when the test button is pressed.

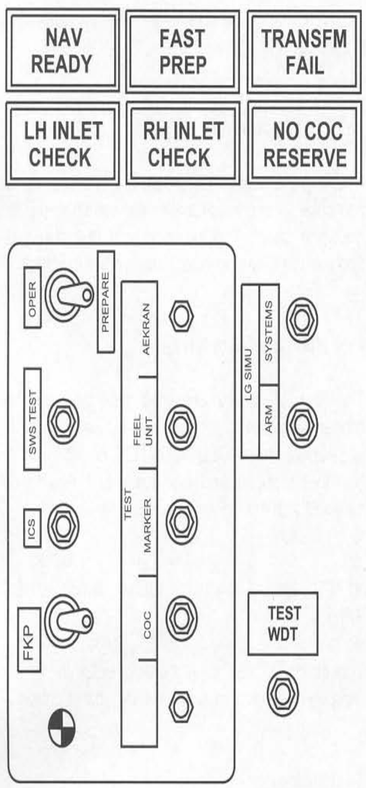


Figure 1-19G

FUEL INDICATION SYSTEM

The fuel indication system consists of a remaining fuel quantity computer, a remaining distance computer, a fuel consumption computer and an indicator, refer to figure 1-20.

The system is interconnected with the refuelling panel and the fuel signals calibration panel. Basic calculations such as total fuel depend on settings on the refuelling panel and indicator calibration. Fuel consumption calculations depend on settings on the fuel signals calibration panel and inputs from the fuel flow sensors.

The system includes capacitance type gaging units in tanks 1, 2 and 3, level control valves, full- and empty sensors, fuel flow sensors and temperature sensors.

The fuel indicator displays the following data:

- Remaining fuel quantity in kg;
- remaining flight distance in NM and ;
- tank empty signals.

The initial fuel quantity is computed using inputs from the capacitance type gaging units plus the quantities for the remaining internal and external tanks based on refuelling information from the refueling panel and density information from the fuel signals calibration panel.
Consecutive fuel quantity data computation is based on fuel flow corrected for density and temperature.
When the CL tank is jettisoned, the computer corrects the remaining fuel quantity accordingly.

NOTE

Jettisoning of the wing drop tanks may lead to a false, normally higher than actual, fuel quantity indication.

The remaining flight distance computer computes the remaining flight distance based on actual fuel consumption and data from the ADC. This distance is not corrected for wind.

FUEL INDICATION SYSTEM

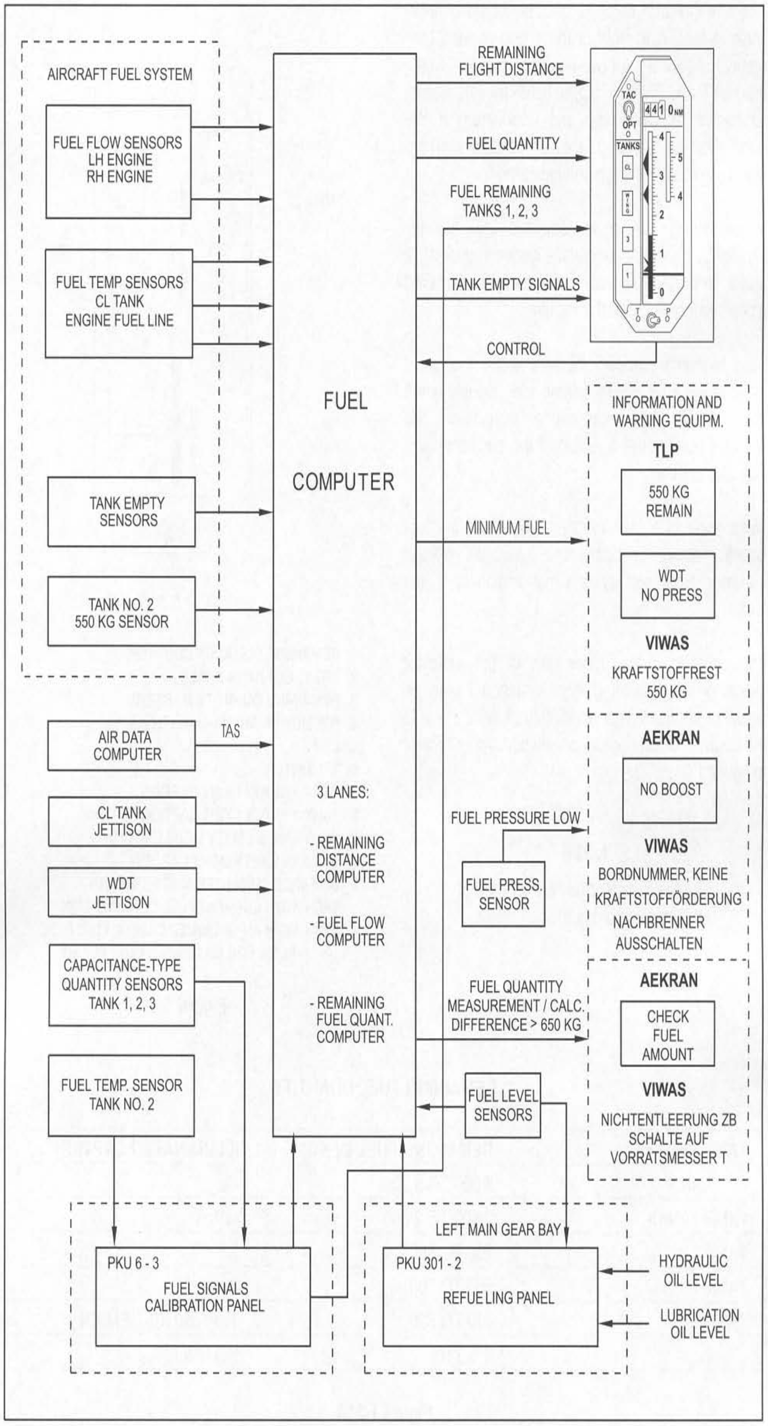


Figure 1-20

FUEL INDICATOR

The fuel indicator consists of a tape-type quantity scale, a remaining flight distance counter and tank empty captions. A two-position toggle switch marked T and P with indicator lights for selection of measured or calculated fuel is located at the bottom of the scale. Triangular shaped markers along the scale complete the indicator.

In position T the scale indicates fuel quantity sensed by the capacitance-type gages in tanks 1, 2 and 3. In position P, total fuel quantity is displayed as calculated by the fuel computer.

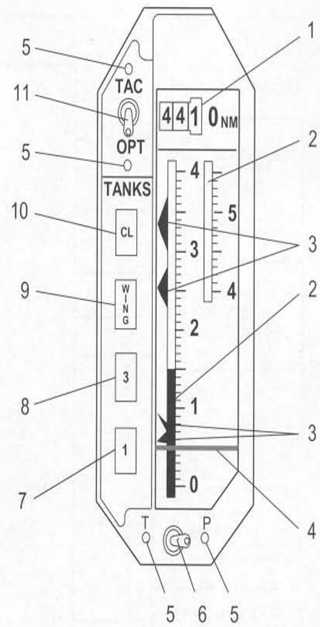
Four triangular shaped markers along the scale indicate the tolerable remaining fuel quantity when the particular tank empty caption illuminates. The markers point in the direction of the corresponding indicator caption.

Illumination of a tank empty caption with the fuel quantity above or below the applicable marker indicates a transfer system malfunction or a fuel leak.

The counter at the upper part of the indicator indicates the remaining flight distance based on actual or optimum flight conditions. A switch next to the counter selects actual or optimum range. Refer to figure 1-21.

NOTE

The fuel indicator has a tolerance of ±3 % of the maximum scale value.



1. REMAINING DISTANCE COUNTER
2. TOTAL QUANTITY SCALE
3. REMAINING QUANTITY MARKERS
4. MINIMUM QUANTITY MARKER (550 kg)
5. LED
6. T/P SWITCH
7. TANK 1 EMPTY LIGHT CAPTION
8. TANK 3 EMPTY LIGHT CAPTION
9. WING TANKS EMPTY LIGHT CAPTION
10. CL TANK EMPTY LIGHT CAPTION
11. DISTANCE COMPUTER MODE SWITCH
    TAC = WITH CURRENT FUEL CONSUMPTION
    OPT = WITH AN OPTIMIZED CALCULATED FUEL FLOW FOR MAXIMUM RANGE FLIGHT

Figure 1-21

REMAINING FUEL QUANTITY

TANK EMPTY	REMAINING FUEL IN KG	ILLUMINATED CAPTION
CL TANK	3 000 TO 3 700	CL
WING TANKS	2 300 TO 2 800	WING
TANK 3	700 TO 850	3
TANK 1	550 TO 700	1
TANK 2	470 TO 630	TLP: 550 KG REMAIN
	0 TO 100	NO BOOST

Figure 1-21A

AFTER MODIFICATION WITH WING DROP TANKS

The tape-type quantity scale has been modified to indicate the additional fuel available. Refer to figure 1-21B. Two markers are available for indication of the tolerable fuel quantity remaining when the CL tank is empty. The triangular marker on the left scale is applicable with no wing drop tanks installed, the marker lines on the right scale are applicable when carrying wing drop tanks.

NOTE

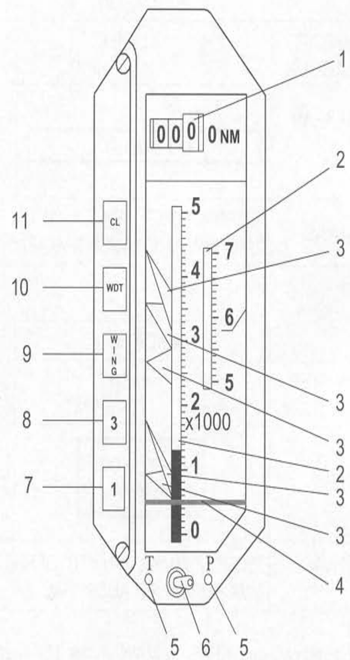
- During level, unaccelerated flight without afterburner, the tank 1 empty caption must not illuminate prior to illumination of the tank 3 empty caption.
- After all fuel from the wing drop tank has been transferred, the wing drop tank empty light caption may flash.

The counter at the upper part of the indicator shows the remaining flight distance based on actual flight conditions / current fuel flow.
The selector switch for optimum or actual range available has been removed.

Two LEDs next to the T/P switch illuminate when the respective position is selected with the T/P switch.

NOTE

The fuel indicator has a tolerance of ±3 % of the maximum scale value.



1. REMAINING DISTANCE COUNTER
2. TOTAL QUANTITY SCALE
3. REMAINING QUANTITY MARKERS
4. MINIMUM QUANTITY MARKER
5. LED
6. T/P SWITCH
7. TANK 1 EMPTY LIGHT CAPTION
8. TANK 3 EMPTY LIGHT CAPTION
9. WING TANKS EMPTY LIGHT CAPTION
10. WING DROP TANK EMPTY LIGHT CAPTION
11. CL TANK EMPTY LIGHT CAPTION

Figure 1-21B

REMAINING FUEL QUANTITY

TANK EMPTY	REMAINING FUEL IN KG	ILLUMINATED CAPTION
CL TANK	5 000 TO 5 700	CL
WING DROP TANKS	2 800 TO 3 500	WDT
INTERNAL WING TANK	2 300 TO 2 800	WING
TANK 3	550 TO 1 000	3
TANK 1	550 TO 1 000	1
TANK 2	470 TO 630	TLP: 550 KG REMAIN
	0 TO 100	NO BOOST

Figure 1-21C

INDICATIONS AND WARNINGS

	INDICATION	FAULT / EFFECT
MASTER CAUTION	LIGHT FLASHING	
AEKRAN	NO BOOST	Fuel pressure drop at the input of the fuel pumps. or: Total fuel quantity below 100 kg.
VIWAS	"BORDNUMMER, KEINE KRAFTSTOFFÖRDERUNG" "NACHBRENNER AUSSCHALTEN"	

	INDICATION	FAULT / EFFECT
MASTER CAUTION	LIGHT FLASHING	
TLP	550 KG REMAIN	Total fuel quantity below 550 kg.
VIWAS	"BORDNUMMER, KRAFTSTOFFREST 550 kg" "NACHBRENNER AUSSCHALTEN"	

The red caption 550 KG REMAIN on the TLP may illuminate occasionally during negative g flight or when the tank depletion sequence is disrupted.

	INDICATION	FAULT / EFFECT
MASTER CAUTION	LIGHT FLASHING	
AEKRAN	CHECK FUEL AMOUNT	After a delay of 35 to 50 seconds the indication is displayed when: measured fuel quantity is below 1 800 kg and the internal wing tanks are not empty; or: measured fuel quantity is below 1 800 kg and a difference of 550 kg to 750 kg between calculated and measured fuel exists; or: a difference of 200 kg to 350 kg exists between measured and calculated fuel quantity with tanks 1 and 3 empty.
VIWAS	"KONTROLLIERE KRAFTSTOFFVORRAT" "SCHALTE AUF VORRATSMESSER T"	

NOTE

Application of g-forces along the longitudinal axis with a duration in excess of 35 sec may cause the indication CHECK FUEL AMOUNT to illuminate until the g-forces subside.

	INDICATION	FAULT/EFFECT
MASTER CAUTION	LIGHT FLASHING	
AEKRAN	DROP TANK NO USAGE	After a delay of 20 to 35 seconds the indication is displayed when: the CL tank is not pressurized; or: when 120 kg to 360 kg of fuel have been used and CL tank fuel is not transferred.
VIWAS	"NICHTENTLEERUNG ZB" "SCHALTE AUF VORRATSMESSER T"	

AFTER MODIFICATION WITH WING DROP TANKS

	INDICATION	FAULT/EFFECT
MASTER CAUTION	LIGHT FLASHING	
AEKRAN	DROP TANK NO USAGE	After a delay of 20 to 35 seconds the indication is displayed when: the CL tank is not pressurized; or: when 120 kg to 360 kg of fuel have been used and CL tank fuel is not transferred.
VIWAS	"NICHTENTLEERUNG RUMPFZUSATZBEHÄLTER" "SCHALTE AUF VORRATSMESSER T"	

	INDICATION	FAULT/EFFECT
MASTER CAUTION	LIGHT FLASHING	
TLP	WDT NO PRESS	Wing drop tank pressurization/transfer failure.
VIWAS	"KEINE BELÜFTUNG DER TRAGFLÜGELZUSATZBEHÄLTER"	

If a BINGO FUEL has been selected with the fuel return selector knob on the fuel signals calibration panel, the following announcement is displayed when the selected fuel quantity is reached.

VIWAS	"BINGO FUEL" - "BINGO FUEL" - "BINGO FUEL"

	INDICATION	FAULT/EFFECT
MASTER CAUTION	LIGHT FLASHING	
TLP	WDT TEST	Indicates a valid system check if the WDT TEST button on the control and test panel on the right console is pressed without engines running.

ELECTRICAL POWER SUPPLY SYSTEM

The electrical power supply system consists of the power generating system and the control and monitoring system. The power generating system is composed of the AC generator, the DC generator, the converter, the batteries and the distribution network.

The control and monitoring system interacts with various other aircraft systems, e.g., engines, fuel system, fire extinguisher system etc.

AC ELECTRICAL POWER

One three-phase 115 / 200 V, 400 Hz constant frequency generator is the primary source of AC power. The generator is equipped with a regulator and overload protection device. Refer to figure FO-9. It is attached to the aircraft GBX. The AC generator is regulated by a hydrodynamic constant speed drive to ensure a stable RPM, regardless of engine RPM and generator load.

Maximum power output of the generator is 30 kVA. A transformer supplies three-phase 36 VAC power at a maximum output of 1.5 kVA. In case of a generator failure or a shut-down triggered by the regulator and protection device or in case of a transformer failure, the systems essential for flight are powered by the DC / AC converter, PTO.

DC ELECTRICAL POWER

One DC generator 28.5 V ±0.5 V, 400 A, 12 kW is the primary source of DC power. The DC generator is equipped with a regulator and overload protection device. Refer to figure FO-10.

This regulator and overload protection device ensures a DC regulated power output and protects the generator and the DC buses against overvoltages as well as short circuits in the generator itself.

DC / AC CONVERTER PTO

A DC / AC converter supplies emergency power in case of an AC generator failure or a transformer failure. The PTO is capable of delivering 115 VAC at a minimum output of 1.5 kVA and three-phase 36 VAC at a minimum output of 1 kVA. If PTO operation is caused by a transformer failure, the LRF, the angular rate sensors of the flight control system and course and glidepath indications of the approach mode render inoperative. In case of an AC generator failure, all systems not essential for flight are automatically disconnected. Refer to electrical system failures section 3.

BATTERIES

Two silver-zinc batteries serve as an emergency power source. Nominal voltage of the batteries is 27.6 V, however, under load (200 A), a minimum of 22 V is delivered.

NOTE

Since the charging voltage of the silver-zinc batteries is higher than the generator voltage, the batteries will not be charged when the generator power is available.

The batteries supply power to the DC bus during:

- Engine start with internal power.
- When the DC generator voltage drops below battery voltage.
- DC generator failure.

EXTERNAL POWER SUPPLY

External DC and / or AC power may be supplied to the aircraft for start-up or alignment purposes. Regardless of whether external power is connected or not, the BAT-GND SUPPLY switch must be switched ON to energize the DC bus of the aircraft. The voltmeter will indicate a voltage in excess of 22.5 V in case the external power is connected and the engines are off.

CONTROLS AND INDICATORS

The controls for the electrical power supply system are located on the electrical power panel. Refer to figure 1-22. The DC power can be checked with a DC voltmeter located on the lower center part of the vertical panel. It measures the voltage of the DC source actually connected with the DC bus.

The charge of the batteries can be checked on the Ah counter in the nose section.

ELECTRICAL POWER PANEL

The electrical power panel is located on the RH console. It contains the switches for the electrical power system and for essential engine control components.

The two-position toggle switches have the following functions:

BAT-GND SUPPLY	Engagement of the batteries.
DC GEN	Engagement of the DC generator.
AC GEN	Engagement of the AC generator.
PTO	Engagement of the DC / AC converter.
ENG SYS	Engagement of various engine control components. Refer to engine controls and indicators in this chapter and figure FO-10.
FUEL PUMP	Activation of the engine fuel pump, refer to fuel boost system in this chapter.
ANTI SURGE	Engagement of the engine anti-surge system, refer to engine controls and indicators in this chapter.

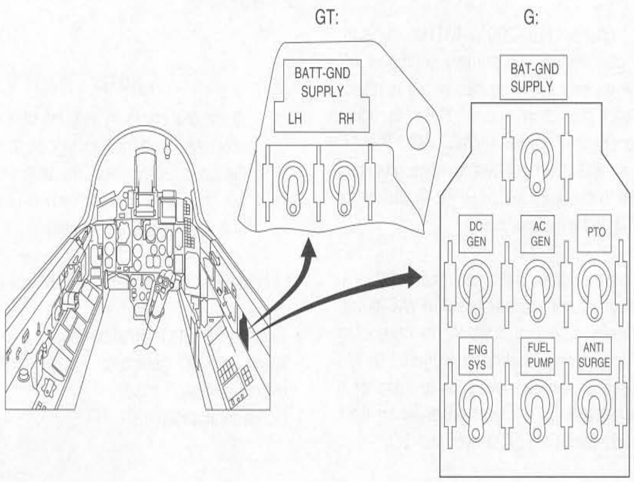


Figure 1-22

INDICATIONS AND WARNINGS

In case of an AC generator failure or a shut-down triggered by the regulator and overload protection device, the most important consumers will be powered by the DC / AC converter.

To prevent a converter overload, the following consumer are automatically shut off:

- Heaters for the main and standby inertial navigation platform
- Radar system and the optical sight, with the exception of the navigation system
- IRSTS / LRF and HMS
- LH AOA probe heater and side slip vane heater
- Windshield heaters, upper and central section
- AFCS system
- The external armament
- IFF altitude encoder

	INDICATION	FAULT / EFFECT
MASTER CAUTION	LIGHT FLASHING	
AEKRAN	AC GEN	AC generator failure or RPM of both engines below 55 %.

The constant speed drive of the AC generator is a hydrodynamic transmission with the generator drive shaft running at 12 000 RPM. An electromagnetic clutch connects the drive shaft to the AC generator and provides for automatic or manual disconnect in case of an constant speed drive failure:

Automatic	If the drive shaft speed is increased to 14 300 to 14 500 RPM, equivalent to a frequency of 465 to 480 Hz.
Manual	If the oil pressure of the constant speed drive drops below 10 kp/cm^2 (1 MPa) or the oil temperature is to high, with the GEN DRIVE EMERG OFF switch.

Illumination of the indication DISCON GEN DRIVE indicates the need for a disengagement of the constant speed drive. Successful cut-off is indicated by illumination of the AC GEN indication.

CAUTION

To avoid serious damage or destruction of the AC generator, the constant speed drive has to be disconnected manually as soon as possible if the DISCON GEN DRIVE indication is displayed. The GEN DRIVE EMERG OFF switch on the emergency panel must be held to the spring-loaded position for a maximum of 25 seconds for generator cut-off and for avoidance of demage to electrical circuits.

	INDICATION	FAULT / EFFECT
MASTER CAUTION	LIGHT FLASHING	
AEKRAN	DISCON GEN DRIVE	Oil pressure of the constant speed drive is below 10 kp/cm^2 (1 MPa) or the oil temperature is to high or generator drive shaft speed has increased to 14 300 to 14 500 RPM, equivalent to a frequency of 465 Hz to 485 Hz.
	AC GEN	Successful automatic or manual disconnect in conjunction with a constant speed drive failure.

If overvoltage or short circuit conditions occur in the DC power supply system, the regulator and overload protection device will disconnect the generator from the DC bus. This fail condition can be reset by the ground crew only.

	INDICATION	FAULT / EFFECT
MASTER CAUTION	LIGHT FLASHING	
AEKRAN	DC GEN WATCH TIME	DC generator failure.
VIWAS	"AUSFALL GLEICHSTROMGENERATOR" "DÄMPFUNG AUS, NB AUS, SN-29 AUF HAND"	

If both generators fail, the voice information and warning system will give a corresponding message as well.

	INDICATION	FAULT / EFFECT
MASTER CAUTION	LIGHT FLASHING	
AEKRAN	TWO GEN WATCH TIME	AC and DC generator failure.
VIWAS	"AUSFALL GLEICHSTROMGENERATOR" "DÄMPFUNG AUS, NB AUS, SN-29 AUF HAND"	

HYDRAULIC POWER SUPPLY SYSTEM

The aircraft hydraulic system consists of two independent systems, the main hydraulic system and the hydraulic boost system. Refer to figure FO-11.

The main hydraulic system provides:

- Operation of the second chamber of the hydraulic actuators of the tailerons, the ailerons, the rudders, and of the hydraulic actuator of the AOA limiter system (COC).
- Extension and retraction of landing gear, flaps / LEF and speedbrakes.
- Control of the variable air intake ramps, the actuator of the APU exhaust door, the nose wheel steering and damper system and the hydraulic actuator of the rudder feel force system.

The hydraulic boost system provides:

- Operation of the first chamber of the dual chamber hydraulic actuators of the tailerons, the ailerons, the rudder and the hydraulic actuator of the AOA limiter system (COC).

HYDRAULIC FLUID RESERVOIRS

The hydraulic fluid reservoirs are located inside fuel tank 3 and ensure normal operation of the pumps under all flight conditions. Due to the arrangement of the two-chamber configuration, they will feed the pumps even during negative g flight.

The reservoirs are filled-up as a closed system through filler caps in the return lines.

To avoid cavitation at the inlet of the hydraulic pumps, the reservoirs are pressurized with low-pressure compressed air.

The necessary compressed air is attained from the main pneumatic system through a pressure regulator valve.

Safety relief valves are incorporated to prevent overpressurization.

HYDRAULIC PUMPS

Both systems are powered by variable volume piston pumps, one for each system, flanged to and driven by the GBX. The pumps operate at a pressure between 190 kp/cm^2 (19 MPa) and 220 kp/cm^2 (22 MPa).

A pressure limiter and isolation valve is installed in the high-pressure lines of the main system. If the pressure drops below 130 kp/cm^2 (13 MPa), it will disconnect all systems except the flight controls and supply only one chamber of tailerons, ailerons, rudders, flaps / LEF and AOA limiter actuator.

To protect the hydraulic lines, pressure relief valves are installed in the main and the boost hydraulic system. The valves open at a pressure of 240 kp/cm^2 (24 MPa) and discharge hydraulic fluid into the return lines.

An emergency hydraulic pump installed in the hydraulic boost system supports basic control functions of the aircraft at an RPM of both engines of at least 85 %. Although the pump delivers hydraulic pressure of up to 240 kp/cm^2 (24 MPa), the delivery rate permits only severely degraded aircraft control. This pump is driven by fuel pressure and is activated automatically whenever the system pressure of both systems drops below 100 kp/cm^2 (10 MPa). It can also be activated manually with the EMERGENCY HYDR PUMP switch located on the control panel next to the CHUTE JETTISON button.

HYDRAULIC ACCUMULATORS

Accumulators in the main and boost systems store a supply of high pressure fluid to damp pressure surges caused by sudden variations in flow demands.

Both accumulators are charged with nitrogen at 80 kp/cm^2 (8 MPa) which corresponds with the marking P_{AK} on the combined pressure indicator (CPI).

HYDRAULIC COOLING

Installation of the hydraulic reservoirs in the fuel tank 3 ensures adequate cooling of the hydraulic fluid due to heat exchange with fuel.

CONTROLS AND INDICATORS

Both hydraulic fluid reservoirs are equipped with level transmitters connected to level indicators installed in the central refueling control panel located in the left main wheel well.

The actual hydraulic pressures of the main system as well as of the boost system are displayed on the CPI. The indicator utilizes 115 VAC power from the AC generator.

COMBINED PRESSURE INDICATOR

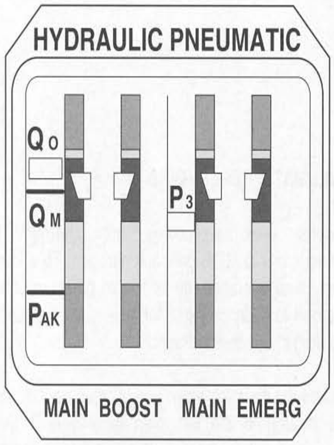


Figure 1-23

The transmitters for this indicator are connected to the nitrogen gas side of the accumulators. Therefore the CPI will indicate nitrogen pressure P_{AK} when the hydraulic system pressure is zero.

Whenever one engine has reached a minimum of 20 % RPM, the hydraulic pressures must be within the green areas on the indicator.

These green areas contain two markers, Q_0 and Q_M which indicate hydraulic pump performance.

Q_0 is the marker for the system pressure with none of the actuators moving, i.e. zero delivery of the pumps.

Q_M is the marker for the system pressure with the hydraulic actuators moving with maximum velocity.

NOTE

During engine start at low ambient temperatures and increased hydraulic fluid flow rate, the hydraulic pressure indication may drop into the yellow area.

INDICATIONS AND WARNINGS

Whenever the pressure of one of the hydraulic systems drops below 100 kp/cm^2 (10 MPa), the respective warning indications are displayed.

NOTE

If hydraulic system pressure is regained, the respective warning indications extinguish.

The AFCS is disengaged if the pressure in both systems drops below 100 kp/cm^2 (10 MPa) until pressure is regained.

With the emergency hydraulic pump running, pressure in the boost hydraulic system may increase up to 240 kp/cm^2 (24 MPa) at zero delivery rate. Whenever a pressure above 100 kp/cm^2 (10 MPa) is regained, the DOUBLE HYD SYS indication on the TLP and the BOOST HYD SYS indication on the AEKRAN extinguish.

WARNING

With the emergency hydraulic pump running, boost hydraulic system pressure may be regained at low or zero delivery rates. Therefore, extinguishing of the double hydraulic system indications must be considered temporary and the situation continued to be treated as a double hydraulic system failure.

	INDICATION	FAULT / EFFECT
MASTER CAUTION	LIGHT FLASHING	Both hydraulic systems below 100 kp/cm^2 (10 MPa), emergency hydraulic pump activated.
TLP	DOUBLE HYD SYS / EMERG HYD PUMP ON	
AEKRAN	BOOST HYD SYS MAIN HYD SYS	
VIWAS	"AUSFALL HYDRAULIKVERSTÄRKERSYSTEM" "NOTAUSFAHREN FAHRWERK BEI 500" "AUSFALL HYDRAULIKHAUPTSYSTEM" "NOTAUSFAHREN FAHRWERK BEI 500"	

PNEUMATIC POWER SUPPLY SYSTEM

The pneumatic power supply system consists of two independent systems, the main and the emergency power supply system. Refer to figure 1-24.

The main system supplies nitrogen pressure to operate the:

- Wheel brakes
- Canopy and canopy seals
- Drag chute
- Fuel shut-off valves
- Radio and radar equipment pressurization
- Venting of the hydraulic reservoirs

GT: Periscope system

The emergency system supplies nitrogen pressure to ensure the:

- Emergency gear extension
- Emergency braking of the main wheels

PNEUMATIC RESERVOIRS

Several pressure bottles are charged to 150 kp/cm^2 (15 MPa) gaseous nitrogen. To ensure drag chute operation, an additional pressure bottle charged to 63 kp/cm^2 (6.3 MPa) is located close to the drag chute compartment.

A common charging valve and a pressure indicator are located in the left main landing gear bay. Crossfeed between the systems is prevented by check valves in the interconnecting lines.

NOTE

The pneumatic power supply system is not charged during flight.

CONTROLS AND INDICATORS

Pressure indicators are integrated in the CPI located at the right side of the main vertical cockpit console.

Two scales display main and emergency pneumatic system pressure. For normal operation, the pressure must remain in the green area.

PNEUMATIC POWER SUPPLY SYSTEM

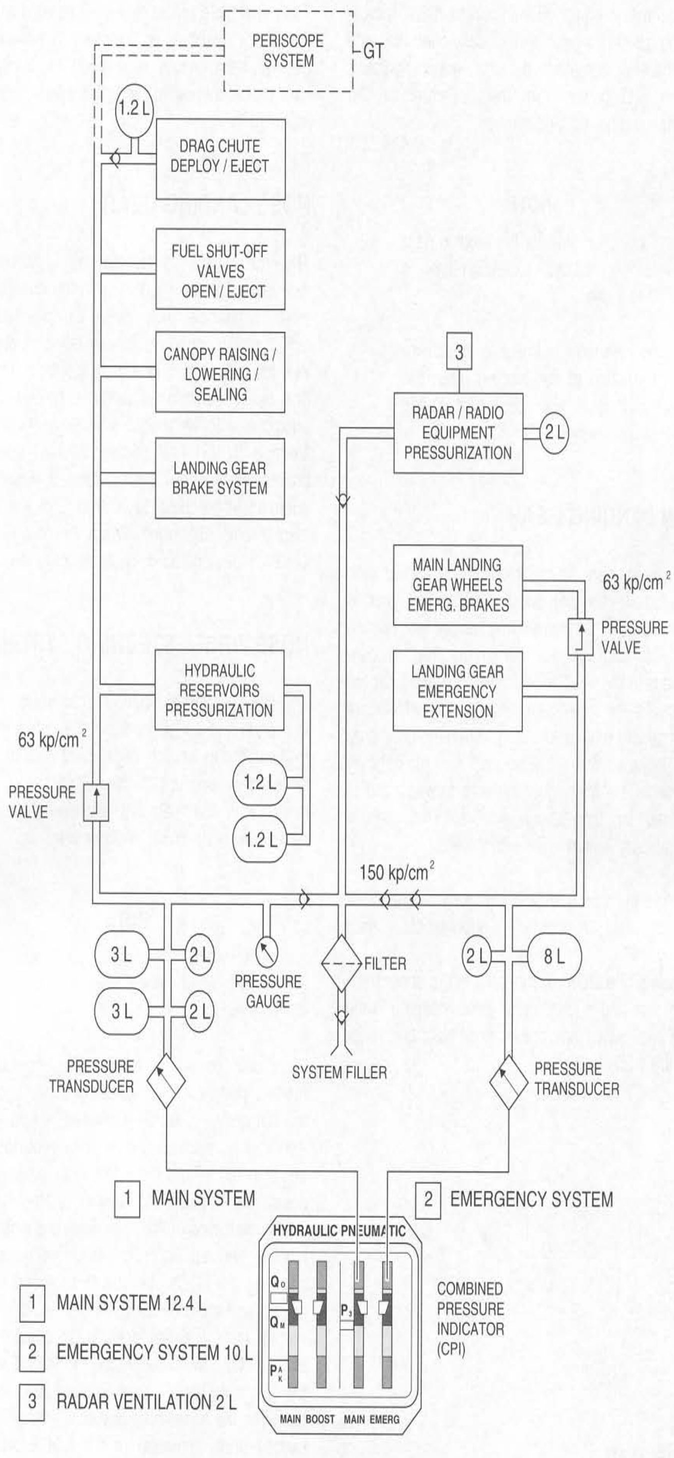


Figure 1-24

LANDING GEAR SYSTEM

The aircraft is equipped with a retractable tricycle landing gear. The gear is electrically controlled and hydraulically actuated by the main hydraulic system. DC power from the generator or the batteries is required for operation.

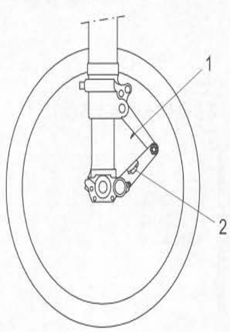
NOTE

- Retraction time for the landing gear is 9 to 10 sec, extension time is 7 to 8 sec.
- Simultaneously to the extension or retraction of the landing gear, the APU doors are opened or closed respectively.

MAIN LANDING GEAR

Each main gear is hydraulically retracted and extended. In the extended position the gear is locked down by an internal mechanical lock in each gear actuating cylinder. When the landing gear handle is in the position RETRACTED, the gear will retract. As the main gear retracts, the wheels are automatically braked to a stop. When the gear is up and locked, brake pressure is automatically released. The main gear retracts forward and is enclosed by three fairing doors. The gear is mechanically locked in the wheel wells.

The right main gear strut is equipped with a shock detector plate to indicate evidence of a hard landing.
It consists of a steel pin mounted in the upper track swivel arm and a small metal plate mounted in the lower track swivel arm of the shock absorber. Refer to figure 1-25.



1. PIN
2. METAL PLATE

Figure 1-25

The metal plate will be dented or pierced whenever the shock absorber is compressed beyond limits during a hard landing. As a result, the landing gear has to be inspected and the plate has to be replaced.

NOSE LANDING GEAR

The nose gear is hydraulically retracted and extended. The gear is locked in the down position by a mechanical lock inside the gear actuating cylinder. A mechanical lock installed in the wheel well locks the gear in the up position. The nose gear retracts aft into the fuselage. The nose gear is equipped with twin nose wheels, a nose wheel steering (NWS) and damper system and wheel brakes. As the nose gear retracts, the wheels are automatically braked to a stop and the strut is mechanically shortened. When the gear is up and locked, brake pressure is automatically released.

NOSE WHEEL STEERING SYSTEM

The NWS system provides two steering modes, a low mode and a high mode. In the low mode, used for takeoff and landing, nosewheel deflection up to 8° to either side is possible. For taxiing, the high mode may be selected allowing nose wheel deflections of up to 31° to either side.

NOTE

Activating the high mode causes the nose wheel brakes to be disabled.

Directional control is obtained by operating the rudder pedals. The nose gear is controlled mechanically, and operated hydraulically. Additionally, electrical power is needed to engage the high mode and simultaneously disengage the nosewheel brakes. A damper system prevents lateral oscillation of the nose wheels during takeoff, landing and taxiing. High mode is engaged by pressing the LOCK ON button, provided the flaps are up and the MRK EMERG OFF switch is in the normal (safety wired) position. In case the MRK EMERG OFF switch is placed to the OFF position, the high steering mode cannot be activated, however, the nosewheel brakes will be disabled as usually upon actuation of the LOCK ON button. When the nose gear is retracted, NWS is disconnected mechanically.

LANDING GEAR EMERGENCY LOWERING SYSTEM

The aircraft pneumatic system provides compressed air to extend the landing gear, regardless of the landing gear handle position. Either the nose gear only, or nose and main gear can be extended. Pulling the EMERG GEAR handle aft directs compressed air to the nose gear hydraulic actuator to extend the nose gear. A pneumatic shut-off valve closes the hydraulic lines to prevent inadvertent gear retraction in case hydraulic pressure is regained. After the nose gear is confirmed fully extended, rotating the EMERG GEAR handle 90° clockwise and pulling full aft activates the main gear hydraulic actuators to extend the main gear. The hydraulic lines are shut-off by pneumatically driven shut-off valves. Normal gear down indication on the landing system signal panel is achieved after all gears are fully extended.

CONTROLS AND INDICATORS

Landing Gear Handle

The landing gear is controlled by a handle on the left side of the instrument panel. Refer to figure 1-25A. To move the handle up or down, it has to be pulled to override a stop. Placing the handle in the RETRACTED or EXTENDED position uses DC power to actuate hydraulic valves to position the landing gear.

Emergency Landing Gear Lowering Handle

A red handle, marked EMERG GEAR is located beneath the left front panel. It is used to lower the landing gear pneumatically.

NOTE

> After the landing gear has been extended with the emergency gear lowering system, normal gear retraction is not possible.

MRK EMERG OFF Switch

The MRK EMERG OFF switch is used to disable the high mode of the NWS system.

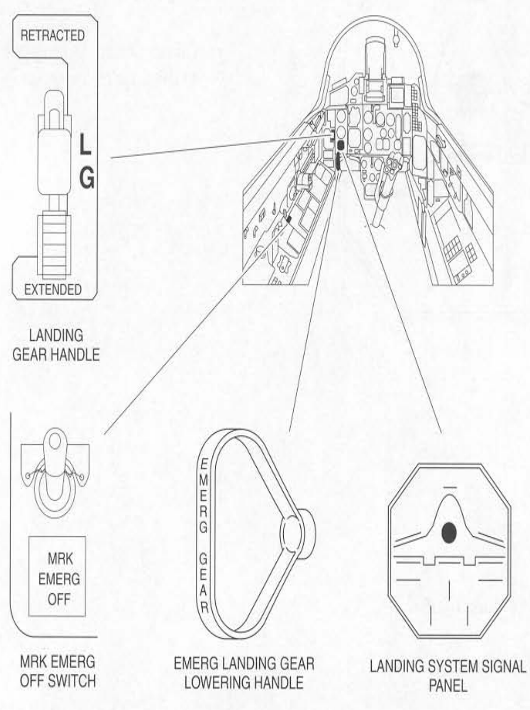


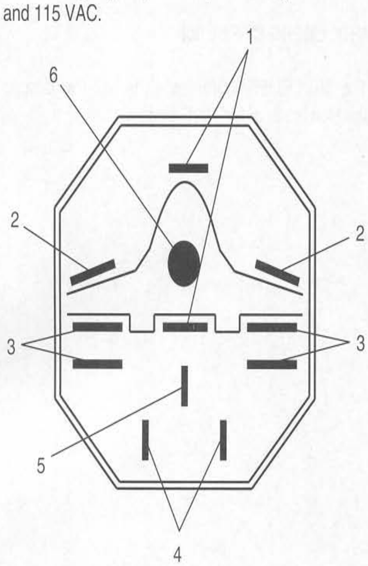
Figure 1-25A

LANDING SYSTEM SIGNAL PANEL

The landing system signal panel (refer to figure 1-25B) provides the following indications:

- Three green lights, one for each landing gear, illuminating when the respective landing gear is down and locked.
- One red warning light that illuminates if any gear is not locked in the position corresponding to the gear handle position.
  The light flashes, if one gear is locked up and the landing gear handle is down or if the landing gear handle is up and the trailing edge flaps are down.
- Four rectangular green lights, two for each trailing edge flap, which illuminate when the flaps are down.
- Two rectangular green lights, one for each LEF, which illuminate when the LEF are down.
- Two rectangular orange lights, one for each speedbrake, which illuminate when the doors are open.

The landing signal panel is powered by 28.5 VDC and 115 VAC.



1. SPEEDBRAKES
2. LEF
3. FLAPS
4. MAIN LANDING GEAR
5. NOSE LANDING GEAR
6. RED LIGHT

Figure 1-25B

LANDING GEAR OPERATION

When the landing gear is selected to RETRACTED, the green lights on the landing system signal panel extinguish as soon as the corresponding gear is unlocked. Simultaneously the red warning light illuminates and remains on until all gears are retracted.

When the landing gear is selected to EXTENDED, the red warning light on the landing system signal panel illuminates. As soon as the landing gear is down and locked, the corresponding green lights on the signal panel illuminate and the red light extinguishes.

The LEF extend automatically when the landing gear is lowered.

WARNING

- There is no warning feature to avoid the risk of an inadvertent gear up landing, except when the trailing edge flaps are down. In this case, a flashing red light on the landing system panel, AEKRAN and VIWAS will remind the pilot to extend the gear.
- Do not put the landing gear handle to UP while on the ground.

BRAKE SYSTEM

The main wheels and the nose wheels are equipped with a pneumatically operated brake system for normal operation.

Additional features are a run-up brake and a nose wheel brake handle to disable the nose wheel brakes if required.

An emergency brake system is available for the main wheels in case of normal brake system failure.

Normal braking action is accomplished by pulling the brake lever at the control stick aft. The braking force is proportional to brake lever displacement. Differential braking is achieved by displacing the rudder pedals. Moving the right rudder pedal forward, releases brake pressure from the left main wheel brake and vice versa. For engine run-up the run-up brake lever has to be pulled together with the brake lever to achieve a higher brake force preventing the aircraft from rolling, refer to figure 1-26.

CAUTION

Under no circumstances, use the run-up brake to slow down the aircraft.

The rims of both main landing gear wheels are equipped with four fuse plugs each. Three of them, with a melting point of 126° C ±1° C, are mounted in the wheel flange, spaced 120° apart. If any of these fuse plugs has melted, it indicates an overheat condition of the brake system, requiring a system checkout. If all three plugs have melted, the entire wheel rim must be considered damaged beyond repair.

The fourth fuse plug, with a melting point of 143.5° C ±1.5° C, is mounted opposite the tire inflation valve. If this plug melts, the air from the tire is released completely and the brakes must be considered defective.

ANTI-SKID SYSTEM

The aircraft wheel brake system is equipped with an electromechanical controlled anti-skid system. It consist of two basic units, a wheel driven mechanical sensing unit and an electrically driven pneumatic valve. The units are designed to give individual anti-skid protection to each main wheel, and to both nose wheels if either one begins to skid.

The system utilizes DC power from the generator or the batteries. It is activated by placing the BAT-GND SUPPLY switch to on.

Whenever a wheel starts to skid, the wheel driven mechanical sensor closes an electrical switch, which causes the electrically driven pneumatic valve to release pneumatic air pressure from the adjacent brake. Once the wheel has regained its speed, the sensor reopens the switch and braking action is resumed.

CAUTION

Applying brake pressure during touchdown will cause the anti-skid system to be inoperative momentarily. Brakes should not be applied until all gears, including the nose gear, have touched down.

EMERGENCY BRAKE SYSTEM

Pulling the emergency brake handle disables the normal braking system and directs compressed air from the aircraft pneumatic system to the main wheel brakes only. Braking action is degraded approximately 40 % compared to normal braking. Differential braking is not possible. The pressure applied to the brakes is linearly proportional to the displacement of the handle. Releasing the handle relieves brake pressure, refer to figure 1-26.

CAUTION

The anti-skid system is inoperative when the EMERG BRAKE handle is pulled.

NOTE

Emergency brakes are not to be used for normal taxiing.

BRAKE SYSTEM CONTROLS AND INDICATORS

BRAKE PRESSURE INDICATOR

The pneumatic control pressures for the left and right main wheel brakes are monitored by a double pointer instrument. Actual brake pressure is three times higher than the indicated control pressure.

NOSE WHEEL BRAKE HANDLE

The nose wheel brake handle is located on the front panel and is moved to the OFF position to disable the nose wheel brake system. Nose wheel brake pressure is twice as high as the control pressure.

EMERGENCY BRAKE HANDLE

The red emergency brake handle is located on the upper left side of the instrument panel and is labeled EMERG BRAKE. Pulling the handle activates the emergency brake, refer to figure 1-26.

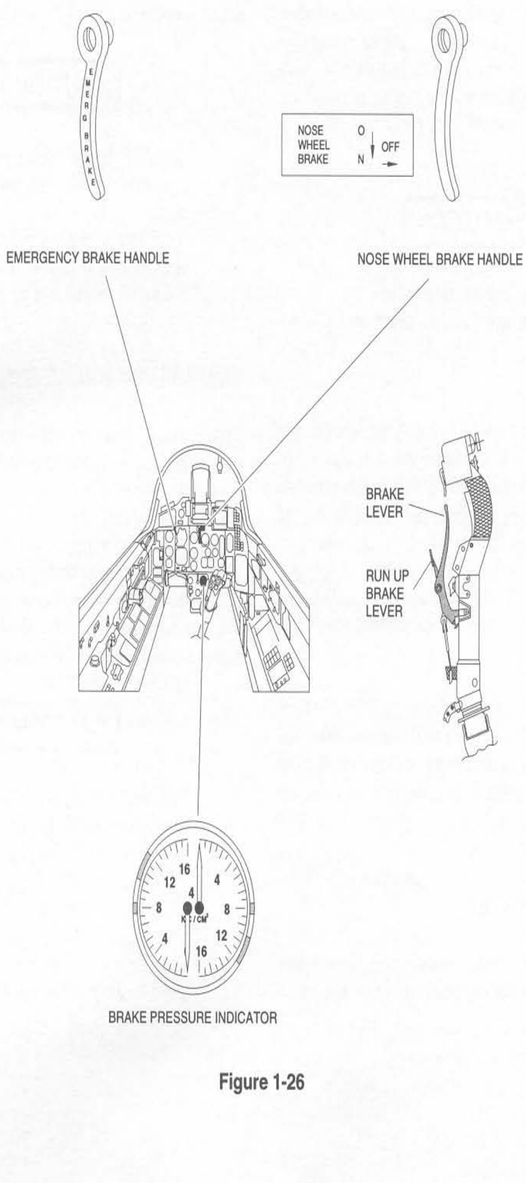


Figure 1-26

DRAG CHUTE SYSTEM

A drag chute, contained in the aft section of the fuselage between the speedbrake doors, reduces landing roll distance. A red control pin is visible whenever the jaws of the attaching mechanism are open. It is pulled into the airstream by a pilot chute when the electrically controlled, pneumatically operated compartment door is opened.

In case of main pneumatic system failure, the system is buffered by a reservoir of 1.2 l, refer to figure 1-24.

If the compartment door opens inadvertently during flight, the chute is allowed to separate from the aircraft by means of a shear bold connecting the chute to the attaching mechanism.

NOTE

The drag chute will separate from the aircraft when exceeding a speed of 175 KIAS.

DRAG CHUTE OPERATION

The drag chute is deployed by pressing the CHUTE DEPLOY button beneath the left canopy rail. Pushing the button activates a pneumatic valve to open the chute compartment door. The spring-loaded pilot-chute pops out and pulls out the drag chute. The drag chute is jettisoned by pressing the CHUTE JETTISON button on the left side panel. To prevent unintentional chute release, the CHUTE JETTISON button is deactivated until the CHUTE DEPLOY button has been depressed.

Use of drag chute is mandatory for:

- Landing immediately after takeoff
- Landing on a wet RWY
- Short field landings
- Landing without LEF
- Abort after nose wheel lift off
- Feel unit is in the position heavy

WING FLAP SYSTEM

The flap system provides an automatic LEF configuration for in-flight maneuvering and a selective flap configuration for takeoff and landing. Each wing has two independent LEF, the root section consisting of three interconnected segments, and the unique end section.

A single slotted flap is mounted on the trailing edge, adjacent to the fuselage. The LEF and the flaps are electrically selected and operated by the main hydraulic system.

The LEF incorporate hydraulic locks, which lock them in either the in or out position.

The flaps are locked in the up position only. The extended position depends on hydraulic pressure only, and as airspeed increases, the flaps are partially blown up by the airstream.

SELECTIVE FLAPS

For takeoff and landing, LEF and the flaps operate together. Anytime the flaps are selected down, the LEF extend automatically. However, if the landing gear is extended, the LEF are extended, regardless of the flaps position.

MANEUVERING LEF

With the flaps in the position UP, the LEF operate automatically as a function of AOA and airspeed. When the AOA is increased to 8.7° or above and the airspeed is below M $0.8^{+0.1}_{-0.05}$, the LEF extend automatically. The LEF retract when the AOA decreases to 7° or airspeed increases above M $0.8^{+0.1}_{-0.05}$. The exact mach number is dependent on the switching point of the mach sensor installed.

CONTROLS AND INDICATORS

Flap operation is controlled by three pushbuttons on the left console. Two are marked FLAPS DOWN, one FLAPS UP. Pushing either FLAPS DOWN button extends all flaps. Pushing the FLAPS UP button will retract the flaps and the LEF, provided the gear is up, refer to figure 1-27.

The position of each flap/LEF is indicated individually by the corresponding light on the landing system signal panel, refer to figure 1-25.

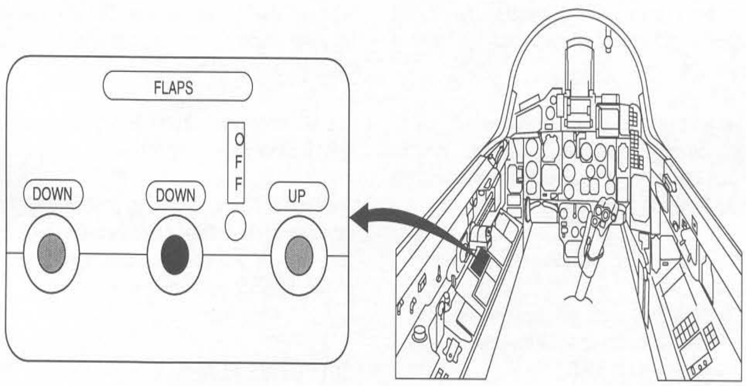


Figure 1-27

SPEEDBRAKE SYSTEM

Electrically controlled, hydraulically operated speedbrakes are mounted above and beneath the drag chute compartment.

The two surfaces are operated simultaneously, but they are not synchronized.

A blow-back feature is incorporated, providing structural protection of the actuators and speedbrake surfaces at airspeeds above 540 KIAS.

The speedbrakes are operated by a spring-loaded switch located on the RH throttle, refer to figure 1-11. It returns automatically to the IN-position upon release. Full extension is achieved within 3 sec.

To protect the operation of the taileron, the speedbrakes are electrically deactivated if main or boost hydraulic pressure decreases. If the boost hydraulic pressure drops below 100 kp/cm^2 (10 MPa), the speedbrakes are retracted automatically by the main hydraulic system. If the main hydraulic pressure drops below 100 kp/cm^2 (10 MPa), the speedbrakes are pushed in by the air stream.

NOTE

Speedbrake operation is not possible with the centerline tank installed, or the gear extended. If total electrical failure occurs, the speedbrakes will retract automatically.

FLIGHT CONTROLS

The aircraft primary flight controls consist of the tailerons, rudders and ailerons. Artificial feel systems provide simulated aerodynamic forces to control stick and rudder pedals. Secondary controls are LEF, flaps and speed brakes. Mechanical linkages transmit control inputs to dual irreversible hydraulic actuators mounted next to the corresponding control surface. All primary flight controls are operated by the main and boost hydraulic system. Full control command is retained if the main or boost hydraulic system fails.

If both systems fail, an emergency hydraulic pump supplies pressure to the boost system, provided hydraulic fluid is still available, refer to FO-11.

WARNING

- If the emergency hydraulic pump has to be used, control will be severely degraded
- In order to maintain aircraft control as long as possible, flight control inputs must be smooth and kept to a minimum.

TAILERONS

Longitudinal control is provided by synchronized deflection of the tailerons. Partial lateral control is achieved by differential deflection. Maximum pitch authority is 15° nose down and 35° nose up. Differential taileron deflection is limited to ± 5°. Taileron authority is varied as a function of airspeed and altitude. It is limited to a minimum of 5°45' nose down and 17°45' nose up near ground level at speeds between 470 KTAS and 650 KTAS. Differential taileron is disabled when the LEF are extended.

AILERONS

Lateral control is provided mainly by the ailerons, assisted by the tailerons if the LEF are IN, and by the rudders at high AOA, provided the stability augmentation system is operating. Maximum aileron deflection is 25° up and 15° down from the neutral position. To prevent excessive yaw during rolls, the neutral position is 5° up from the aircraft horizontal reference line. For the same reason, aileron authority is reduced above 18° AOA.

RUDDERS

The aircraft vertical stabilizers are equipped with small rudders, deflecting 25° to either side. The rudder feel gradient is increased by 30 kp at a rudder pedal deflection of 24 mm from the trimmed position
G: at airspeeds above M 0.8
GT: with gear up.

It is strongly recommended not to override the artificial stop.

CAUTION

To prevent overstress of the vertical stabilizers it is prohibited to override the rudder artificial stop at airspeeds
G: >485 KIAS,
GT: >432 KIAS.

ARTIFICIAL FEEL SYSTEM

Artificial feel is provided by a system of springs. The artificial feel applies centering forces to the stick and the rudder pedals towards the trimmed position.

FEEL CONTROL UNIT

The pitch feel control unit utilizes signals from the air data computer to control an electric actuator gearbox. This gearbox varies the length of a rod by up to 50 mm, to change the stick to taileron linkage ratio. This results in alteration of the taileron deflection range and required stick force with respect to aerodynamic forces, i.e. airspeed and altitude. The FEEL UNIT TO / LD light on the TLP illuminates whenever the feel control unit is in the easy position, e.g. during takeoff and landing. Refer to figure 1-29.

At altitudes below 3000 ft, the length of the variable rod depends on airspeed only. At 215 KTAS, the rod starts to retract. It is fully retracted at 470 KTAS and stays fully retracted up to 650 KTAS. At 650 KTAS, the rod starts to extend again and is fully extended at 810 KTAS, the FEEL UNIT TO / LD light illuminates again.

At altitudes above 3000 ft, rod retraction becomes smaller with increasing altitude. Above 30 000 ft, it is always fully extended. For detailed operation see figure 1-28.

If the feel control unit fails, it can be controlled manually with the FEEL UNIT control switch on the left console. Refer to figure 1-29.

WARNING

If the feel control unit fails, stick movements should be minimized to prevent PIOs.

FEEL CONTROL UNIT SCHEDULE (PITCH)

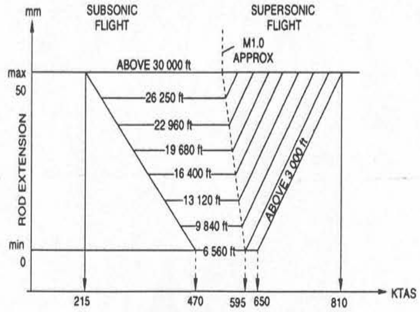


Figure 1-28

INDICATION AND WARNINGS

	INDICATION	FAULT/EFFECT
AEKRAN	FEEL CONT UNIT	Feel control unit out of limit
VIWAS	"AUSFALL ARU" "VOR LANDUNG AUF STELLUNG LEICHT"	

ROLL

Roll feel forces are generated by a mechanical spring unit with linear force characteristics. Non linearities are induced with the stability augmentation system engaged to provide low sensitivity for small control inputs and high sensitivity for large control inputs.

YAW

Pedal feel forces are generated by a spring unit system with linear force characteristics. When the gear is retracted, a hydraulic actuator adds additional centering forces at airspeeds higher than M 0.8 and rudder pedal displacements of more than 24 mm, equivalent to 6° rudder deflection.

TRIM SYSTEM

The trim system is used to relieve control stick pressure. Actuating a trim switch causes the appropriate trim actuator to move either in yaw, roll or pitch.

PITCH TRIM

Pitch trim is affected by a trim actuator incorporating an electric motor. When operated, the trim actuator varies the translation ratio of the taileron linkages, which in turn provides a new stick center position. Trim authority is 80 % of available taileron deflection.

ROLL TRIM

Roll trim is similarly affected by an electric motor driving a trim actuator. Trim authority is 60 % of available aileron deflection.

YAW TRIM

Yaw trim is similarly affected by an electric motor driving the trim actuator. Trim authority is 60% of the available rudder deflection.

CONTROLS AND INDICATORS

Trim Button Unit

The trim button unit on the control stick grip consists of a pyramid cap which houses two toggle switches. It provides trim control in the pitch and roll axis. The trim button is springloaded to the center and can be moved forward, aft, left and right.

Rudder Trim Switch

The rudder trim switch is located on the left vertical panel.

Trim Indicators

Three lights on the TLP indicate the neutral position of the corresponding trim actuator.

FEEL AND TRIM CONTROLS AND INDICATORS

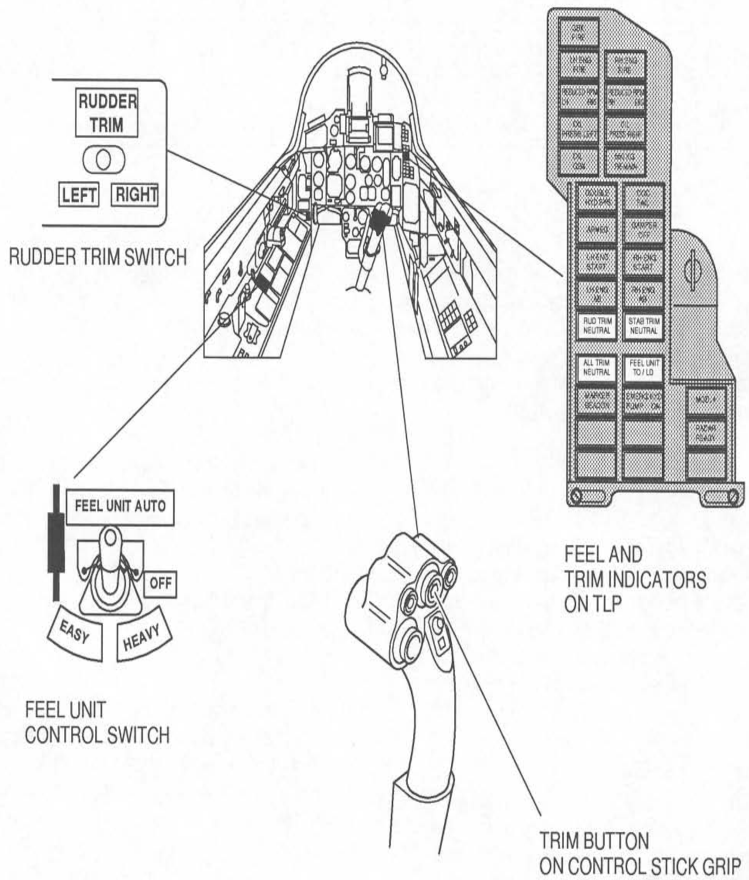


Figure 1-29

CONTROL STICK

The control stick consists of a grip with an adjustable hand rest and the following functions:

1. Gun trigger
2. Missile trigger
3. AP cut-out lever
4. Brake lever
5. Run-up brake lever
6. CL tank jettison button
7. Trim button
8. Levelling button
9. AFCS MODES OFF button
10. Target acquisition symbol button
11. Break-lock button
12. Rudder pedal adjustment handle

The AFCS MODES OFF button interrupts the power supply to the automatic flight control system. The AP cut-out lever disables all automatic flight modes of the AFCS as long as it be pressed.

CONTROL STICK

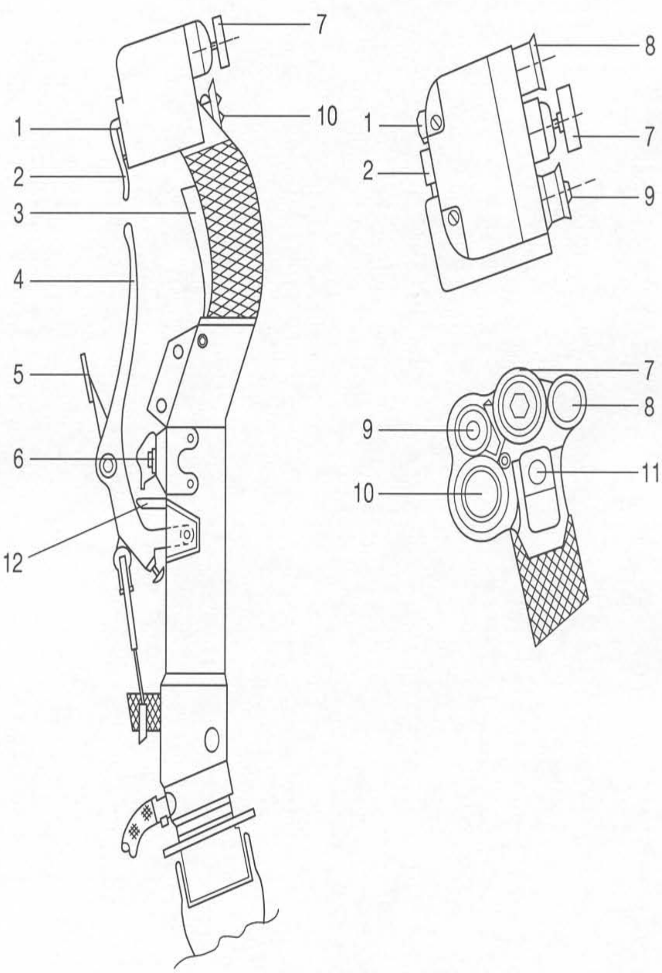


Figure 1-30

RUDDER PEDALS

Primary controls for the rudders consist of conventional rudder pedals mechanically connected to hydraulic actuators.

During ground operation, differential braking is controlled by the rudder pedals. The rudder pedals can be adjusted by the ring-type rudder adjustment handle on the control stick.

AOA / G CONTROL SYSTEM

The AOA / G control system (COC) measures and indicates angle of attack (AOA) and g-forces, it controls automatic LEF operation and prevents inadvertent stalls by moving the control stick forward. The system is powered by 28.5 VDC and 2 phases 115 VAC.

The system consists of the AOA / G computer, the combined AOA / G meter as well as warning and indicator lights. It utilizes inputs from the AOA vanes, Mach sensors, the g-sensor and the LEF down limit switches to perform the following tasks:

- Display of actual and maximum g-forces
- Display of actual AOA
- Automatic LEF operation considering pitch velocity
- Computation of the maximum AOA, considering LEF position and pitch rate
- Operation of the pitch kicker considering pitch rate and AOA
- Display of system malfunctions

The g-sensor measures g-forces between -2 g and +10 g. The signals are amplified in the computer and displayed on the g-scale of the combined AOA / G meter at a rate of at least 5 g per second with an accuracy of ±0.3 g (±0.4 g under extreme weather conditions).

Actual AOA is measured by the LH and the RH AOA vanes from -1.5° to +29°. The computer selects the higher value, amplifies the signals and displays the AOA on the AOA scale of the combined AOA / G meter at a rate of at least 20° per second with an accuracy of ±1° (±1.5° under extreme weather conditions).

AOA LIMITER

The AOA / G computer utilizes signals from the AOA vanes and the Mach sensors to position the LEF and to actuate the pitch kicker. The system is disabled when the nose landing gear is not up and locked.

The LEF extend at an AOA of 8.7° at Mach numbers below M $0.8^{+0.1}_{-0.05}$. Depending on pitch rate, the LEF may extend prior to reaching 8.7° AOA.

The signals from the LEF down limit switches are utilized to switch the AOA / G computer from the low AOA value of 15° (GT: 14°) maximum to the high AOA value of 26° (GT: 24°) maximum.

The pitch kicker is designed to prevent inadvertent stalls by moving the control stick forward of neutral when either pitch rate or AOA, or a combination of both, reaches the critical value. The computer triggers solenoid valves to operate the hydraulic actuators, which cause the taileron to assume an aircraft nose-down deflection and the control stick to move forward. Thus the pilot is immediately made aware of an approaching stall condition of the aircraft. A force of 17 kp, in addition to normal control forces, applied on the stick can override the pitch kicker.

NOTE

Full aft pitch trim reduces the forward force on the control stick considerably. Under this condition, caution should be used when reapplying backstick pressure.

CAUTION

- Due to extremely reduced stability margin at high AOA, an AOA reduction of approximately 4° is strongly recommended prior initiating any roll maneuver.
- Overriding the pitch kicker intentionally is prohibited.

System redundancy is achieved by using dual actuators operated by the main and the boost hydraulic system and by duplicating the computer channels.

The AOA limiter system contains continuos BIT. It monitors the heating system of the AOA vanes, AOA signal inputs and DC electrical power. The heating system of the AOA vanes will operate with reduced power when the pitot heat switch is positioned to ON, however, full heating power is automatically provided when weight is off the RH main gear, regardless of switch selection.

A test button on the control and test panel can be used for initiating an extended self test for maintenance purposes.

AOA / G CONTROL SYSTEM

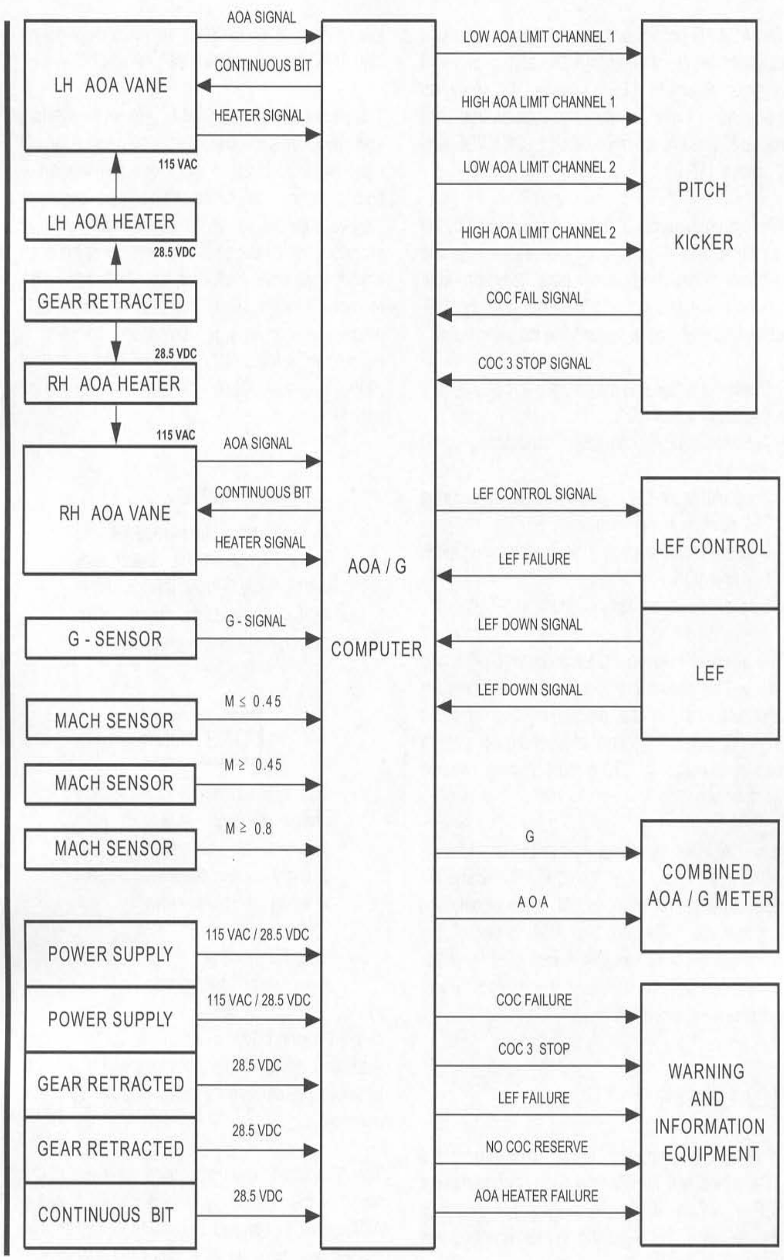


Figure 1-30A

INDICATIONS AND WARNINGS

A complete COC failure is indicated on the TLP, when both AOA limiter channels of the AOA/G computer have failed.

CAUTION

With a complete COC malfunction, pitch kicker warning is not available. Extreme care should be used when operating near the allowable AOA limit.

	INDICATION	FAULT/EFFECT
MASTER CAUTION	LIGHT FLASHING	
TLP	COC FAIL	Complete AOA limiter failure

A COC 3 STOP indication on the AEKRAN during landing gear extension indicates a failure of the pitch kicker hydraulic actuator. A forward force of 17 kp is added to normal control forces when the landing gear is extended and airspeed is below M 0.45.

	INDICATION	FAULT/EFFECT
AEKRAN	COC 3 STOP	Pitch kicker hydraulic actuator failure.

If the LEF down limiter switches do not signal LEF down when an AOA of 12.5° is reached, the signal LEAD EDGES NOT EXTEND is displayed on the AEKRAN. The extension signal for the LEF is deleted in this case.

	INDICATION	FAULT/EFFECT
AEKRAN	LEAD EDGES NOT EXTEND	LEF fail to extend, maximum AOA limited to 15° (GT: 14°) AOA.

A single AOA limiter channel failure of the AOA/G computer is indicated on the control and test panel.

	INDICATION	FAULT/EFFECT
CONTROL AND TEST PANEL	NO COC RESERVE	Single channel AOA limiter failure, no effect on maximum allowable AOA.

AUTOMATIC FLIGHT CONTROL SYSTEM

The automatic flight control system (AFCS) is an electro-hydraulic system designed to provide automatic, semiautomatic and manual flying modes without interfering with manual control. The system requires DC power and 36 VAC power.

It consists of the AFCS computer, the stability augmentation system, and the trim actuators, refer to FO-13.

The AFCS computer receives signals from the gyro platforms, the accelerometers, the g-meter, the control stick position and the navigation system. The signals are corrected for altitude, mach number, AOA and pitot pressure.

The inputs are processed into control signals for the dampers, the trim actuators and the flight instruments.

The automatic flight control system is capable of performing the following modes of operation:

- DAMPER (stability augmentation)
- ATT HOLD (attitude hold)
- AUTO RECOVER (level off mode)
- APPROACH
- ALT HOLD (altitude hold)
- Automatic landing approach control
- Levelling (automatic unusual attitude recovery)

OPERATING MODES

DAMPER

Stability augmentation is obtained for pitch, roll and yaw by placing the AFCS switch to the ON position. The AFCS computer controls electro-hydraulic actuators within the mechanical control linkages to compensate any tendency of the aircraft to oscillate in roll, yaw and pitch. Aileron-rudder-interconnect is provided at high AOA by the stab aug system to improve lateral stability.

The automatic longitudinal stability control adjusts the taileron actuator to counteract pitch moments during LEF operation. The automatic longitudinal stability control is disengaged when the LEF are in, the flaps are down or the dampers are off.

The dampers are disengaged if

- Hydraulic supply to the actuators fails
- Any phase of the 200 V, 400 Hz electric power fails
- The AFCS computer fails
- The AFCS MODES OFF button on the control stick is pressed

If the AFCS MODES OFF button is pressed less than 3 sec, the stab aug system is reengaged automatically upon release. If the button is pressed more than 3 sec, the stab aug system disengages completely. The DAMPER pushbutton on the AFCS mode control panel must be pressed to reengage the system.

ATTITUDE HOLD MODE

The Attitude Hold mode is designed to maintain the airplane's attitude. At bank angles from 7° to 80° and pitch angles of ±80°, the aircraft attitude is maintained. At bank angles below 7° and pitch angles of ±40°, attitude and heading are maintained.

GT: At bank angles from 7° to 70° and pitch angles of ±50°, the aircraft attitude is maintained.

To engage the attitude hold mode, the ATT HOLD button on the autopilot control panel is pressed. If the damper system is off, it will automatically be engaged. The ATT HOLD light will flash until the autopilot AP cut-out lever is released. Releasing the lever starts mode operation, and the light becomes steady.

Aircraft attitude is changed by pressing the A/P cut-out lever, attaining new attitude and releasing the lever. Stick forces have to be trimmed to balance prior releasing the lever.

Engaging the attitude hold mode automatically disengages the levelling mode. The attitude hold mode is automatically disengaged if the levelling mode or auto recover mode are engaged.

Trim condition may be slightly out of balance when disengaging the attitude hold mode.

AUTO RECOVER MODE

Auto recover mode is designed to recover the aircraft to a minimum altitude set on the radar altimeter during flights below 3 000 ft above ground level. It is engaged by pressing the AUTO RECOVER pushbutton on the AFCS control panel. However, engagement should not take place when flying below the preset minimum altitude. Operation is indicated by illumination of the AUTO RECOVER light.

If the aircraft descends below the preset altitude, the low altitude warning light on the radar altimeter illuminates. The AEKRAN displays ALT ALERT and VIWAS says "Gefährliche Höhe". The aircraft starts an 8° climb, initiated with 1.5 to 5.0 g. The wings are set level and the levelling button light on the control stick illuminates simultaneously. Upon reaching the preset altitude, the levelling mode is engaged automatically. When the aircraft is in level flight, ALT HOLD mode is engaged automatically.

If the AP cut-out lever is pressed, or trim is applied during the descent, the aircraft does not recover automatically. However, the low altitude warnings are displayed and an aft stick force is applied within 3 to 4 sec.

Auto recover mode is disengaged by pressing the AUTO RECOVER button again on the AFCS control panel or by pressing the AFCS MODES OFF button for more than 3 sec. In this case the dampers disengage simultaneously and must be reengaged by pressing the DAMPER button on the AFCS control panel.

NOTE

- The auto recover mode is restricted to a minimum altitude of 600 ft AGL, a max bank angle of 30° and a max descent rate of 2 000 ft per min.
- During AUTO RECOVER, flying with the parameters mentioned above, an altitude loss of up to 300 ft has to be anticipated.

At descent rates of less than 200 ft per min with wings level, no altitude restrictions apply.

WARNING

Due to radar altimeter restrictions, the AUTO RECOVER mode is not reliable at bank angles in excess of 30°.

APPROACH MODE

The approach mode provides ILS information and command steering. It can be engaged by pressing the APPROACH button on the AFCS control panel as soon as reliable ILS signals are received for course and glideslope.

Operation is indicated by the illumination of the APPROACH light and the disappearance of the pitch and course OFF-flags on the ADI.

CAUTION

To prevent (violent) control transients, the AFCS mode ATT HOLD must be disengaged prior to engagement of the APPROACH mode.

Bank and pitch commands are provided by the course and pitch steering bar on the ADI and the command circle in the HUD. Bank steering commands are based on a roll rate of 5 to 8° per sec. The pitch steering bar provides steering towards the engagement altitude of the APPROACH mode until glide path interception. Centering the pitch and course steering bar, as shown by the command circle in the HUD, ensures proper steering.

Failure of the glide slope indication will cause a level-off command by the pitch steering bar on the ADI. The pitch OFF-flag on the ADI and the ILS glide slope OFF-flag on the HSI will appear.

WARNING

When any OFF-flag on HSI or ADI appears, level off immediately and execute a missed approach.

Approach mode can be deselected by pressing the AFCS MODES OFF button for less than 3 sec.

ALTITUDE HOLD MODE

The altitude hold mode is designed to maintain the aircraft at a specific barometric altitude. Altitude hold is engaged by pressing the ATT HOLD button first and then the ALT HOLD button on the AFCS control panel. Illumination of both lights indicates proper operation.

To engage the mode, the pitch attitude must not exceed ± 5°. If the pitch angle exceeds 5°, the aircraft stabilizes at the given angle and the ALT HOLD light flashes until the angle is decreased below 5°.

After correction to the engagement altitude, the aircraft is stabilized in bank angle and altitude. If the bank angle was less than 7° during engagement, heading and altitude are stabilized.

Attitude hold can be cut out intermittently by pressing the AP cut-out lever, which is indicated by flashing of the ATT HOLD and ALT HOLD lights. Pressing the AFCS MODES OFF button for less than 3 sec disengages the altitude hold mode.

After recovery to level flight with the levelling mode, ALT HOLD is engaged automatically.

NOTE

- Altimeter fluctuations while accelerating through the transsonic range will produce transient fluctuations, which, although not violent, may cause the reference altitude to slip.
- Do not use ALT HOLD at altitudes below 300 ft AGL.

AUTOMATIC LANDING APPROACH CONTROL

The automatic landing approach system can be engaged after the approach mode has been selected and the pitch and course steering bars on the ADI have been centered.

For smooth operation, airspeed should be below 215 KIAS. Automatic throttle adjustment is not available.

To engage automatic landing approach control, the ATT HOLD button has to be pressed in addition to the APPROACH button on the AFCS control panel. Illumination of the ATT HOLD and the ALT HOLD lights as well as the disappearance of the OFF-flags on the ADI/HSI indicate proper system operation.

Level flight is maintained until glide slope interception. Upon glide slope interception, the ALT HOLD light extinguishes and the aircraft begins the descent. Course corrections are performed with bank angles up to 5°, glide slope corrections with pitch angles up to 2°.

The automatic landing approach system can be temporarily disengaged by pressing the A/P cut-out lever and is automatically reengaged as soon as this lever is released.

The automatic landing approach has to be discontinued if the pitch or course steering bar on the ADI indicate a difference to the course or glide slope indication on the HSI, or the minimum altitude of 150 ft is reached.

The automatic landing approach control is disengaged by pressing AFCS MODES OFF button for less than 3 sec or by engaging the AFCS levelling mode.

WARNING

The autopilot may trim the aircraft considerably out of balance. Therefore, when disengaging the automatic landing approach mode, be prepared to counteract large control transients.

LEVELLING MODE

Levelling mode is designed to recover the aircraft to straight and level flight in case of pilot's spatial disorientation. Pressing the levelling button on the right side of the trim button disengages all other AFCS modes, and engages the levelling mode, provided the AP cut-out lever is released. If the dampers are OFF, they are automatically engaged. Levelling operation is indicated by steady illumination of the button light.

At bank angles below 80°, bank and pitch attitude are recovered to level flight simultaneously. At bank angles of more than 80° bank is recovered to below 80° before simultaneous recovery. The recovery rate varies from 10° to 45° per sec in bank and -1 g to +5 g in pitch, depending on altitude, attitude and airspeed.

Once the aircraft is recovered to ±7° AOB and ±5° of pitch or below, the ALT HOLD mode is automatically engaged within 3 to 4 sec as indicated by the ALT HOLD light.

If the pilot interferes during levelling operations by pressing the AP cut-out lever or using the trim button, the levelling mode disengages momentarily which is indicated by flashing of the levelling light.

Levelling mode is disengaged either by pressing the AFCS MODES OFF button for less than 3 sec, or by engaging the attitude hold mode.

NOTE

- During levelling operations, the rudder pedals must be neutralized and maintained in neutral position.
- Throttle adjustments may be required according to airspeed and altitude.
- If a forward trim condition exists prior to engagement of levelling, negative g may be experienced momentarily before positive recovery.
- During recovery from negative pitch angles, or bank angles of 40° to 50°, bank may increase up to 70°, not resulting in additional loss of altitude.

AFCS BITE

Placing the AFCS switch to ON, initiates the BIT, provided weight is on the nose gear, the inertial platforms are ready and hydraulic pressure is available.

Prior to engagement, the control surfaces must be trimmed to neutral, as shown by the indicator lights.

During the BIT, controls must be released to allow unrestricted movements. The DAMPER OFF light illuminates on the TLP and the MASTER CAUTION light flashes. The DAMPER light flashes continuously at a rate of 1.5 to 2.0 cycles per second and all other lights on the AFCS control panel may illuminate temporarily, except for the MISSED APPROACH light.

Upon completion of the BIT, the DAMPER OFF light on the TLP extinguishes and the DAMPER light illuminates steadily. It indicates satisfactory BIT completion and the stab aug system engaged. If the control stick is out of the neutral position it must be trimmed back to neutral.

An AFCS malfunction is indicated by flashing of all lights on the AFCS control panel, except for the MISSED APPROACH light. If the malfunction is not within the stab aug system, the dampers can be engaged by pushing the DAMPER button. In this case only the damper function is usable, none of the other AFCS modes may be engaged.

A normal test cycle lasts 90 sec. However, the dampers can be engaged after 40 sec. In this case, the BIT is interrupted and none of the other AFCS modes can be engaged. After neutralizing the control stick the BIT may be reinitiated by pressing the AFCS MODES OFF button momentarily.

NOTE

With the ICAO II modification implemented, the course pointer must be set to a vertical position before the AFCS self test is initiated.

CONTROLS AND INDICATORS

AFCS Switch

The AFCS switch is located on the system power panel. Refer to figure 1-31. It is used to switch the AFCS ON and OFF.

AFCS CONTROL PANEL

The AFCS control panel is located in front of the left console and has five pushbuttons to select the AFCS modes. When a mode is selected, the corresponding green light illuminates.

The button MISSED APPROACH is used to obtain steering information from the navigation system.

AFCD CONTROL PANEL

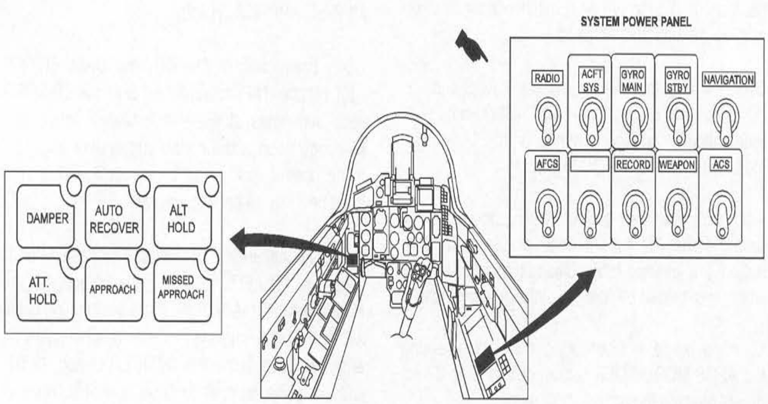


Figure 1-31

STICK CONTROLS

Refer to figure 1-30.

AP Cut-Out Lever

The AP cut-out lever is integrated into the control stick grip and disables the AFCS flying modes while pressed. The associated AFCS modes indicator lights begin to flash.

AFCS MODES OFF Button

The AFCS MODES FF button on the left side of the trim button disengages all AFCS modes. However, the stab aug system will be reengaged if the button is pressed for less than three seconds. If it is pressed for more than three seconds, the system is switched off and the DAMPER OFF light on the TLP illuminates. The AFCS is disengaged completely.

Levelling Button

The levelling button with an integrated indicator light located to the right side of the trim button is used to engage the unusual attitude recovery mode of the AFCS.

WARNING

When an AFCS mode is selected, be prepared to manually counteract any abrupt control movements in the event of an AFCS malfunction.

PITOT STATIC SYSTEM

Two pitot booms, a main and a emergency pitot boom, supply impact and static pressures to various flight instruments and aneroid switches.

The main pitot boom provides pressure to the IAS/TAS indicator, the VVI, the ADC and the IFF.

The emergency pitot boom provides pressure for the Mach transducer, the LEF controls, the ECU, the AFCS, the engine intake ramp control and the ejection seat.

If the main system fails, the emergency pitot boom can be selected to provide pressure to the main system users, for details see figure 1-32.

PITOT STATIC SYSTEM

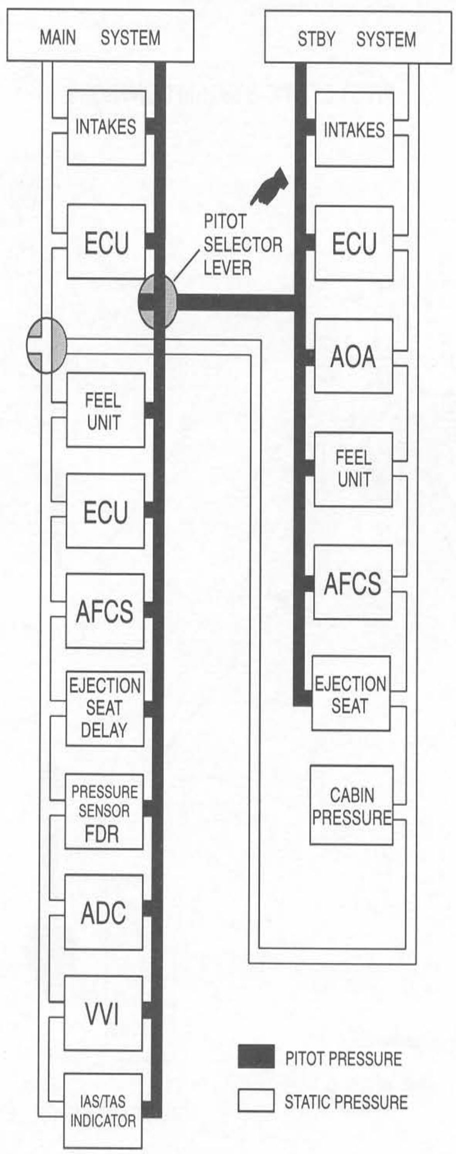


Figure 1-32

CONTROLS AND INDICATORS

Pitot Selector Lever

The pitot selector lever is located at the pedestal panel with the positions MAIN and STBY.

Pitot Heat Switch

The pitot heat switch is located on the RH side wall. It controls operation of the heating elements in both pitot-booms, AOA probes and the windshield. The heater elements are energized any time 28 VDC power is available and the pitot heat switch is in the ON position. AOA probe and windshield heater elements are energized when the weight is off the wheels and 115 VAC / 400 Hz power is available.

CAUTION

Pitot heat should not be used for more than one minute during ground operations to prevent damage to the system.

PITOT STATIC SYSTEM CONTROLS

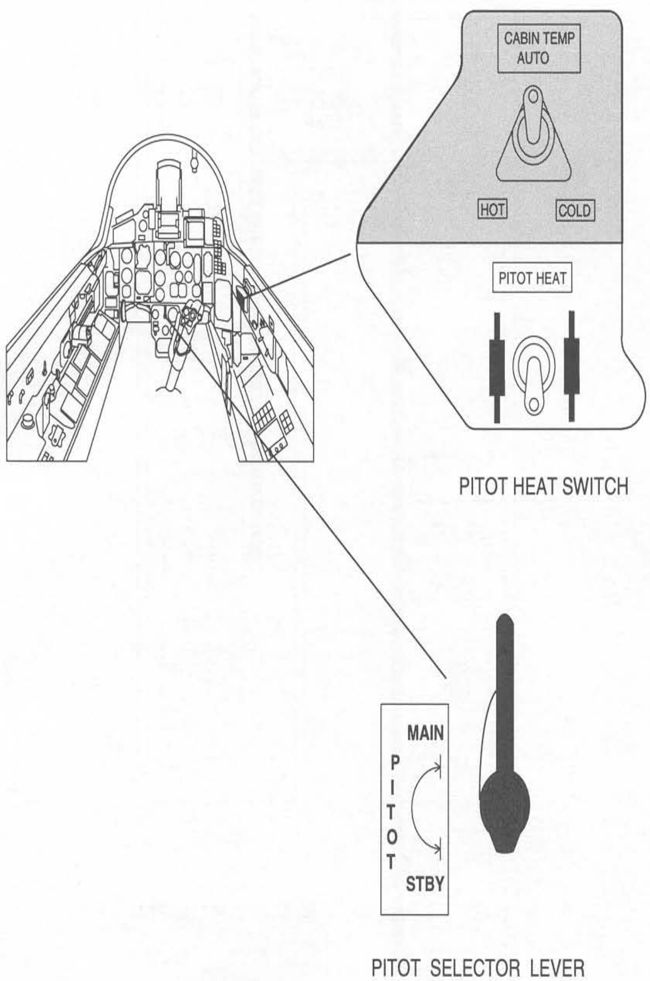


Figure 1-33

AIR DATA COMPUTER

The air data computer (ADC) is part of the pitot static system and consists of:

- Air data system
- Pressure altimeter
- TAS indicator

It utilizes inputs of pitot and static pressure from the main pitot system and OAT.

The computer provides electrical outputs representing:

- TAS
- Mach number
- Pressure altitude
- Density altitude

Data are supplied to the navigation system, the AFCS, the fire control system and the fuel indication system. The ADC utilizes DC power from the generator or the batteries, 36 VAC and 115 VAC.

A build in test is provided to check system readiness during preflight preparation and check-out for maintenance purpose.

AIR DATA COMPUTER

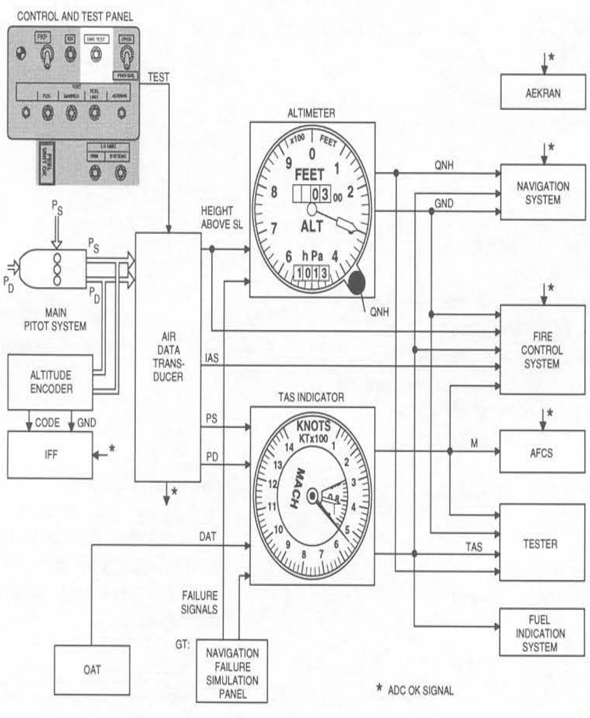


Figure 1-34

INDICATIONS AND WARNINGS

	INDICATION	FAULT/EFFECT
AEKRAN	**AIR DATA SYS**	Unreliability of airspeed, altitude and vertical velocity
VIWAS	"AUSFALL SWS" "AP AUS, V_{max} 600"	

INSTRUMENTS

IAS INDICATOR

The IAS indicator USM-2AE displays indicated airspeed. A single pointer indicates airspeed values between 0 and 800 kts on a non-linear scale. Mach number is indicated on the inner scale.

The pneumatic inputs for the indicator are impact and static pressure supplied by the main or the backup pitot tube.

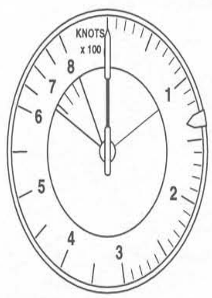


Figure 1-35

NOTE

Since the indicator is directly driven by the pneumatic outputs of one of the pitot tubes, the indicated mach number may differ from the real value by as much as M 0.05 due to non-linearities of those pitot tubes.

TAS INDICATOR

The TAS indicator UMS-2,5-2U provides a combined display of TAS and mach number. Electrical power is supplied from the ADC, since it is part of the system. The longer pointer rotates at the linear outer scale to indicate values between 100 and 1 400 kts. The shorter pointer traverses the inner mach number scale. The input signals for the indicator are supplied by the ADC and the ambient air temperature sensor.

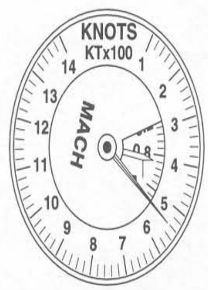


Figure 1-36

GT, R/C:

The TAS indicator UIS-1250 AE provides the display of true airspeed between 100 and 1 250 kts.

NOTE

Since the indicator is directly driven by the pneumatic outputs of one of the pitot tubes, the indicated mach number may differ from the real value due to non-linearities of those pitot tubes.

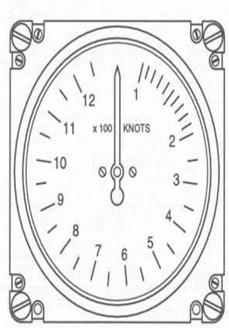


Figure 1-37

ALTIMETER

The altimeter is an electrically operated instrument, indicating from 0 to 100 000 ft. Electrical power is supplied by the ADC system, since the altimeter is an integral part of this system.

An adjustable barometric scale is provided so that the altimeter may be set at the corrected sea level pressure.

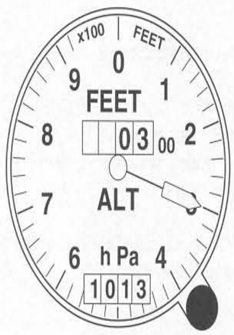


Figure 1-38

GT, R/C:

The altimeter in the rear cockpit is a pneumatically operated instrument, indicating from 0 to 100 000 ft. The altimeter incorporates a vibrator which reduces mechanical friction of gear trains and linkages of the mechanical assembly. The vibrator is powered by 28.5 VDC from the generator, or in case of failure by the batteries.

A barometric setting knob adjusts the barometric setting on the hPa counter of the altimeter between 700 and 1 080 hPa.

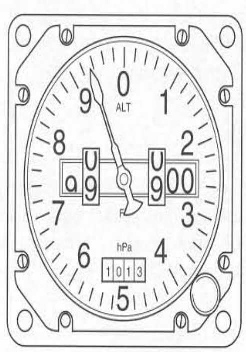


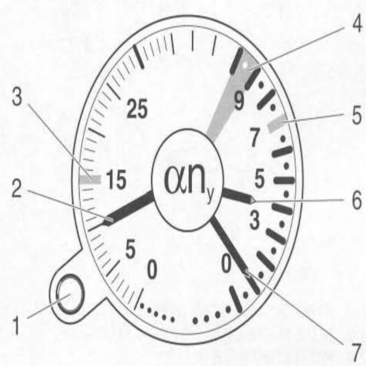
Figure 1-39

COMBINED AOA / G METER

The angle of attack and g meter is a combined instrument with two different indicating systems. Since it is part of the COC, it receives electrical power via this system.

The AOA pointer, moving along the left scale, is electrically connected to AOA probes located at the left and right forward section of the aircraft.

G-loads are indicated on the right scale by a main pointer indicating instantaneous g-loads and an index tab driven by the main pointer. The index tab remains on it's maximum indication until resetted. The g meter is electrically connected to an external g-sensing transducer.

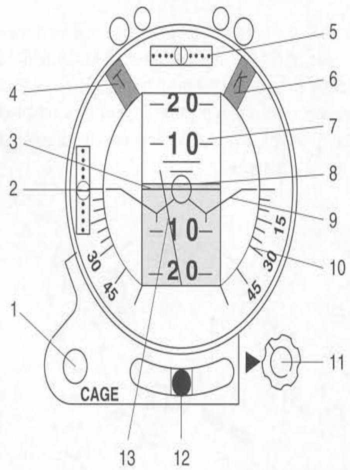


1. RESET BUTTON FOR G-INDEX TAB
2. AOA POINTER
3. 15° MARKER (RED)
4. RED REGION
5. 7 G-INDEX (RED)
6. MAX G-INDEX TAB
7. G POINTER

Figure 1-40

ATTITUDE DIRECTOR INDICATOR

The attitude director indicator (ADI) provides a pictorial display of the aircraft's attitude in pitch, roll and turn. It utilizes 36 VAC and 28.5 VDC received from the gyro system. A slip indicator is integrated at the bottom part of the instrument. Attitude is indicated by the aircraft symbol in relation to the horizon, pitch is indicated by the attitude sphere.



1. GYRO CAGE BUTTON / GYRO FAIL LIGHT
2. GLIDE SLOPE DEVIATION INDICATOR
3. PITCH STEERING BAR
4. PITCH OFF FLAG
5. COURSE DEVIATION INDICATOR
6. AZIMUTH OFF FLAG
7. ATTITUDE SPHERE
8. CENTER DOT
9. AIRCRAFT SYMBOL
10. BANK SCALE
11. AIRCRAFT SYMBOL SETTING KNOB
12. SLIP INDICATOR
13. COURSE STEERING BAR

Figure 1-41

Pitch and Bank

The pitch angle of the aircraft is displayed by the pitch scale on the spheroids surface and the center of the aircraft symbol. The vertical position of the aircraft symbol can be adjusted with the aircraft symbol setting knob.

The bank angle is displayed by the aircraft symbol rolling on the spheroids surface to indicate aircraft its bank on the bank scale.

Glide Slope Deviation Indicator

During the NAV mode RETURN, a 7° glide slope is displayed on the glide slope deviation indicator for a extended runway centerline interception at 2 000 ft AGL.

During the NAV mode MISSED APPROACH, deviation from an altitude of 2 000 ft AGL is displayed. In the AFCS mode LANDING, deviation from the ILS glide path is displayed.

Course Deviation Indicator

During the NAV modes RETURN and MISSED APPROACH, the index on the course deviation indicator provides steering for extended runway centerline intercept.

In the AFCS mode LANDING, deviation from the ILS course is displayed.

Command Steering

During an ILS approach, with the AFCS mode APPROACH selected, command steering information is available by the pitch steering bar and the bank steering bar. When the aircraft is exactly on the desired flight path, the intersection of the two bars coincide with the center dot. The bars will be parked in the center also when the system is not engaged. However, the pitch and azimuth OFF flags will be visible.

OFF Flags

Two red flags are incorporated in the upper left and right part of the instrument. The pitch OFF flag marked T and the azimuth OFF flag marked K will be visible when either channel of the ILS system is failed or not activated. As soon as the AFCS mode APPROACH is selected and no malfunctions exist, both OFF flags will disappear.

NOTE

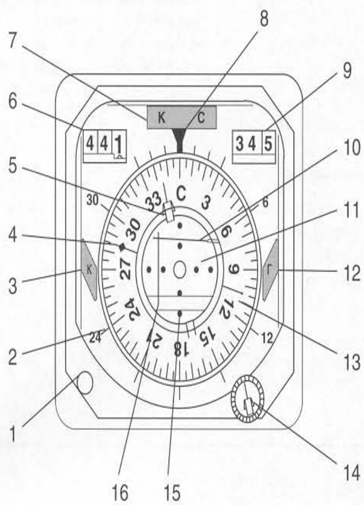
During an automatic landing approach, the appearance of either OFF flag initiates an automatic level off by the AFCS.

Slip Indicator

Aircraft slip is indicated by a ball inside a tubular case located at the lower part of the instrument face.

HORIZONTAL SITUATION INDICATOR

The horizontal situation indicator (HSI) provides a horizontal view of the aircraft with respect to the navigation situation. The compass card rotates so that the aircraft heading is always under the course index. Three OFF flags provide warnings for course and glide path indicator failures and navigation or gyro / platform malfunctions. Depending on the selection on the NAV panel, indications on the HSI vary. The HSI utilizes 36 VAC power.



1. TEST BUTTON
2. FIXED COMPASS CARD
3. ILS COURSE OFF FLAG
4. BEARING POINTER
   BEARING (BRG) POINTER (YELLOW)
5. COURSE POINTER (WHITE)
6. RANGE (RNG) COUNTER
7. HSI OFF FLAG
8. COURSE INDEX
9. BRG COUNTER
10. ILS GLIDE SLOPE INDICATOR
11. ILS COURSE DEVIATION SCALE
12. ILS GLIDE SLOPE OFF FLAG
13. COMPASS CARD
14. COURSE SELECTOR KNOB
15. ILS GLIDE SLOPE DEVIATION SCALE
16. ILS COURSE DEVIATION INDICATOR

Figure 1-42

CLOCK

A mechanical clock allows determination of normal daytime, elapsed (mission) time and has a stopwatch feature. The indications as mentioned may be read on three individual scales:

- Normal daytime is displayed on the outer scale with an hour and a minute pointer.
- Elapsed time is displayed in hours and minutes on the upper inner scale.
- Elapsed time is displayed in minutes and seconds (stopwatch) on the lower inner scale.

A red winding and setting knob is provided on the left lower corner of the clock. Rotating the knob counter-clockwise winds up the clock. Pulling the knob permits setting the clock. Pushing the knob starts the small elapsed time scale on the upper portion of the face, a small status indicator window within the scale changes color from white to red. Pushing the knob again stops the small clock, the indicator turns red / white. Pushing the knob a third time resets the elapsed time and the status indicator turns white.

A setting knob on the lower right corner of the clock is used to start and stop the seconds pointer of the normal daytime scale and to operate the stopwatch on the lower portion of the clock face.

Rotating the knob clockwise stops the seconds pointer, rotating the knob counter-clockwise starts it again. Pushing the knob starts the stopwatch located at the lower part of the face, pushing it again stops it and pushing a third time resets both pointers to the zero position.

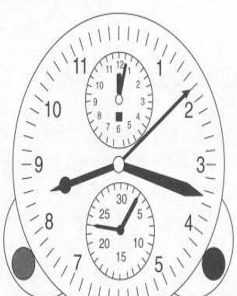


Figure 1-42A

HSI INDICATION

MODE SETTING	COURSE POINTER	BEARING POINTER	BRG COUNTER	RANGE COUNTER	COURSE INDEX	ILS COURSE INDICATOR	ILS GLIDE SLOPE INDICATOR
NAV	Course to selected navi-gation point	Bearing to selected TACAN / NDB	Course to selected navigation point	Distance to selected navigation point	Aircraft HDG	-	-
NAV RETURN	An offset point to intercept final	Bearing to TACAN / NDB	Aerodrome reference point	Distance to aerodrome	HDG	-	-
NAV RETURN without TACAN update	Course to the aerodrome reference point	Unreliable	Course to the aerodrome reference point	Distance to the aerodrome reference point	HDG	-	-
NAV landing approach	Final course	Bearing to selected NDB	Final course	Distance to touchdown	HDG	Deviation from final course, max deviation is indicated 0.5° (4 dots) on the course deviation scale	Glide slope deviation, max deviation is indicated 0.5° (4 dots) on the glide slope deviation scale
NAV missed approach	Course to an offset point to intercept final approach	Bearing to TACAN / NDB	Course to the aerodrome reference point	Distance to the aerodrome reference point	HDG	-	-
MANUAL TACAN / RSBN for non programmed aerodrome	Course set by the course selector knob	Bearing to selected station	Course selected	Distance to selected station	HDG	-	-
BIT initiated by pressing the TEST button	Will rotate 20° ±5° CCW	-	-	Indicates 43 ±2.5 NM	Will rotate 20° ±5°	-	-

Figure 1-43

VERTICAL VELOCITY INDICATOR

The vertical velocity indicator (VVI) indicates the rate of climb or descent of the aircraft. The indicator is connected to the static pressure system and actuation of the pointer is controlled by the rate of change of the atmospheric pressure. It can register a rate of gain or loss of altitude which would be too small to cause a noticeable change in the altimeter reading.

TURN AND SLIP INDICATOR

A turn and slip indicator is incorporated in the VVI. The turn needle indicates direction of turn but does not provide accurate turn rate. The instrument receives 3 phases 36 VAC from the gyro system.

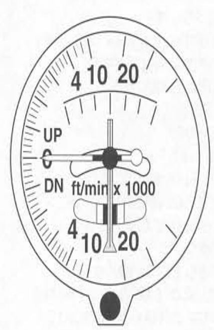


Figure 1-44

RADAR ALTIMETER

The continuous wave radar altimeter (RAD ALT) measures height above surface. It supplies information to the avionics equipment and the radar altimeter indicator. The height marker may be set to the desired minimum height. If the aircraft is below this height, the radar altimeter forwards inputs to AFCS, AEKRAN, VIWAS and the RAD ALT indicator warning light. Accuracy of the min. height selected is 1.5 ft from 0 to 60 ft and ±3 % above 60 ft.

The radar altimeter is switched on with the ACFT SYS switch. After the warm-up period, the indicator OFF flag disappears and an altitude of 0 ±3 ft is indicated.

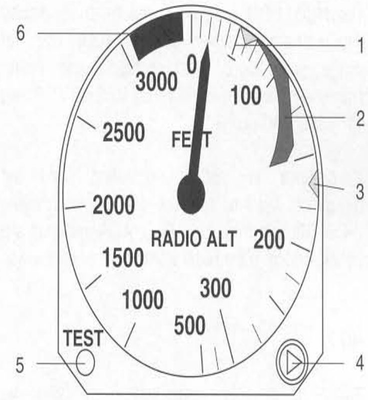
The RAD ALT contains continuous BIT. It is powered by 28.5 VDC and 115 VAC. If the DC generator fails, power is supplied from the aircraft batteries and if the AC generator fails, from the PTO.

The system provides height information from 0 to 3 000 ft AGL within bank angles up to 15°. The system accuracy is:

±3 ft from 0 to 30 ft
±10 % above 30 ft.

WARNING

At bank angles above 30° or over rough terrain, RAD ALT may give false height information. At bank angles from 15° to 30° system accuracy decreases, above 30° bank it should be considered unreliable.



1. 45 FT TEST MARK
2. OFF FLAG
3. MINIMUM HEIGHT SET MARKER
4. MINIMUM HEIGHT SET / WARNING LIGHT
5. TEST BUTTON
6. BLACK SECTOR

Figure 1-45

At heights above 3 000 ft an OFF flag appears on the indicator and the pointer rotates to the black sector. Identical indications occur with a malfunction.

A test button is provided to check the instrument. When the button is pressed, the pointer moves to the test mark at 45 ft.

INDICATIONS AND WARNINGS

	INDICATION	FAULT / EFFECT
AEKRAN	ALT ALERT	Descent below set minimum height.
VIWAS	"GEFÄHRLICHE HÖHE"	

HUD / HDD

The HUD / HDD consists of the head up display (HUD), the head down display (HDD), units for image processing, synchronization and power supply. The system is powered by 28.5 VDC and 115 / 200 VAC power.

It displays information originating from the navigation system and the fire control system (FCS). Signals from the AFCS, AOA and side slip vanes, and from the radar altimeter are processed.

HUD

The HUD projects information in symbolic and numeric form into the pilot's field of view. This source of information provides steering commands in the navigation mode and constitutes the primary source of information during attack phase.

The image processing unit receives inputs from the navigation system, the FCS and additionally from the AFCS, AOA and sideslip vanes and from the radar altimeter. It generates symbols which are displayed on a cathode ray tube (CRT) and projected into the pilot's line of sight by means of a collimator and a combining glass. The collimator focuses the HUD picture to infinity.

The combining glass projects the symbology within a space of 13° in azimuth and 18° in elevation resulting in a circular field of view of 24°. A light filter may be raised to ensure readability of the HUD display against a bright background.

HUD CONTROLS

Filter Operating Handle

The filter operating handle on top of the left mirror unit of the helmet mounted sight is used to erect the light filter to the vertical position.

BRIGHTNESS Control Knob

The BRIGHT knob is used to adjust the brightness of the HUD.
In addition, a light dependent resistor (LDR) on the front side of the HUD display unit automatically adjusts the brightness of the display depending on ambient light conditions. The brightness of the image as seen by the pilot is the result of the setting of the BRIGHT knob and the intensity of ambient light.

HUD Selector

The HUD selector has three positions:

- NIGHT — The color of the HUD image is amber.
- DAY — The color of the HUD image is green.
- RETICLE — The HUD image is blanked off, a fixed reticle is displayed for A/A weapon employment.

TEST Button

A TEST button is provided for equipment test. When pressing the button, the boresight cross appears in a square on the HDD, on the HUD, identical crosses appear in the center of each quadrant of the display additionally, indicating system readiness.

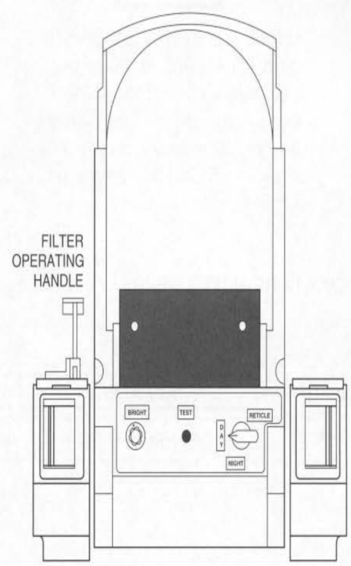
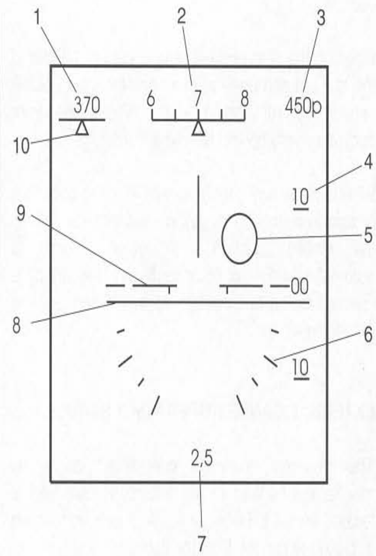


Figure 1-46

HUD Display

Following navigational symbols can be displayed on the HUD.



1. INDICATED AIRSPEED
2. HEADING REFERENCE
3. PRESS ALT / RAD ALT
4. PITCH ANGLE
5. STEERING CIRCLE
6. BANK ANGLE
7. NAV RANGE
8. ARTIFICIAL HORIZON
9. AIRCRAFT SYMBOL
10. IAS TREND INDEXER

Figure 1-47

HUD Weapon Employment Display

For weapon employment see GAF T.O. 1F-MIG29-34-1.

HDD

The HDD is a TV monitor on the right side of the instrument panel. It displays essentially the same picture as the HUD. A light dependent resistor (LDR) in the lower right corner of the front panel automatically adjusts the brightness of the display depending on ambient light conditions. In combination with the setting of the CRT brightness control knob, it renders the displayed information readable even in direct sunlight.

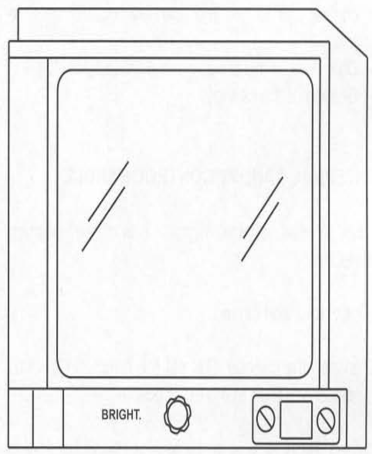


Figure 1-48

CANOPY

The canopy consists of a rigid curved front section, the windshield, fixed to the fuselage and a section that can be raised which is hinged aft.

CANOPY OPERATION

Normal canopy operation is controlled by the canopy control handle and powered by the pneumatic power supply system. Refer to figure 1-49.

The pneumatic canopy operation system ensures:

- Raising and lowering of the canopy corresponding to the canopy control handle position.
- Downlock of the canopy in the closed position.
- Sealing of the canopy.

INTERNAL CANOPY CONTROL HANDLE

The internal control handle has three position detents:

Open, taxi, and closed.

To open the canopy, first set the handle in the taxi position and then in the open position.

When the handle is in the taxi position, the seal is deflated and the canopy will be released and lifted approximately two inches above the cockpit rim.

When moving the handle further into the open position, the canopy will be raised and held by a pneumatic actuator.

CAUTION

- Taxiing with the canopy in the open position is prohibited.
- Max speed for taxiing is 16 kts with the canopy in taxi position.

GT:

Identical internal control handles are located in both cockpits. The rear cockpit canopy control handle is safety wired to the close position, since normal canopy operation is performed from the front cockpit.

Opening the rear cockpit canopy control handle to the taxi or open position overrides the front cockpit canopy control handle and positions the front cockpit canopy control handle accordingly.

When the canopy control handle in either cockpit is moved from the open position towards the taxi or the closed position, the other handle is automatically positioned accordingly. The canopy is lowered to the taxi position or the closed position respectively.

EXTERNAL CANOPY OPERATING HANDLE

The external canopy operating handle is mechanically linked to the internal handle and is located on the LH front fuselage. It is used to open or close the canopy from the outside.

CANOPY OPERATION WITHOUT PNEUMATIC PRESSURE

To open the canopy without pneumatic pressure available, the control handle has to be set in the open position (to disengage the locks), the canopy has to be raised manually and held in the open position with the canopy retaining rod.

CANOPY JETTISON

The canopy emergency jettison system provides release and separation from the cockpit:

- If the emergency jettison handle on the right cockpit sill is pulled.
- Automatically, if ejection is initiated.

A pyro-mechanical system is used to jettison the canopy. Explosive cartridges are used to open the locks.

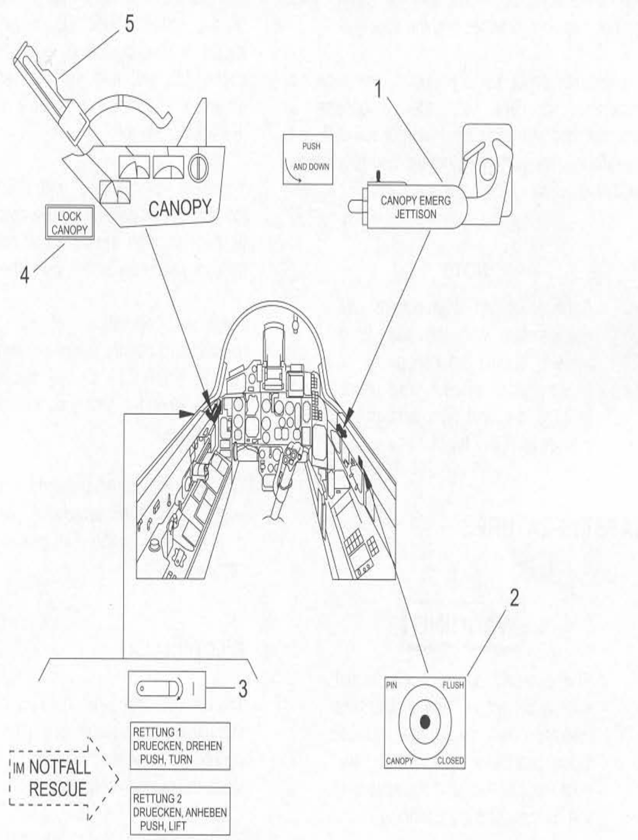
GT:

Canopy emergency jettison handles are located in both cockpits on the right cockpit sill. Pulling either handle jettisons the canopy.

INDICATIONS AND WARNINGS

	INDICATION	FAULT / EFFECT
MASTER CAUTION	LIGHT FLASHING	
CANOPY WARNING LIGHT	LOCK CANOPY	Canopy downlock failure.
CANOPY LOCK PIN	Pin protruding	
AEKRAN	LOCK CANOPY	
VIWAS	"KABINENDACH SCHLIESSEN" (message will be paged twice)	

CANOPY INTERNAL AND EXTERNAL CONTROLS



1. INTERNAL CANOPY EMERGENCY JETTISON HANDLE
2. CANOPY CLOSED CONTROL PIN
3. EXTERNAL CANOPY OPERATING HANDLE
4. LOCK CANOPY CONTROL LIGHT
5. INTERNAL CANOPY CONTROL HANDLE

Figure 1-49

EJECTION SEAT SYSTEM

The K-36 DM ejection seat system provides the pilot with a safe escape from the aircraft under various combinations of aircraft altitude, speed, attitude and flight path.

The seat is propelled from the aircraft by a cartridge-operated twin barrel ejection gun assisted by a rocket motor, both located at the back of the seat. The ejection system is designed to function at all altitudes at airspeeds up to 700 kts. However, during ground operation, a minimum of 40 kts (80 kts for the trainer version) is required for safe canopy separation.

Pulling the ejection handle initiates the ejection sequence, causing the canopy to be jettisoned and the ejection gun to fire. Caution should be used to maintain a continuous pull until full travel of the ejection handle is reached and the seat fires.

The ejection sequence continuous until a normal parachute descent of the occupant is accomplished. After the initial firing of the seat, seat operation is completely automatic and requires no additional action by the occupant.

NOTE

Canopy jettison malfunctions will not interfere with the seat firing system. Should the canopy fail to jettison after ejection has been initiated, the seat fires through the canopy after a delay of 1 sec.

SAFETY FEATURES

WARNING

The escape system is a potential source of danger and inadvertent operation may cause fatal injuries. Upon completion of the flight, the pilot must ensure that the seat is in the 'safe for parking' condition.

Safety pins are provided to various components of the escape system to prevent inadvertent initiation. Refer to figure FO-18.

EJECTION SEQUENCE

Ejection is initiated by pulling the seat firing handle. The sequence is electrically controlled until firing of the ejection gun. A mechanical backup provides fail-safe operation. As the main cartridge of the pyro-mechanical system is fired, gases are ducted to the canopy lock-down mechanism to jettison the canopy, to retract and lock the shoulder harness, and lap belt by means of the retraction units, and to activate both leg raisers and arm protectors.

Simultaneously, a backup system is activated to open the canopy locks after 0.5 seconds in case of a main breech unit failure. It allows the seat to fire through the canopy after another 0.5 seconds.

As the canopy is jettisoned, the canopy firing cable is pulled, allowing the twin barrel ejection gun to fire and to accelerate to at least 13.6 m/s. As the seat rises along the cockpit rails, the emergency oxygen supply is tripped, a body windshield is activated above 485 kts, and the leg restraint lines are retracted. The rocket motor fires to propel the seat to a greater height.

The seat is stabilized and decelerated by two rotating drogues on telescopic struts during descent through the upper atmosphere with the occupant securely restrained in the seat.

Automatic operation of the delay-release-mechanism occurs after reaching the barostat altitude (16 000 ft) or, in ejections below this altitude, when the seat is decelerated to parachute-opening speed.

The headrest / parachute container is fired from the seat to pull out the parachute. The recoil produced is also used during the process of man / seat separation.

EJECTION SEAT

The ejection seat is mounted on the guide rails and the telescopic ejection gun. The firing handle is connected to an electromagnetic ignitor unit which starts the ejection sequence.

Electromagnetic ignitor cartridges are installed for initiating the ejection gun, activating the retraction units and raising the windshield.
Percussion cartridges are installed for the ejection gun, the drogue gun and the firing mechanism of the rocket motor.

EJECTION SEQUENCE

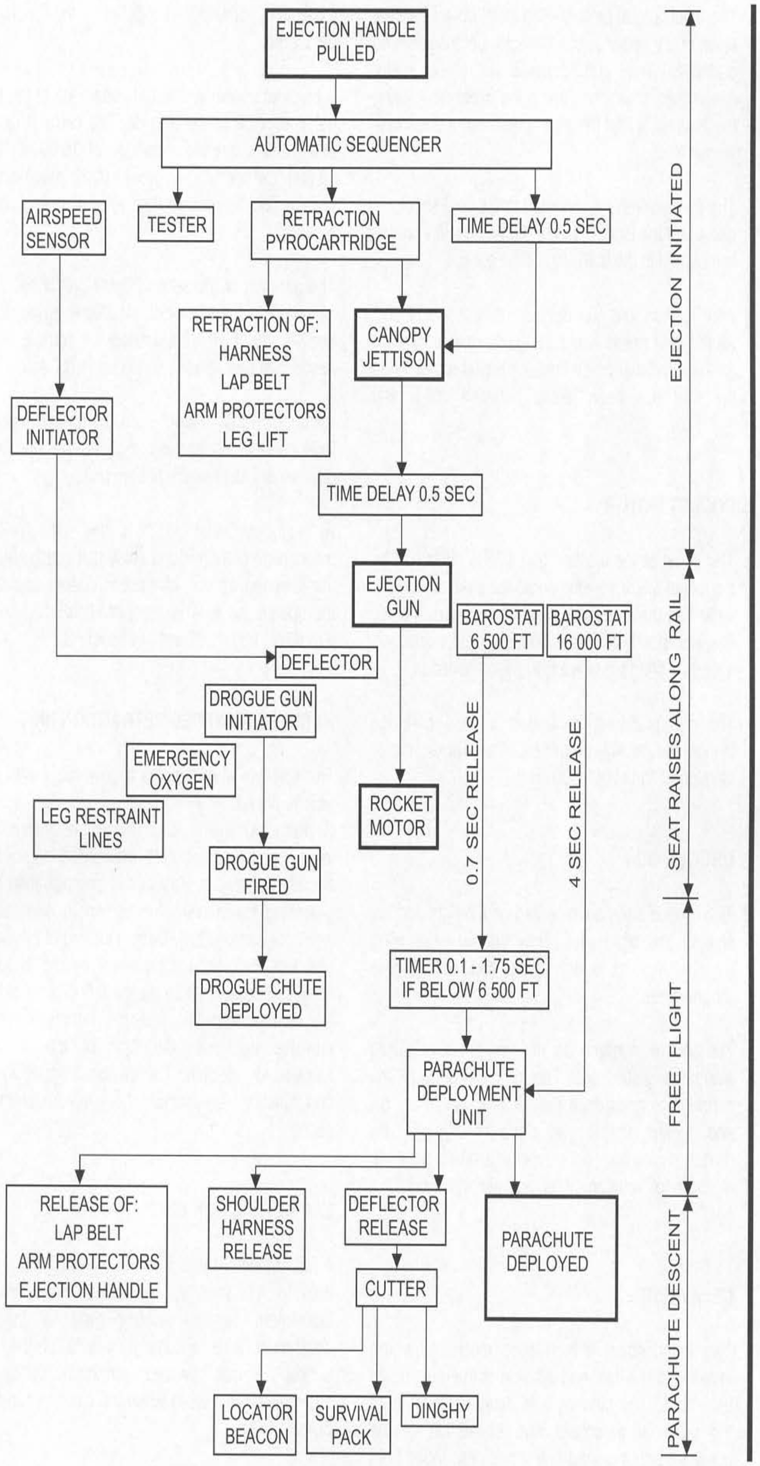


Figure 1-50

EJECTION GUN

The ejection gun provides the initial power for seat ejection by means of a single percussion-fired cartridge. The gun consists of three major assemblies, which are the breech firing mechanism, a fillet transition piece and a telescopic launch tube.

The gun assembly is mounted to the seat structure, except for the inner barrel of the launch tube, which is mounted to the bulkhead of the cockpit.

After ignition, the gun develops thrust for 0.2 sec. As the seat raises along the guide rails, it extends an initiator cable which fires the rocket motor when the seat has been raised between 104.5 and 107.5 cm.

ROCKET MOTOR

The thrust of the ejection gun will be sustained by the rocket motor, located under the seat pan, and is ignited as the seat leaves the ejection gun. A static line, incorporated in the rocket firing unit, cocks and triggers a firing pin to fire the ignition cartridge.

The gas pressure, generated by this cartridge ignites the rocket propellant. The rocket motor develops a thrust of 3 300 kg.

DROGUE GUN

Two drogue arms are mounted on the right and left side of the head rest. They consist of a firing mechanism and a telescopic rod with built-in drogue chute.

The unit is triggered as the ejection seat raises along the guide rails. The gas pressure of the cartridge extends each rod aft at an angle of 15°, and deploys the drogue chute of 0.06 m^2. The drogue chutes are ribbon-type chutes with opposite direction of rotation, thus actively stabilizing the seat.

DELAY UNIT

Two independent time release mechanisms are installed to the right and left side of the main beam assembly. Their function is to delay deployment of the personal parachute and separation of the occupant from the seat until it has descended from high altitude and / or slowed enough to prevent excessive opening shock of the personal parachute.

A barostat assembly prevents operation of the time delay above a preset altitude. The barostat of one delay unit is set to an altitude of 16 000 ft MSL, 19 500 ft when flying above 13 000 ft mountainous terrain. The associated time release unit is set to 4 sec.

The barostat of the second delay unit is set to an altitude of 6 500 ft MSL, 10 000 ft when flying above 18 000 ft mountainous terrain. The associated time release unit is set to 0.7 sec.

Although both time delay units operate independently, each unit triggers the parachute deployment mechanism of both units.

At altitudes below 6 500 ft, the time release mechanism of the second delay unit is adjusted for the airspeed at time of ejection. Depending upon the speed, the time is readjusted from 0.1 sec at 375 KTAS up to 1.75 sec at 750 KTAS.

HARNESS POWERED RETRACTION UNIT

The ejection seat contains a powered inertia lock which provides a velocity (g-sensing) system (inertia lock) and a power retraction system. The inertia lock provides safe restraint during violent aircraft maneuvers. Restraint is accomplished by a g-sensing mechanism functioning in accordance with acceleration (2 g). Manual locking of the inertia reel lock can be accomplished by the shoulder harness release handle on the left forward side of the seat bucket. The powered retraction system provides automatic retraction of the shoulder harness for ejection. The device is gas-powered and functions only when the ejection handle is pulled.

LAP RETRACTION UNIT

A lap arrestment unit provides the pilot with a safe hold in the seat during normal flight. Manual adjustment can be accomplished by the lap adjustment lever on the right side of the seat bucket. A gas-powered retraction system is automatically activated when the ejection handle is pulled.

ARM PROTECTION SYSTEM

To prevent flailing injuries to the arms during ejection, an arm protection system has been fitted. The system consists of two metal blades mounted to the side of the backrest. As ejection is initiated, the arm protectors are rotated down to a horizontal position. The device is gas-powered and operated simultaneously with the shoulder harness and the lap retraction.

WINDSHIELD

A windshield is mounted to the front of the seat bucket to protect the pilot from the windblast during high speed ejection. The unit consists of two telescopic rods which extend and raise a shield of Kopran ribbons in front of the pilot. The system is designed to extend even when one of the telescopic rods fails.

The windshield is activated above 485 KTAS only and is raised by an electro-pyrotechnic charge.

LEG RESTRAINT LINES

The leg restraint lines are routed along the cockpit sidewall, the instrument panel and the control stick casing. The restraint lines are fixed into position with clips.

Paddings are fixed to the section of the restraints which actually retract the legs.

When the seat is ejected, the occupants legs are firmly pulled against the seat bucket. Simultaneously the thighs are lifted to optimize body position during ejection.

PERSONAL PARACHUTE

A 60 m^2 personal parachute is packed into the headrest container, located on top of the seat beam.

Upon release from the delay units, two cartridges are fired to separate the container and pull out the parachute.

The gases of the cartridge are also used to operate cutters for simultaneous man / seat separation and activation of the emergency locator beacon and the survival pack.

The personal parachute is connected to both shoulder harnesses by canopy quick release connectors. The quick release connectors can be opened by pressing the latches on both sides simultaneously after a safety guard, located between these latches has been pulled forward. The purpose of the safety guard is to prevent inadvertent operation of the quick disconnect.

EMERGENCY OXYGEN SYSTEM

An emergency oxygen bottle is installed in the ejection seat bucket. Activation of the oxygen bottle is accomplished automatically upon ejection. The emergency oxygen can be activated manually by pulling upon the emergency knob (red mushroom).

The pressure bottle contains 0.7 l of compressed oxygen at a pressure of 180 kp/cm^2, indicated on the pressure gage.

The bottle supplies 100 % oxygen for about 6 min during emergency descent, 3 to 4 min during high altitude ejection and 3 min at low altitude.

EMERGENCY OXYGEN KNOB (Red Mushroom)

The emergency oxygen knob is on the right side of the seat bucket. Once the emergency oxygen knob is pulled, it cannot be shut off.

SEAT POSITION SWITCH

The seat may be adjusted vertically only. Positioning is accomplished by actuating a momentary contact switch located on the right side of the seat bucket. The seat can be adjusted (up or down) through a total range of 135 mm. It is not necessary to adjust the seat height before ejection.

SURVIVAL PACK

The survival pack contains the survival equipment, the emergency locator beacon, the emergency ration, the first aid kit and the distress signaling kit.

It is stored in the seat pan, side by side with the dinghy. A cushioned profile seating face, designed and shaped to give maximum support to the crewmember covers the equipment.

The survival pack will be released automatically after man / seat separation thereby inflating the self inflating floating device of the emergency locator beacon and the dinghy automatically. Dinghy bottom and the spray deflector can be inflated through rubber tubes after landing.

The profile seating face will be retained, and the dinghy, emergency locator beacon and survival pack remain attached to the life vest by a lowering line. If the dinghy fails to separate completely, tearing up the sewed up portion of the dinghy lowering line abruptly will cause the lowering line to extend completely separating the dinghy from the seating face.

NOTE

- Should the dinghy fail to unfold before landing, it can be inflated manually by pulling a handle on the CO_2 bottle.
- Should the self inflating floating device of the emergency locator beacon fail to inflate completely, it can be inflated manually.

DUAL EJECTION

As soon as either the F/C or the R/C ejection handle is pulled, the ejection sequence starts. The rear seat always ejects first, followed by the front seat after 1 sec.

AIR CONDITIONING AND PRESSURIZATION SYSTEM

The air conditioning and pressurization system (refer to figure FO-14) consists of two major systems, one for the cockpit and one for electronic equipment compartments. The cockpit air is conditioned so that it will have a defined temperature and pressure. The air conditioning system for the avionics provides cooled air for the various equipment compartments.

Engine bleed air for both systems passes through a common line to a pair of identical pressure reducer valves, arranged in series for fail-safe operation.

It is routed through a parallel arrangement of two air-air coolers and an evaporator cooler. Behind the evaporator cooler, the airstream is divided for equipment cooling and cockpit air conditioning.

The air for equipment cooling is passed through a turbo cooler, and as a cooling medium through a heat exchanger / dehumidifier for the cockpit air before being supplied to the equipment compartments.

The air for the cockpit is passed through the heat exchanger / dehumidifier and cooled down in a second turbo cooler. After being mixed with hot air from the pressure reducer valves, it enters the cockpit through several manifolds.

Hot bleed air used for windshield defogging is taken from the pressure reducer valves and routed to a motor driven valve which remains open at airspeeds below M 0.8.

CABIN TEMPERATURE CONTROL

The temperature of the air which is supplied to the cockpit and / or canopy is regulated by regulating the mixing ratio of cold and hot air. Normally the ratio is adjusted automatically to maintain the selected cockpit temperature. However, manual adjustment is also possible. DC power is required for temperature control.

CABIN PRESSURIZATION MIG-29G

Pressure in the cockpit is controlled by a cabin pressure control valve. When the aircraft is below 6 500 ft, the control valve automatically maintains a pressure difference of 0.05 kp/cm^2 (50 hPa) or less. From 6 500 ft up, differential pressure increases up to 40 000 ft. The differential pressure of 0.29 to 0.31 kp/cm^2 (300 ±10 % hPa) obtained between 30 000 and 40 000 ft is maintained constant at higher altitudes. Refer to figure 1-51.

CABIN PRESSURIZATION SCHEDULE MIG-29G

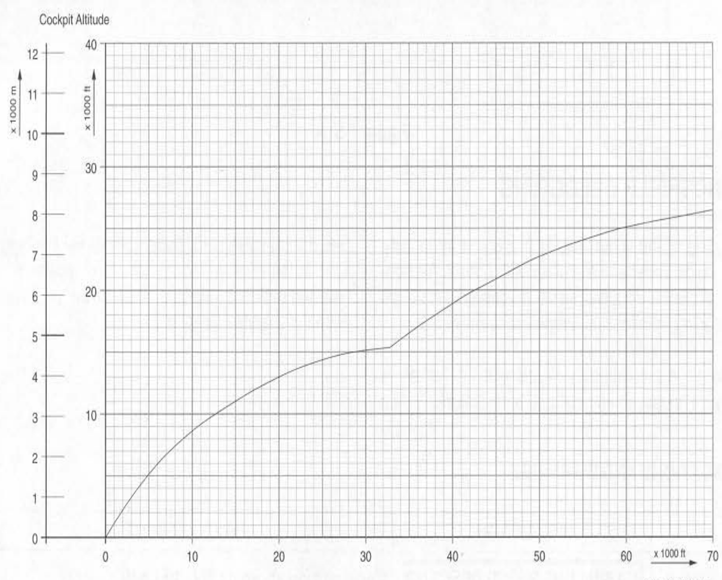


Figure 1-51

A safety relieve valve controls the cabin pressure at a nominal 0.33 kp/cm^2, 33 kPa above ambient pressure in case the cabin pressure control valve fails. If ambient pressure exceeds cabin pressure, a vacuum valve opens to allow pressure compensation.

CABIN PRESSURIZATION MIG-29GT

Cabin pressure is controlled by a cabin pressure control valve. Prior to takeoff and immediately after landing, the cockpit is not pressurized. Inflight, the cockpit is pressurized to a cockpit altitude equivalent to an altitude below mean sea level immediately after takeoff. As altitude increases, differential pressure increases so that a cockpit altitude equivalent to mean sea level is maintained up to approximately 4 000 ft. From 4 000 ft up, the pressure differential increases continuously until a differential pressure of 290 hPa is reached at 12 000 ft MSL. Above 12 000 ft a differential pressure of 290 hPa is maintained. Refer to figure 1-51A.

A safety relieve valve controls the cabin pressure at a nominal 315 hPa to 340 hPa above ambient pressure in case the cabin pressure control valve fails. If ambient pressure exceeds cabin pressure, a vacuum valve opens to allow pressure compensation.

CABIN PRESSURIZATION SCHEDULE MIG-29GT

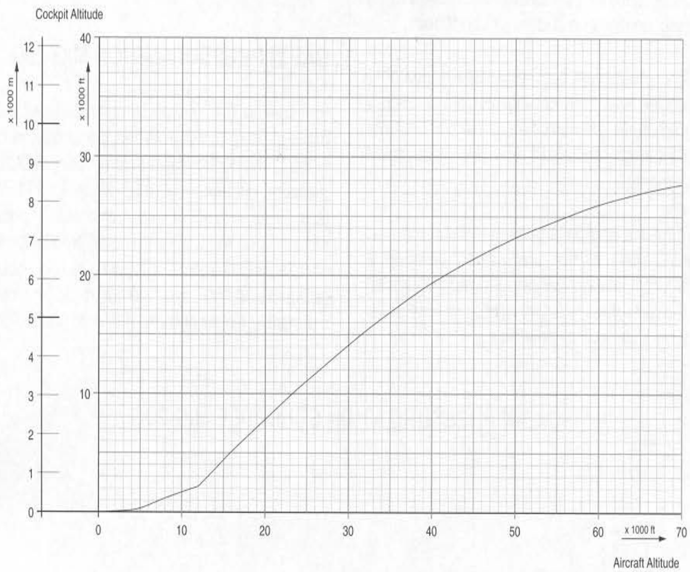


Figure 1-51A

WINDSHIELD DEFOGGING

Fogging of the windshield is prevented by heating the inside surface of the glass with hot air. Air from the pressure reducer valve is delivered through defogging manifolds at airspeeds below M 0.8.

Cold air is automatically mixed with the hot air to prevent inconvenient cockpit temperature. When the mixing valve is fully open, windshield defogging is automatically shut off to prevent an overtemperature. Manual shut down is possible with the CABIN AIR lever.

INDICATIONS AND WARNINGS

	INDICATION	FAULT / EFFECT
AEKRAN	CABIN LIMIT PRESS DESCEND	Cabin altitude above 42 650 ft ±1 640 ft.

ANTI G VALVE

The anti g valve controls air delivery to the anti g suit. Air is tapped from downstream of the air-air coolers, passed through a regulator valve, an anti g valve, and delivered to the suit via the PEC. Below 2.5 g no pressure passes through the suit. Above 2.5 g, the anti g valve controls the suit pressure in proportion to the g-forces experienced.

NOTE

For proper inflation of the anti g suit, the pressure regulator must be set to min. Any position other than min will result in premature pressurization.

VENT SUIT VALVE

The ventilation suit valve controls air delivery to a ventilation suit. Air is tapped from downstream of the turbo cooler, passed through an ejector valve and mixed with hot air, and delivered via the PEC.

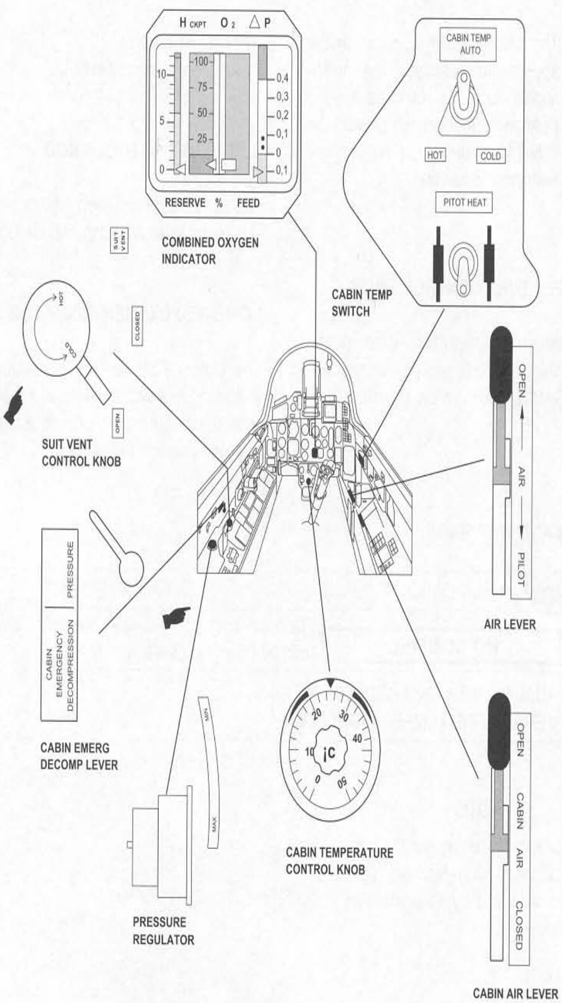


Figure 1-52

CABIN TEMP SWITCH

The cabin temp switch is located on the RH side wall. The four position switch permits selection of automatic temperature control system or manual adjustment of cockpit temperature.
The switch positions are:

AUTO	Cockpit temperature is automatically adjusted in accordance with the setting of the cabin temperature control knob on the main vertical console.
Center position	It is the neutral position and removes the electrical supply from the mixing valve and as a result freezes the valve in it's last position.
HOT / COLD	The mixing valve is driven in the appropriate direction. The switch should only be bumped to the position momentarily to prevent the valve from driving to an extreme temperature position.

CABIN TEMPERATURE CONTROL KNOB

The cabin temperature control knob permits selection of the desired cockpit temperature, provided the CABIN TEMP switch is in the AUTO position.

CABIN AIR LEVER

The cabin air lever regulates the volume of air delivered from the air conditioning system. In the CLOSED position, windshield defogging is manually shut down.

AIR LEVER

The air lever routes the air either to the manifolds directed towards the pilot in the position pilot or the ones towards the canopy in the position open.

PRESSURE REGULATOR

The pressure regulator controls volume and pressure of the air used for inflation of:

- Anti g suit in MIN.
- Partial pressure suit in MAX.

SUIT VENT CONTROL KNOB

The suit vent control knob adjusts temperature and flow of the air routed to the ventilation suit.

COMBINED OXYGEN INDICATOR

The utmost right scale of the combined oxygen indicator displays differential pressure between cockpit pressure and outside air pressure. See oxygen system in this section.

INDICATIONS AND WARNINGS

	INDICATION	FAULT / EFFECT
AEKRAN	NO COOLING	Temperature of the air towards the equipment compartments exceeds +80° C.
VIWAS	"AUSFALL KÜHLUNG GERÄTESEKTION" "VERRINGERE TEMPERATURREGIME"	

NOTE

A reduction of the temperature in the equipment compartment can only be achieved by reducing the airspeed.

LIGHTING SYSTEM

The lighting system consists of the external and internal lighting equipment. Refer to figure 1-53.

LIGHTING SYSTEM CONTROLS

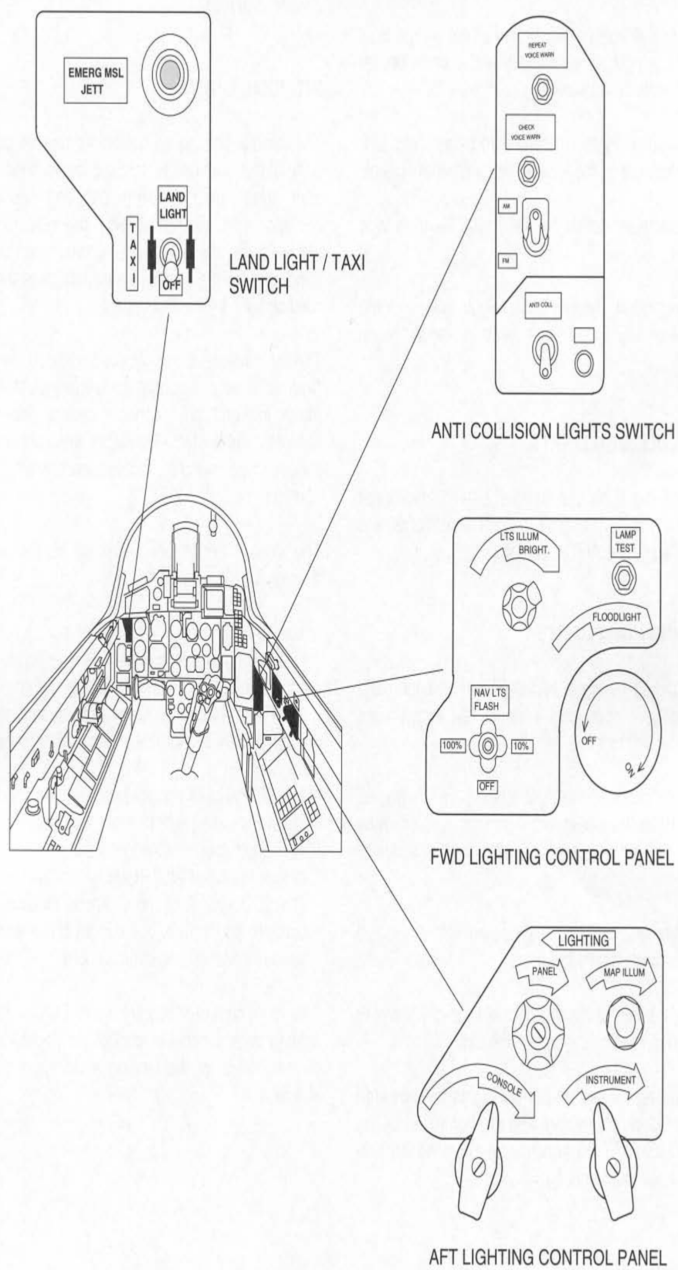


Figure 1-53

EXTERNAL LIGHTING

The external lights include navigation lights, anti collision lights, landing and taxi lights. All external lights are powered by the DC system.

NAVIGATION LIGHTS

Two position lights are installed at the wing tips, a green one right, a red one left and a white one at the left vertical stabilizer.

All navigation lights are controlled by the NAV LTS switch located on the forward lighting control panel.

The selectable modes are: OFF, 100 %, 10 %, and FLASH.

On the ground, the navigation lights will be in the 10 % intensity mode regardless of mode switch setting.

ANTI COLLISION LIGHTS

Anti collision lights are installed behind the cockpit and on the left engine bay. These lights are controlled by the ANTI COLL switch.

LANDING / TAXI LIGHTS

Two landing lights are installed, one on each main landing gear door, and a single taxi light on the nosewheel strut.

The light beam of the right landing light is angled down 10° with respect to the horizon, and offset by 12° to the left with respect to the aircraft's center line.

The light beam of the left landing light is angled down 8° and offset 14° left.

The light beam of the taxi light is aligned parallel to the horizon and to the center line of the aircraft.

The landing as well as the taxi lights are powered by the DC supply system and are controlled by the LAND LIGHT / TAXI switch located on the left side of the instrument panel.

With the switch in position TAXI, only the taxi light is on, whereas both taxi and landing lights are on when the switch is in the LAND LIGHT position.

The landing lights are disabled when the landing gear is retracted regardless of the position of the control switch.

INTERNAL LIGHTS

The internal lighting equipment comprises console panel lights, instrument lights, console flood lights, spot lights, map reading light and associated controls. The control panels and indicators are powered by the AC system, and the console floodlights for the panels, instruments and the map reading light, by the DC system.

The instruments are illuminated with shielded light fixtures located adjacent to each indicator. The major left and right console control panels are indirectly illuminated. The lights are controlled by rheostat-type switches located on the aft lighting control panel.

The control knobs are assigned to the various illumination systems as follows:

- The PANEL control knob has a dual function. If pushed in, it allows manual intensity control of all cockpit information and warning lights except AEKRAN. If pulled out, intensity is automatically controlled by a photo diode according to ambient brightness.
- The MAP ILLUM control knob switches and dims the map reading light located near this panel.
- The instrument illumination is switched and dimmed with the INSTRUMENT control knob.
- The CONSOLE control knob switches and controls the intensity of the indirect illumination of various switches and control knobs.

Two more control knobs are located on the forward lighting control panel to control the floodlights and the brightness of the landing system signal panel illumination.

OXYGEN SYSTEM

The oxygen system is a pressure demand system, and consists of a main system, located in the fuselage, an engine supply system and an emergency system on the ejection seat. Refer to figure FO-15. The oxygen supply for the main oxygen system and for the engine supply is replenished through one single charging connection. Emergency oxygen supply is charged directly to the bottle.

MAIN OXYGEN SYSTEM

The main oxygen system supply consists of three 4 liter high pressure gaseous oxygen bottles (MiG-29GT seven bottles), charged at 150 kp/cm^2. Further components are a oxygen flow valve, a pressure reduction valve, an oxygen flow regulator, a PEC, a pressure regulator, the combined oxygen indicator and the oxygen control panel. The system is mechanically controlled, however, 115 VAC is required for indicator operation.

ENGINE SUPPLY

Refer to ENGINE STARTING SYSTEM in this section.

EMERGENCY OXYGEN SYSTEM

Refer to EJECTION SEAT SYSTEM in this section.

OXYGEN SYSTEM CONTROLS AND INDICATORS

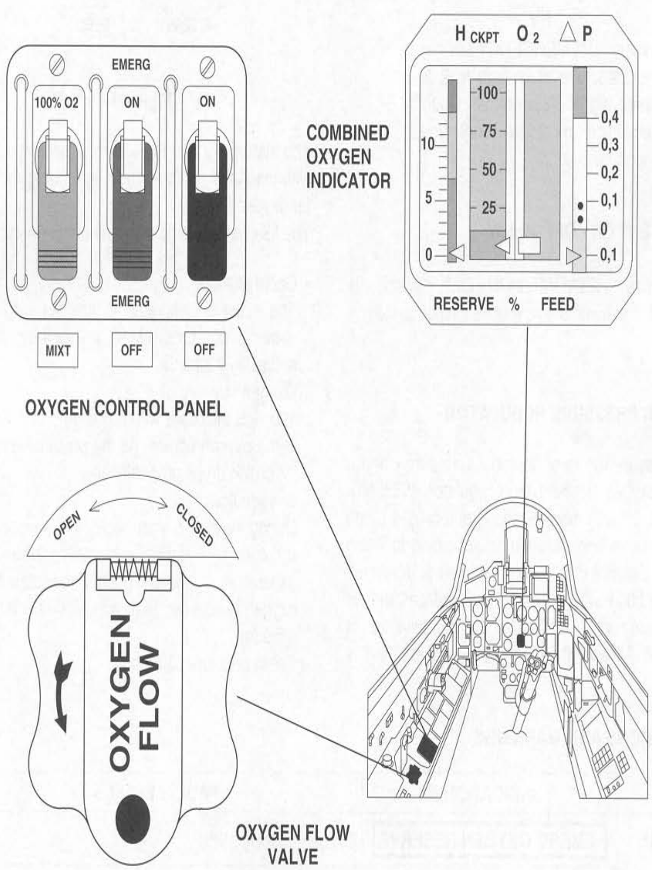


Figure 1-54

OXYGEN FLOW VALVE

The oxygen flow valve is a rotary knob marked OPEN / CLOSE on the LH console. It controls the supply of oxygen to the system.

OXYGEN CONTROL PANEL

MIX - 100 % switch

The blue MIX - 100 % switch allows the selection of either an oxygen / air mixture or pure oxygen.

EMERGENCY ON - OFF switch

The red EMERGENCY ON - OFF switch permits selection of 100 % oxygen with positive pressure or normal oxygen supply. The switch should remain in OFF position at all times, unless an unscheduled pressure increase is required. Moving the switch to EMERGENCY ON provides 100 % oxygen with continuous positive pressure to the face mask.

NOTE

When EMERGENCY ON is selected, use of oxygen is 2 to 3 times higher than normal. Quantity remaining must be continuously monitored.

HELM VENT ON - OFF switch

The black HELM VENT ON - OFF switch is provided to activate the helmet ventilation system.

OXYGEN PRESSURE REGULATOR

The pressure regulator comprises an airmix and a 100 % oxygen demand type regulator. With MIX selected, the air / oxygen ratio is determined by an air inlet valve and thus varies according to cabin altitude. Below 6 600 ft, pure cabin air is delivered. Above 6 600 ft, the air inlet valve reduces the air percentage until 100 % oxygen is delivered at 26 000 ft. Above 40 000 ft, pressure breathing is introduced with pressure increasing with altitude. Between 0 and 40 000 ft, with 100 % selected, the 100 % regulator delivers 100 % oxygen. Above this level, pressure breathing is introduced with pressure increasing with altitude.

COMBINED OXYGEN INDICATOR

Operation of the oxygen system can be monitored on the combined indicator located in the center of the front panel.

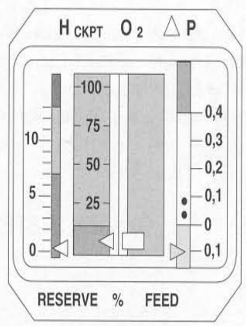


Figure 1-55

The instrument has three thermometer-type scales with triangular pointers and one rectangular pointer for oxygen flow.
The following parameters can be monitored:

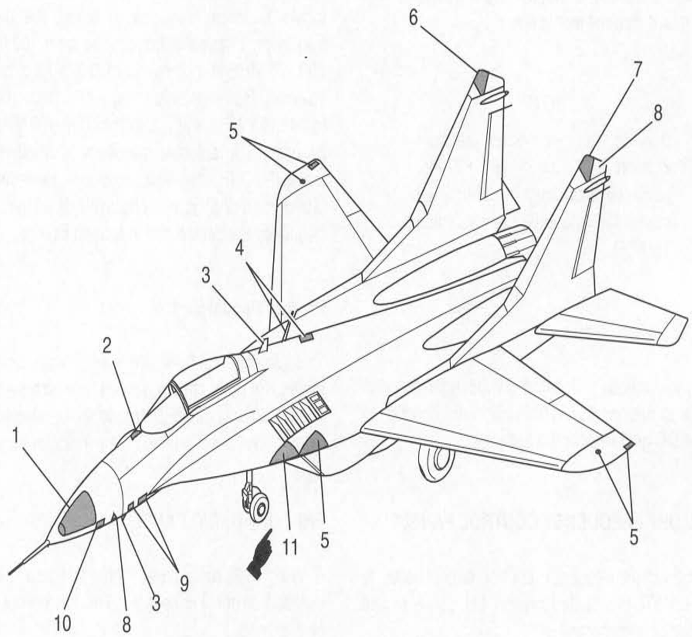
- Cabin altitude:
  The scale is calibrated in km. As long as the cabin is not pressurized, the pointer indicates actual flight altitude.
- Oxygen quantity:
  100 % is indicated with a pressure of 150 kp/cm^2 in the oxygen bottles. As the pressure decreases indication drops proportionally.
- Oxygen flow:
  During normal oxygen flow, the pointer moves up during inhalation and moves down during exhalation. A steady pointer indicates that no oxygen is supplied (e.g. with MIX selected at low altitude).
- Cabin pressure differential.

INDICATIONS AND WARNINGS

	INDICATION	FAULT / EFFECT
AEKRAN	EMERG OXYGEN RESERVE	Oxygen quantity 15 %.
VIWAS	"SAUERSTOFFVORRAT MINIMAL"	

COMMUNICATION AND AVIONIC EQUIPMENT

ANTENNA SYSTEM



1. RADAR
2. IRSTS
3. TACAN
4. ADF
5. RHAW
6. UHF / VHF RADIO
7. XT-2000
8. IFF / SIF
9. RAD ALT
10. MARKER BEACON
11. NOT USED

Figure 1-56

VHF / UHF RADIO

Voice communication is provided by the VHF / UHF radio. 2 000 VHF and 7 200 UHF frequencies can be used. 29 preset frequencies are available, with UHF guard channel monitoring.

NOTE

Due to the wide-band antenna location in the right fin-tip, communication may be interrupted momentarily during turns exceeding 45°AOB.

RADIO Switch

The radio switch is located on the right console. Power to operate the VHF / UHF radio is supplied by the DC generator or the batteries.

VHF / UHF FREQUENCY CONTROL PANEL

A VHF / UHF frequency control panel (refer to figure 1-57) is installed on the LH console. The function of each control is:

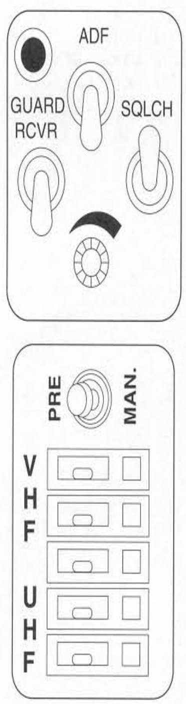


Figure 1-57

Communication Frequency Toggle switches

With the preset / manual switch on MAN., five toggle switches are used to select the desired frequency. Physically, frequencies from 100.000 to 399.975 MHz in increments of 0.025 MHz can be selected. However only frequencies from 100.000 to 149.975 MHz and 220.000 to 399.975 MHz can be used. The selected frequency is displayed on the VHF / UHF radio indicator panel. However, the last digit (0 or 5) is not displayed. If an unusable frequency is selected, the indication flashes.

Preset / Manual Switch

This switch controls the frequency selection method. In MAN., the frequency is selected with the toggle switches , in PRE, frequency is selected with the channel selector knob on the indicator panel.

VHF / UHF RADIO PANEL

A VHF / UHF radio panel (refer to figure 1-57) is installed on the LH console. The function of each control is:

Volume Control Knob

Clockwise rotation of the volume control knob increases the communication receiver volume.

Guard Receiver Select Switch

With GUARD RCVR selected, UHF guard frequency is monitored.

Squelch Switch

The squelch switch enables and disables communication receiver squelch.

Guard Receiver Control Light

The light illuminates when guard transmissions are received even if the guard receiver is deselected.

ADF Switch

With ADF selected, transmissions on the selected ADF frequency can be monitored.

VHF / UHF INDICATOR CONTROL PANEL

A VHF / UHF indicator control panel (refer to figure 1-58) is installed on the instrument panel. The function of each control is:

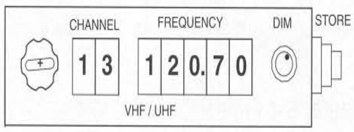


Figure 1-58

Channel Selector Knob

With the preset / manual switch in PRE, 29 preset frequencies can be selected.

Channel Display

The selected channel is displayed.

Frequency Display

With the preset / manual switch in PRE, the frequency of the selected channel is displayed. In MAN., the manually selected frequency is displayed, except the last digit.

DIM Knob

The DIM knob is used to adjust the brightness of the channel and frequency display.

Store Pushbutton

Pushing the store button enters the frequency selected with the toggle switches to the indicated channel.

VHF / UHF RADIO OPERATION

The VHF / UHF equipment is activated by switching the RADIO switch to ON. Transmission is accomplished by pressing the throttle-mounted microphone button. The receiver signal can be controlled with the volume knob on the control panel.

Manual Frequency Selection

Set preset / manual switch to MAN. Enter a six-digit frequency via the toggle switches. The last two digits (00-25-50-75) are selected with one toggle switch.

Channel Selection

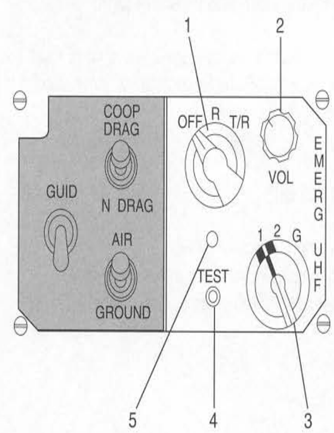
Set preset / manual switch to PRE. Select desired channel with the channel select knob. Channel number is displayed on the channel display, and the corresponding frequency on the frequency display.

Channel / Frequency Loading

If a stored frequency needs to be changed, select the desired channel. Insert the new frequency via the toggle switches. After pressing the STORE button, the new frequency is displayed on the frequency display and stored simultaneously.

EMERGENCY UHF RADIO (XT-2000)

The emergency UHF radio provides air-to-air and air-to-ground communication on the UHF preset distress frequency of 243.0 MHz, and two further preset channels. The radio can also be used as guard or auxiliary receiver in the airborne communication system. The radio is powered by 28.5 VDC and utilizes the emergency UHF antenna in the left vertical fin.



1. FUNCTION SELECTOR
2. VOLUME CONTROL KNOB
3. CHANNEL SELECTOR
4. TEST PUSHBUTTON
5. TEST INDICATOR LIGHT

Figure 1-59

CONTROLS AND INDICATORS

The emergency UHF control panel is installed on the forward LH console.

Function Selector

The function selector is a rotary knob with positions marked OFF, R and T/R.

OFF	Electrical power is disconnected
R	The system can only receive
T/R	The system is able to transmit and receive

Volume Control Knob

The volume control knob adjusts the audio level of the receiver.

Channel Selector

The channel selector, which is labeled CHAN, is a rotary knob with positions 1, 2 and G.

1, 2	Select one of two preset channels
G	Select the UHF distress frequency (GUARD) of 243.0 MHz

Test Pushbutton and Indicator Light

The test pushbutton and indicator light is used for performing built-in test to determine if the system is operating properly.

Built-In Test

1. Function selector - T/R
2. Channel selector - To desired channel
3. Test pushbutton - Press and hold

The indicator light illuminates and remains illuminated as long as the pushbutton is held, and a short tone is heard if the system is operating properly. If there is a system malfunction, the indicator light flashes momentarily and then extinguishes, and the audio tone is not heard.

EMERGENCY UHF RADIO OPERATION

Use as guard or auxiliary receiver :

1. Function selector - R
2. Channel selector - To desired channel
3. Test pushbutton - Press
4. Volume control knob - To desired audio level

Use as a transmitter / receiver :

1. Function selector - T/R
2. Channel selector - To desired channel
3. Test pushbutton - Press
4. Volume control knob - To desired audio level
5. PTT button - Press for transmission

INTERCOM SYSTEM

The intercom (I/C) system enables communication between the ground crew and the pilot.

GT: The I/C enables additionally communication between the two cockpits.

All audio warnings produced by various aircraft systems and identification signals from radio and navigation equipment are routed to the pilot's headset. Volume of the radio and navigation equipment can be adjusted by the relevant volume control. Aircraft warnings are transmitted at an audio level high enough to attract attention. Ground crew / pilot communication is adjusted at a level to provide understanding. Audio signals which may be heard over the I/C are listed with the relevant system, VIWAS signals in section 3.

RECORDERS

HUD CAMERA

Control signals from the fire control system triggers camera operation, refer to GAF T.O. 1F-MIG29-34-1.

FLIGHT DATA RECORDER

The flight data recorder (FDR)/TESTER records flight parameters and the operation of important aircraft systems.

Conservation of recorded data is assured under the following conditions:

- Impact with g-forces up to 1 000
- Temperatures up to 1 000° C during 15 minutes
- Exposure to sea water up to 5 days
- Exposure to fuel up to two days

The recorder is powered by 28.5 VDC. The data recording is made of the last three hours of the aircraft operation.

Controls and Indications

The recorder is activated manually with a switch labeled RECORD on the RH console.

If not activated manually, automatic operation starts at or above 85 % engine RPM with the trailing edge flaps down, or if the weight is off the right main gear at any RPM.

Operation

Data from the flight data recorder are transferred to the ground evaluation system without extracting the tape, at a rate 8 - 12 times faster than the recording. They are used to make an express analysis of aircraft and system operation.

The express analysis contains following information on a data sheet:

- Aircraft number
- Flight number
- Date of flight
- Sequence number of the malfunction
- Channel number for recorded data and extreme values
- Start and end time of occurrences or malfunctions

In addition, the following possibilities are available:

- Display in a graphical form of the coded values as recorded by the FDR
- A print-out of all malfunctions

List of Recorded Parameters

Aircraft velocities, rates and control surface positions:

- Aircraft velocity
- TAS
- Barometric altitude
- Altimeter setting
- G-forces in all axes
- True course.
- AOB
- Pitch angles
- AOA
- Deflection angle of tailerons
- Deflection angles of the rudders
- Control stick deflection
- Pedal position
- Aileron position
- Mach number

Engine parameters:

- RPM of engine HP compressors
- RPM of engine LP compressors
- Air temperature at the intake of the engines
- Fuel pressure at the first stage of the engines
- Fuel quantity
- Oil pressure in the ENG GBX
- Oil pressure of the engines
- Position of the exhaust nozzle flaps at the critical cross section
- Pressure at the exhaust of both engines turbines
- Pressure at the intakes of both engines
- Temperature at the exhaust of the engine turbines
- Throttle positions
- Vibration of the ENG GBX
- Vibration of the engine turbines

AFCS system:

- Stroke of the yaw damper actuator
- Stroke of the longitudinal damper actuator
- Stroke of the feel unit actuator
- Stroke of the aileron trim drive
- Stroke of the pitch trim drive
- Discrete signals of the AFCS system

Electrical power supply:

- AC bus voltage 115 V, 400 Hz
- DC bus voltage 22 to 28.5 V

Discrete signals:

- Failure of the main hydraulic system
- Failure of the hydraulic booster system
- Backup system of the LH engine
- Backup system of the RH engine
- LH engine overheated
- RH engine overheated
- No fuel flow
- Reduce RPM of LH engine
- Reduce RPM of RH engine
- Surge of RH engine
- No oil pressure in the GBX
- Fire
- Speedbrakes out
- Landing flaps down
- Landing gear retracted
- Eject
- Engine surge LH
- Engine surge RH
- Jettison of the canopy
- Louvers open/closed
- AB of the LH engine
- AB of the RH engine
- Position of LEF
- Signal of the marker receiver
- PTT button depressed
- 550 kg fuel remaining
- Trigger operation
- External stores loaded

Service parameters:

- Calibration voltage index for self-check
- Mission time in seconds
- Mission time in minutes
- Initialization sequence number of the FDR
- Overflow voltage
- Aircraft number

NAVIGATION SYSTEM

The aircraft navigation system consists of the gyro platform reference system, navigation computer, air data computer (ADC) and radio navigation equipment. The gyro platform reference system consists of a main and a standby platform, the radio navigation system of TACAN, ADF and marker beacon receiver. All systems are closely interfaced to supply complete navigational information throughout all flight phases.

NAV ARCHITECTURE

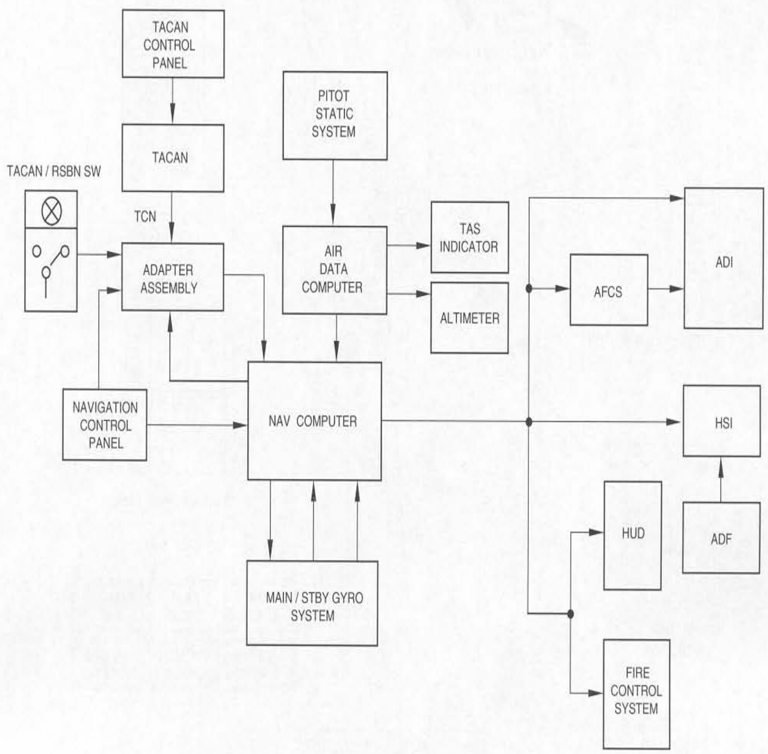


Figure 1-60

NAVIGATION SYSTEM CONTROLS

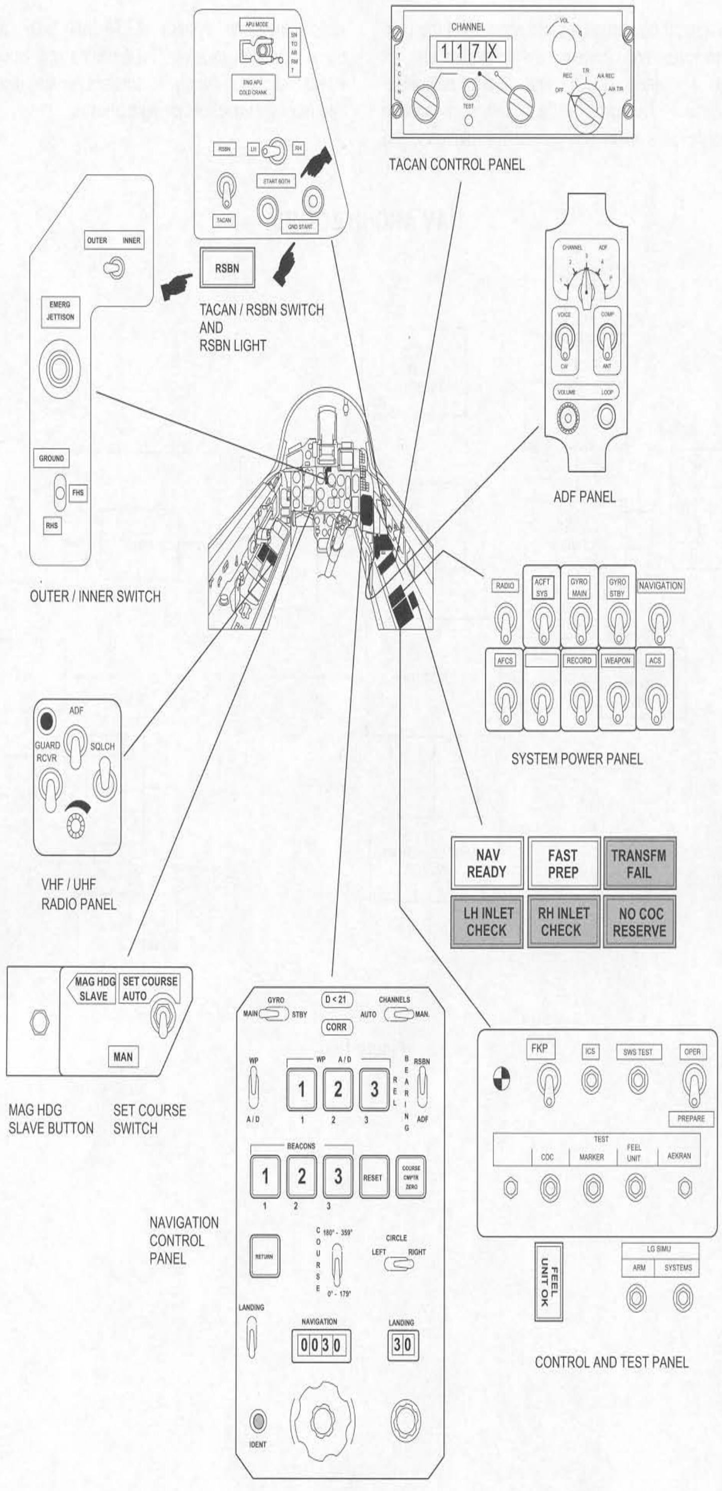


Figure 1-61

GYRO SYSTEMS

The gyro systems are used to measure bank and pitch angles, course and acceleration along the axis of the platform. They supply the primary azimuth and attitude reference, and additionally supply direction, velocity, and distance inputs to the navigation computer. The system utilizes DC power from the generator or the batteries. 115 VAC and 3 phases 36 VAC are supplied by the AC generator and the transformer, or by the PTO. However, the PTO capacity is insufficient to supply heating power to the gyro system.

The unit consists of the main and of the standby gyros, an analog / digital computer, operating controls for variation (behind the ejection seat) and latitude, a flux valve and BITE.

Each system uses a gyro-stabilized platform upon which three accelerometers are mounted. With the platform stabilized in pitch and roll by gyros and oriented along the aircraft axis, the accelerometers sense acceleration in any direction. This acceleration is processed by the analog / digital computer to provide course reference, attitude information, main gyro platform stabilization and signals for the navigation computer. A circuitry corrects for apparent precession, based on preset latitude.

GYRO ALIGNMENT

With the BAT-GND SUPPLY switch and the generator and navigation switches placed to ON, power is applied to bring the gyro platforms to operating temperature. MAIN and STBY switches are selected for stabilization of the platforms. Prior to the alignment, the appropriate aerodrome has to be selected.

Fast Alignment

The alignment cycle is started by placing the MAIN and STBY gyro switches to ON, PREPARE / OPERATE switch in PREPARE.

After approximately 30 to 40 sec, heading reference is inserted to the analog / digital computer by pressing the mag heading slave button and COURSE CMPTR ZERO pushbutton simultaneously for 10 to 15 sec. The PREPARE / OPERATE switch has to be placed to OPERATE within 90 sec after switching both gyros to ON. After a total time of 3 minutes, the fast prepare light on the right console rear panel illuminates, indicating completion of the alignment and system readiness. The light distinguishes during T/O when the weight is off the main landing gear.

Long Alignment

The PREPARE / OPERATE switch is left in the PREPARE position until the NAV READY light illuminates on the right console rear panel after 15 minutes, indicating completion of the alignment. Alignment may last up to 20 minutes at temperatures between -30° C and -60° C. When switching the PREPARE / OPERATE switch to OPERATE, the light extinguishes, indicating system readiness.

NOTE

If long alignment has been selected, and circumstances dictate switchover to fast alignment, at least 5 minutes should elapse prior switching from PREPARE to OPERATE.

GYRO OPERATION

The gyro system can be operated either with the main gyro platform or in the standby gyro platform. However, the main gyro platform is more accurate since digital integration is provided to the main gyro platform only. In case of a main gyro system failure, switchover from main to standby has to be accomplished manually.

INDICATIONS AND WARNINGS

	INDICATION	FAULT / EFFECT
MASTER CAUTION	LIGHT FLASHING	
AEKRAN	MAIN DIR VERT GYRO or STBY DIR VERT GYRO or TWO DIR VERT GYRO	Failure of corresponding gyro system(s).
ADI	Gyro fail light	

NAVIGATION COMPUTER

The navigation computer is the central unit of the navigation system. It processes data from the inertial navigation unit and from the air data computer (ADC) to compute the present position and to correct it according to TACAN signals, to compute azimuth and distance information to a selected, programmed navigation point, and altitude deviations as well as ground track information.

Additionally, the navigation computer produces discrete control signals for automatic control of the complete navigation system.
The navigation computer is provided with 28.5 VDC, 115 VAC and 3 phases 36 VAC.

To reduce required computational capacity, a relative coordinate system, restricted in latitude and longitude, is used. The zero point of the system is in the lower left corner. Required navigation points are entered into the navigation computer via the navigation computer programming panel, located on the left side of the nose section.

Two different types of navigation computers are available, CWU A-340-071M version 2204 and version 2205.

Computational capability of the CWU version 2204 is restricted in latitude and longitude to an area of 36° and one set of coordinates, while the CWU version 2205 is restricted to an area of 40° and two sets of coordinates.

OPERATING MODES

Four operating modes are possible. Normal operating mode is dead reckoning with TACAN update.

DEAD RECKONING Mode

This mode is available after fast alignment, only analog integration of both gyro platforms is performed. Accuracy is minimal: 4 % of distance traveled per hour of circular error probability, 1.5° precession per hour. However, since no aerological wind information data are processed, large computational errors may be present.

INERTIAL NAVIGATION Mode

The inertial navigation (IN) mode is available after long alignment with the main gyro platform. Since precise alignment was performed, maximum error is 4.5 NM per hour of circular error probability, precession 1° per hour.

UPDATE Mode

Automatic continuous navigation computer update is available in both operating modes. System inaccuracy is reduced to ±0,2 NM +0,1 % of distance to the station used for update. Three individual TACAN stations can be programmed prior flight for update purposes. The channel select switch must be placed to AUTO, the REL BEARING switch to RSBN, and the landing switch to OFF. TACAN is selected on the RH console. The CORR light illuminates if proper signals are received and automatic update is performed. For update with a TACAN station, the programmed station must be selected on the TACAN control panel additionally.

Visual Update

The navigation computer can be manually updated by pressing the COURSE CMPTR ZERO illuminated pushbutton and releasing it upon overflight of a selected and programmed waypoint (WP) or airfield.

NOTE

Update is not possible if a discrepancy of more than 21 NM exists between the present position computed and the actual position.

NAVIGATIONAL OPTIONS

Various navigational options are operated according to the setting on the navigation control panel:

- Point-to-point navigation
- Return
- Landing approach
- Traffic reentry (missed approach)
- Manual station select

POINT-TO-POINT NAVIGATION

Six navigation points can be programmed and are selected by setting the WP-A/D switch and selection of one of the three WP-A/D illuminated pushbuttons.

The course to the selected coordinate is displayed by the course pointer and the course window, distance is displayed by the range indicator on the HSI and on the HUD. As the aircraft closes on the selected coordinate the D < 21 NM light illuminates. Passing the coordinate, the lost bearing indication will be shown until exceeding 3.2 NM distance outbound.

RETURN

Pressing the RETURN illuminated pushbutton provides bearing information to a lead point for the nearest 9.2 NM final intercept to the selected airfield, provided the correct landing direction is selected with the COURSE switch and the update function is operating. Slant range is indicated to the selected A/D coordinates.

If automatic navigation computer update is inoperative, course and distance to the aerodrome reference point are provided.

During the approach, glide path information is displayed on the ADI for a 7° glide slope to the final intercept point at 3 700 ft AGL or QFE.

TRAFFIC RE-ENTRY (MISSED APPROACH)

If the missed approach button is pressed, the navigation computer supplies steering information for a traffic pattern, provided the landing select switch is off and TACAN correction is operative. Steering is provided for a 5.4 NM downwind leg and final intercept.

Pattern direction left or right hand is selected by placing the circle left-right switch to the corresponding direction. Glidepath information is displayed for a pattern altitude of 2 000 ft AGL or QFE.

MANUAL STATION SELECT

With the channels MAN. / AUTO switch in MAN., bearing and distance to a selected TACAN station is displayed. Navigation computer update is not provided.

NOTE

With the CHANNELS switch in manual, the final course must be dialed in on the HSI to receive steering commands.

NAVIGATION CONTROL PANEL

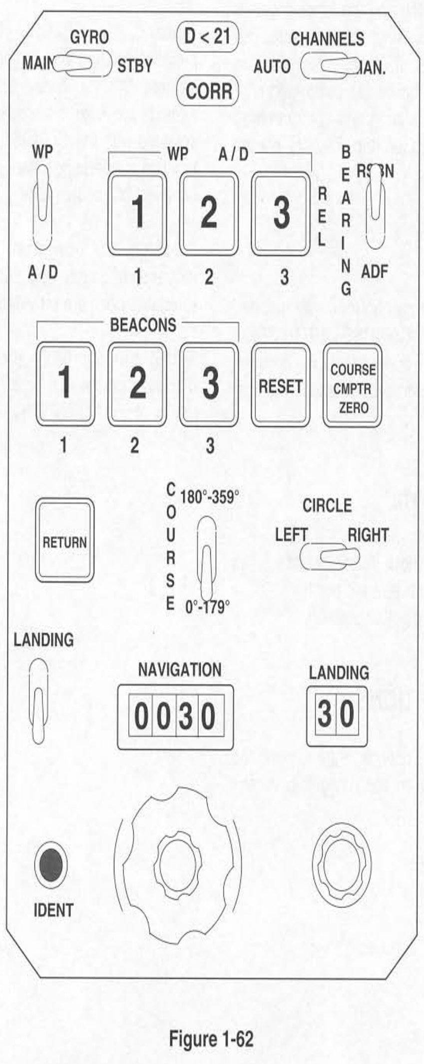


Figure 1-62

NAVIGATION CONTROL PANEL

GYRO Switch

A two position toggle switch, positions marked MAIN-STBY, selects the appropriate gyro system.

CHANNELS Switch

A two position toggle switch with following functions:

AUTO- Beacon selected for NAV system update

MAN. - NAV system not updated

WP-A/D Switch

A two position toggle switch, marked WP-A/D, selects appropriate function of the corresponding pushbuttons.

REL BEARING Switch

A two position toggle switch, positions marked RSBN-ADF, selects TCN / RSBN or ADF display on the HSI.

COURSE Switch

A two position toggle switch, positions marked 0 - 179° and 180 - 359°, selects appropriate hemisphere for RWY in use.

CIRCLE Switch

A two position toggle switch, positions marked LEFT-RIGHT, selects direction of LDG pattern.

LANDING Switch

A two position toggle switch to select the ILS if not automatically switched in.

IDENT Button

This button is not in use.

WP A/D Buttons

Three combined pushbutton and indicator lights, marked 1, 2, 3, to select a navigation point or an aerodrome.

BEACONS Buttons

Three combined pushbutton and indicator lights, marked 1, 2, 3, to select a beacon for NAV system update.

RESET Button

A combined pushbutton and indicator light to deselect the previously selected BEACON.

COURSE CMPTR ZERO Button

A combined pushbutton and indicator light to reset the NAV computer.

RETURN Button

A combined pushbutton and indicator light activates RETURN.

NAVIGATION Channel Window

Manually selected RSBN channel is displayed.

RSBN Channel Selector Knob

Selects desired RSBN channel in MAN.

LANDING Channel Window

Manually selected ILS channel is displayed.

ILS Selector Knob

Selects desired ILS channel.

NAVIGATION COMPUTER PROGRAMMING

The navigation computer programming panel is located on the lower left side of the nose section. Refer to figure 1-62A. It is used to program following data:

- Reference latitude for the coordinate square
- Relative coordinates for 3 airfields
- Relative coordinates for 3 waypoints
- Relative coordinates for 3 beacons
- RWY direction for 3 airfields between 0° to 179.9°
- Heading for 4 visual heading reference points (not in use)
- Reference heading for parking spot (not in use)
- 3 RSBN channels
- 3 ILS channels.

A second set of data has to be programmed with the computer CWU version 2205, restricted to a 40° area, however, it cannot be selected from the cockpit.

Programming is performed with an eight-digit code, consisting of a two-digit address number, a single-digit prefix number and the five-digit programming code. Refer to figure 1-62B.

REFERENCE LATITUDE

Reference latitude has to be entered into the computer to adjust the relative coordinate system. In the Northern hemisphere, the lateral geographical coordinate complemented by three zeros. In the Southern hemisphere, the lateral geographical coordinates is subtracted from 360 and the result complemented by two zeros.

HEADINGS

The programming code for headings consists of the geographical heading with the arc minutes and arc seconds expressed in hundredth of degrees.
For programming of runway directions, the value between 0.00 and 179.99 has to be selected.

COORDINATES

For programming of coordinates, the relative coordinate is calculated to an accuracy of four decimals, rounded to the third decimal and expressed as an unfragmented number. The relative coordinates are obtained subtracting the reference coordinates of the relative coordinate system from the geographical coordinates.

Sample problem:

Geographical coordinate: 54°20'22"N, 07°34'56"E.
Reference coordinate for the relative coordinate system: 30°N, 10°W.

Latitude:	Longitude:
54°20'22"N	07°34'56"E
- 30°00'00"N	- 10°00'00"W
24°20'22"	17°34'56"

To receive the five-digit programming code, the relative coordinate has to be converted to a decimal number by the following formula:

$$\text{arc degrees} + \frac{\text{arc min}}{60} + \frac{\text{arc sec}}{3600} = \text{five - digit code}$$

Sample relative latitude:

$$24 + 0.\overline{3333} + 0.006\bar{1} = 24.3394$$

Five-digit code 24339

Sample relative longitude:

$$17 + 0.56\overline{66} + 0.01\overline{55} = 17.5822$$

Five-digit code 17582

The five-digit code has to be combined with the address and the prefix number listed in figure 1-62B.

Sample:

Waypoint 3, relative latitude	24°20'22"
Address number for waypoint 3 latitude	41
Prefix number	0
Five-digit code for 24°20'22"	24339
Programming code	41024339

RSBN / ILS CHANNELS

RSBN and ILS channels are entered in coded format for navigation computer update. Since RSBN and ILS are presently not in use, the appropriate code list is not published in GAF T.O. 1F-MIG29-1. However, a random code has still to be entered to permit nav computer update by use of TACAN stations.

ENTERING DATA SET

To enter the data set, DC and AC power must be available and the NAVIGATION switch on the system power panel has to be switched to the ON position.

The navigation computer programming panel is switched on with the ВКЛ ОТКЛ (ON) button.

Illumination of the data input display indicates system readiness.

Pressing the СБРОС (RESET) pushbutton on the keyboard sets the data input display to zero.

Before entering the data set in random sequence, the opening code 77127777 has to be entered.

After entering each eight-digit code, the ЗАЛ (ENTER) button has to be pressed for data input.

After resetting the system with the СБРОС (RESET) pushbutton, the next code can be entered. The СБРОС (RESET) pushbutton can be used to delete the displayed code in case of an input failure. After input of the complete data set, the closing code 77139999 has to be entered to complete data input.

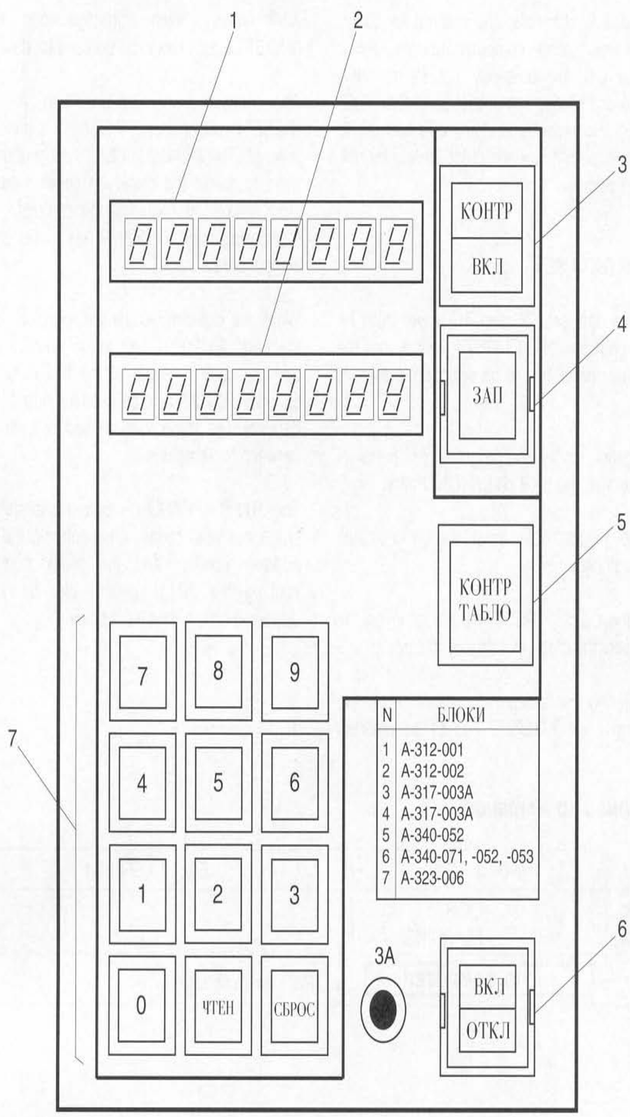
When the computer CWU version 2205 is in use, the code 25100001 has to be entered after the opening code for input of the first data set, and code 25100002 has to be used for input the second data set. The same code is used for switching sets between two sorties.

The ЧТЕН (READOUT) button can be used to check out valid codes. After entering the two-digit address number and the prefix number and pushing the ЧТЕН button, the valid code is displayed on the data input display.

INDICATIONS AND WARNINGS

	INDICATION	FAULT / EFFECT
MASTER CAUTION	LIGHT FLASHING	
AEKRAN	NAVIG COMPUTER	No NAV system update.

NAVIGATION COMPUTER PROGRAMMING PANEL



1. DATA INPUT DISPLAY
2. REPEATER DISPLAY
3. BIT
4. ENTER BUTTON
5. LAMP TEST BUTTON
6. ON / OFF BUTTON
7. KEYBOARD

Figure 1-62A

ADDRESS AND PREFIX NUMBERS

Reference		Address number	Prefix	Code
Reference latitude		07	0	latitude complemented by zero's
A/D 1	relative latitude	11	0	thousands of degrees
A/D 1	relative longitude	12	0	"
A/D 2	relative latitude	31	0	"
A/D 2	relative longitude	32	0	"
A/D 3	relative latitude	51	0	"
A/D 3	relative longitude	52	0	"
WP 1	relative latitude	01	0	"
WP 1	relative longitude	02	0	"
WP 2	relative latitude	21	0	"
WP 2	relative longitude	22	0	"
WP 3	relative latitude	41	0	"
WP 3	relative longitude	42	0	"
BEACON 1	relative latitude	44	0	"
BEACON 1	relative longitude	14	0	"
BEACON 2	relative latitude	45	0	"
BEACON 2	relative longitude	15	0	"
BEACON 3	relative latitude	46	0	"
BEACON 3	relative longitude	16	0	"
RWY direction A/D 1	geographical heading	10	0	hundredth of degrees
RWY direction A/D 2	geographical heading	30	0	"
RWY direction A/D 3	geographical heading	59	0	"
Heading reference 1	geographical heading	27	0	"
Heading reference 2	geographical heading	37	0	"
Heading reference 3	geographical heading	47	0	"
Heading reference 4	geographical heading	57	0	"
Parking position	geographical heading	55	0	"
BEACON 1 channel	code	04	1	not published in GAF T.O. 1F-MIG29-1
BEACON 2 channel	code	05	1	
BEACON 3 channel	code	06	1	
ILS 1 channel	code	13	1	
ILS 2 channel	code	33	1	
ILS 3 channel	code	53	1	

Figure 1-62B

TACAN

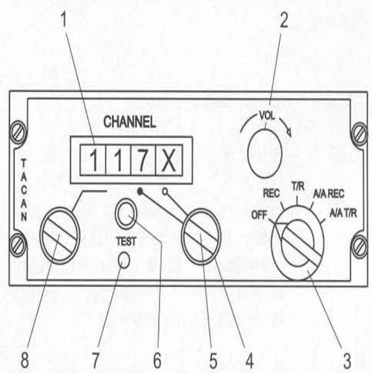
The TACAN system provides magnetic bearing and slant range to the selected ground station, or to a suitably equipped cooperating aircraft (air-to-air). A suitably equipped cooperating aircraft is one equipped with bearing transmitting equipment. The TACAN system can transmit only distance information when interrogated in the A/A, T/R mode. The TACAN system determines the identity of the transmitting station and indicates the dependability of the transmitted signal.

The system utilizes radio navigation frequencies, the propagation of which is virtually limited to line of sight distances. In case of co-channel interference in T/R mode, the interfering channel identifier is garbled. When a temporary loss of signals occurs, a memory keeps range tracking for 15 seconds and bearing tracking for 3 seconds. The TACAN automatically self-tests after a temporary signal loss and displays its status on the control panel. The TACAN is supplied with 115 VAC by the AC generator or the PTO.

TACAN ANTENNAS

The TACAN system uses an upper and lower antenna to receive TACAN signals. Antenna switching to the antenna with greatest signal strength is automatic. For antenna location, refer to figure 1-56.

TACAN CONTROLS AND INDICATORS



1. NAV CHANNEL WINDOW
2. VOLUME CONTROL
3. TACAN FUNCTION SELECTOR KNOB
4. CHANNEL SELECTOR CONTROL KNOB (X/Y SELECTION)
5. CHANNEL SELECTOR CONTROL KNOB (UNIT DIGIT SELECTION)
6. TEST INDICATOR LIGHT
7. TEST BUTTON
8. CHANNEL SELECTOR CONTROL KNOB

Figure 1-63

REL BEARING Switch

A two position toggle switch on the NAV panel, selects the appropriate system for navigational display.

TACAN Function Selector Knob

OFF	Power disconnected
REC	In the receive mode, no interrogation pulse is transmitted. The bearing identification of a selected ground station are received. Range information is not available.
T/R	In the transmit / receive mode, the transmitter and receiver are active, generating range and bearing information from a selected ground station.
A/A REC	In the A/A receive mode, the system receives and decodes bearing information from a suitably equipped cooperating aircraft. The channel of the receiving aircraft must be either 63 channels above or 63 channels below the suitably equipped, cooperating aircraft channel but must be within the 1 through 126 X or Y channel range. Both aircraft must be either in the X or Y channel.
A/A T/R	In the A/A transmit / receive mode, the TACAN system interrogates a reference aircraft and the slant range to the cooperating aircraft is displayed, see A/A REC above for channel selection. In this mode, the TACAN system provides distance replies to other aircraft when interrogated. Bearing to a suitably equipped cooperating aircraft is also displayed. The TACAN AN / ARN-118 system can transmit only distance information when interrogated in the A/A, T/R mode. The maximum number of aircraft to receive range information simultaneously is limited to 5.

NOTE

- In the air-to-air modes, to prevent possible interference from IFF or transponder signals, channels 1 thru 11, 58 thru 74, and 121 thru 126 should not be used.
- To reduce the possibility of DME interference, the use of Y channels is recommended if the suitably equipped, cooperating aircraft is equipped with Y channel capabilities.

Channel Selector Control

The two rotary knobs are used to set the desired TACAN channel. The left knob selects the tens and hundreds digits of the operating channel. The right knob selects the units digits of the operating channel and contains an outer knob which selects the X or Y channel. Placing the knob to X provides capability for 126 channel operation. Placing the knob to Y adds an additional 126 channel capability to the TACAN system. The dial system is numbered 0 to 129, each number from 1 to 126 represents a specific pair (transmitting and receiving) of frequencies. Number 0, 127, 128 and 129 on the channel dial are not usable.

Channel Window

The selected TACAN channel is displayed on the NAV channel window, followed by a X or Y for the corresponding channel.

Navigation Volume Control Knob

The VOL control knob controls the volume of the audio identification signal received from the transmitting station.

TACAN Test Button

The TACAN test button may be used to test the TACAN as follows:

- TACAN / RSBN switch - TACAN
- REL BEARING switch - RSBN
- Function selector knob - T/R
- Allow 90 sec for warm-up
- TACAN test button - press and release

Observe the following:

- Test indicator light flashes momentarily
- (HSI) Distance indicates 0.0 ± 0.5 miles (-0.5 miles indicated as 399.5 miles)
- Bearing pointer slew to 180° ± 3°
- After about 15 sec normal TACAN lock-on

This test does not check the antenna interface. TACAN accuracy should be checked against a ground check point.

Automatic Self-Test

If the TACAN bearing signal becomes lost or is unreliable, the TACAN system switches to automatic self-test. The indications of the self-test correspond to the manual test. If there is a detected malfunction in the system, the test indicator light comes on steady. If the indicator light illuminates steady during the test cycle in both the T/R and REC modes, the bearing and distance information on the HSI is invalid. The self-test can be terminated any time by turning either the TACAN function selector knob or any of the channel selector knobs.

Inflight Confidence Test

If TACAN indicator readouts become suspect during flight, perform an inflight confidence self-test of the TACAN system by setting the TACAN function selector knob to T/R and then pressing the TACAN test button, the test indicator light flashes momentarily. If the test indicator light illuminates steady during the test cycle in both the T/R and REC modes, the bearing and distance information are invalid. If the test indicator light comes on in the T/R mode but not in the REC mode, the distance information is invalid and the bearing on the HSI is valid.

ADAPTER ASSEMBLY TACAN / RSBN

The adapter assembly TACAN / RSBN converts TACAN signals to match NAV system requirements. Since RSBN inputs to the NAV system, refer to TRUE NORTH, TACAN signals must be corrected for variation to simulate RSBN signals. DC power is required for operation.

Adaptation is limited to three programmed TACAN stations selected with the BEACON buttons on the navigation panel, CHANNEL select switch in AUTO.

Requirements for adapter assembly operation are:

TACAN / RSBN switch	TACAN
CHANNEL select	AUTO
BEACON	1, 2 or 3 select
TACAN control panel	Channel selected corresponding to the beacon.

CONTROLS AND INDICATORS

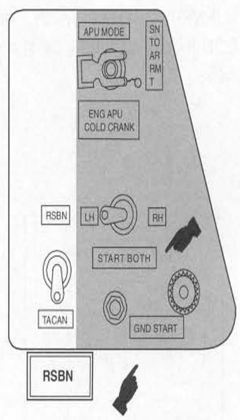


Figure 1-64

TACAN / RSBN Switch

A two position toggle switch on the RH console, selects the appropriate system as reference for the navigation system.

RSBN Light

The light illuminates when RSBN is selected.

AUTOMATIC DIRECTION FINDING

The ADF provides direction finding or radio monitoring in the HF frequency band (150 to 1299.5 kHz). Eight different stations can be channelized for inflight use. However, a standard setting is normally programmed.

The system is powered with 28.5 VDC and 36 VAC from a transformer. Battery and DC / AC converter supply the system with power in case of a generator failure.

ADF CONTROLS AND INDICATORS

The controls consist of the ADF select switch on the radio panel, the REL BEARING / ADF switch on the navigation panel, the INNER / OUTER switch and of the BEACON INNER light on the instrument panel above the radar altimeter, as well as of the ADF channel select knob, the VOICE / CW switch, the COMPASS / ANTENNA select switch, VOL control knob and LOOP pushbutton on the ADF panel.

GT: The INNER / OUTER switch and the BEACON INNER light are located on the LH side wall.

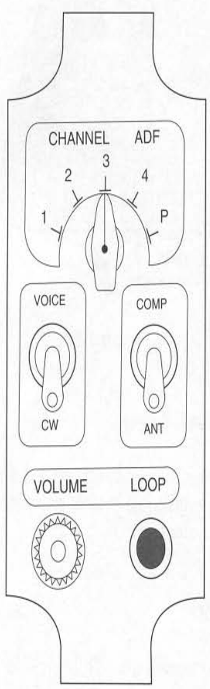


Figure 1-65

ADF Operation

The ADF operation is as follows:

- Set the ADF select switch (radio panel) to off
- Set the RSBN / ADF select switch (navigation panel) to ADF
- Set the COMPASS / ANTENNA select switch to COMP
- Set the INNER / OUTER select switch to the desired position (according to the required channel), check that the BEACON inner light is illuminated if INNER is selected
- Select desired channel with the ADF channel select knob
- Set the VOICE / CW switch as required

The ADF radio receiver operation is as follows:

- Set the ADF select switch (radio panel) to ADF
- Set the RSBN / ADF select switch (navigation panel) to ADF
- Set the COMPASS / ANTENNA switch to ANTENNA
- Select the desired channel (INNER / OUTER switch and ADF channel select knob)
- Set the VOICE / CW switch as required

ADF Self-Test

To initiate the self test:

- Set the RSBN / ADF select switch to ADF.
- Set the ADF channel select knob to position P. Check bearing pointer rotating to approximately 195°.
- Set the VOICE / CW switch to CW.
  Check for 800 Hz tone transmission.

LOOP Pushbutton

To manually rotate the ADF loop antenna press the LOOP button. The antenna will return to its original position upon release.

RADIO MARKER RECEIVER

The radio marker receiver indicates the overflight of a marker beacon.

Frequency is 75 MHz in accordance with ICAO standards.

Overflight of a marker beacon is indicated by illumination of the MARKER BEACON light on the TLP and by an audio signal of 3 000 Hz.

The marker beacon receiver is operated by 28.5 VDC from the DC generator or battery power. It is switched on by placing the ACFT SYS switch to the ON position.

NOTE

The marker beacon receiver will switch the ADF from a selected OUTER channel to INNER channel when passing a marker beacon within 15° of the final course, provided the gear is down.

IFF EQUIPMENT

The identification system STR 700 provides automatic identification of aircraft in which it is installed when challenged by surface or airborne IFF interrogation sets. It identifies the aircraft position momentarily upon request, reports the altitude of the aircraft and indicates an emergency. Altitude is given from the air data computer. In operation, the identification system receives coded interrogation signals and transmits coded response signals to the source of challenging. Five modes of operation are provided for interrogation and response to interrogation signals.

Mode 1	Security identification
Mode 2	Personal identification
Mode 3/A	Traffic identification
Mode C	Altitude reporting
Mode 4	Crypto identification

The codes for mode 1 (00-73) and 3/A can be set in the cockpit during flight, but the code for mode 2 must be set on the ground. Mode 2 and mode 3/A can be set from code 0 000 to 7 777. When mode C is selected, coded altitude information from the altitude encoder is applied to the IFF system for reply to mode C interrogation. The code represents aircraft altitude. There are no provisions to manually set mode C code.

Failure of mode 4 reply is indicated by an optical and an audio signal. The system is supplied with 28.5 VDC and 115 VAC, 400 Hz for the altitude encoder.

IFF CONTROL PANEL

The IFF control panel is located on the right console (GT: front cockpit only).The controls on the IFF panel are shown in figure 1-66. There is also a MODE 4 light on the TLP.

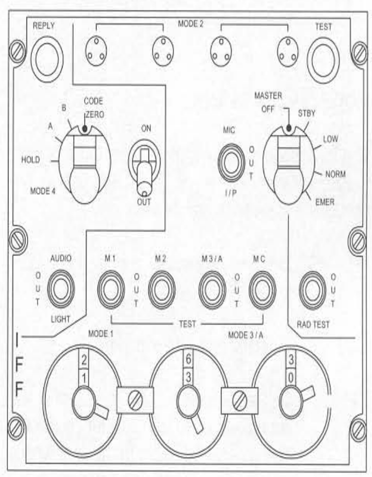


Figure 1-66

Master Function Selector Knob

A five-position rotary knob, marked MASTER, has the following functions:

OFF	Power disconnected.
STBY	Full power supplied to the system, but with interrogation replies blocked.
LOW	System operates with reduced sensitivity. However, transmitted power from the transponder is the same for both the LOW and NORM positions.
NORM	System operates at full sensitivity.
EMER	Allows the system to respond interrogations in modes 1, 2, 3/A and C. The reply for modes 1 and 2 is a special emergency signal of the codes selected on the applicable dials, while mode 3/A replies a special emergency signal of code 7 700, regardless of the selected code.

MODE Selector Switches

The four mode selector switches are three-position toggle switches for modes 1, 2, 3/A and C and control the operations as follows:

M1 - MC	Enables respective mode (M1, M2, M3/A, MC)
OUT	Disables respective mode.
TEST	Self-test position. TEST position is springloaded to the center position. The green TEST light illuminates when the respective mode is operating.

Test Light

The test light is a green press-to-test light which illuminates when the BITE check performs satisfactorily.

Position Identification Switch

The position identification switch is a three-position toggle switch used by the AC to provide momentary identification of position upon request.

I/P	Enables the system to respond with identification of position replies in modes 1, 2, 3/A and C. The response is continued for a 30 ±10 sec duration after the switch has been released.
OUT	Disables identification of position capability.
MIC	Same as positioning the switch to I/P, except that the microphone button must be pressed.

Radiation Test Switch

The radiation test switch is a two-position toggle switch used for the radiation test. The positions are OUT and RAD TEST. This switch is presently inoperative.

Mode 1 Code Selector

A rotary knob, incorporating two concentric wheels, marked MODE 1 for setting one of 32 available 2-digit codes.

Mode 2 Code Selectors

The four mode 2 code selectors are used to set the code for mode 2 operation. Each switch can be set from 0 to 7. The knob is removed upon completion of the setting on the ground.

Mode 3/A Code Selector

Two identical rotary knobs, incorporating two concentric wheels, marked MODE 3/A for setting one of 4 096 available 4-digit codes.

Mode 4 Selector Switch

ON	Enables replies to mode 4 interrogations.
OUT	Disables mode 4 replies.

Mode 4 Function Knob

This knob operates in conjunction with the master function selector knob.

A four-position rotary knob, marked MODE 4, has the following functions:

A	Interrogations from an interrogator using code A are answered.
B	Interrogations from an interrogator using code B are answered.
ZERO	To erase mode 4 code settings, provided the MASTER function selector knob is not in the OFF position. Both mode 4 codes are automatically erased after landing when the IFF system is switched off, except if the mode 4 function switch is placed to HOLD.
HOLD	This position may be used to retain mode 4 code settings, if another flight is anticipated during the coded period. HOLD must be selected at least 15 seconds before system shut-down.

Mode 4 Monitor Switch

A toggle switch with the positions AUDIO / OUT / LIGHT which enables or disables the audio / light monitor indications.

AUDIO	Interrogation and reply of mode 4, is indicated by an audio signal and the lights REPLY and IFF.
OUT	Disables all mode 4 audio / light indications.
LIGHT	Audio disabled, mode 4 interrogation is indicated by the lights REPLY and IFF only.

Mode 4 Reply Indicator Light

The green mode 4 reply indicator illuminates when mode 4 replies are transmitted, provided that the mode 4 monitor switch is in AUDIO or LIGHT. Filament press-to-test, turn-to-dim features are incorporated into the indicator.

IFF Mode 4 Warning Indicator Caption

A green MODE 4 caption is installed on the TLP. The indicator illuminates if the aircraft is interrogated by a valid mode 4 signal, but does not reply.

IFF NORMAL OPERATION

BIT Check

Prior to each flight the following check should be performed with the built-in test equipment (BITE). This will assure that the transponder system is working properly.

Test light (press-to-test) - CHECK
Master knob - STBY
(allow 2 minutes warm-up time)

Master knob - NORM
Mode 1 selector switch - TEST and hold.
Test light should illuminate. If not, the selected mode is at fault.

Test mode 1, 3/A and C respectively.

Before Takeoff

Master knob - NORM
BIT check - COMPLETED
Perform the test according to the requests of the interrogating ground station.

The above check evaluates the IFF / SIF system including the antennas.

ARMAMENT SYSTEM

The armament system consists of:

- Fire control system
- Radar system
- IRSTS / LRF
- Associated weapons

It is described in GAF T.O. 1F-MIG29-34-1.

DEFENSIVE AIDS SUBSYSTEM

The defensive aids subsystem (DASS) consist of:

- RHAW system
- FLARE dispenser

It is described in GAF T.O. 1F-MIG29-34-1.

EXTERNAL STORES

A variety of stores can be carried on the seven external stations. For stores configurations and limitations refer to section 5 of this manual. For information on armament and ECM equipment loading and operation refer to the applicable weapons delivery manual.

WARNING AND INFORMATION EQUIPMENT

To keep instruments cross-check to a minimum, warning and indicator lights are incorporated throughout the cockpit. Additional voice warning is provided for abnormal conditions.
The warning equipment consists of three independent systems:

- TLP
- AEKRAN
- VIWAS

A MASTER CAUTION light flashes whenever a warning light illuminates on the TLP (red lights) or an AEKRAN warning signal is displayed.

NOTE

All warning equipment is operated with 28.5 VDC from the generator or battery power. Refer to figure 1-67.

MASTER CAUTION LIGHT

The MASTER CAUTION light is located on the instrument panel. Whenever a warning signal is displayed on the TLP or the AEKRAN, the MASTER CAUTION light starts flashing. Brightness of the light can be adjusted by rotating the light case. Pressing the MASTER CAUTION light extinguishes the light, warnings on the TLP turn steady, AEKRAN displays are not affected.

TELELIGHT PANEL

The TLP provides immediate warning of the existence of an abnormal condition, which could affect the safety of the aircraft (red lights). Additional information lights (green) indicate system operation or condition. Refer to section 3.

A malfunction is indicated by a flashing warning light in conjunction with the MASTER CAUTION light flashing. After reset of the MASTER CAUTION light, the warning light illuminates steady until the problem is solved.

AFTER MODIFICATION WITH WING DROP TANKS

Three previous spare captions have been modified to read WDT NO PRESS, WDT TEST and FEEL UNIT OK.

The WDT NO PRESS caption illuminates prior to engine start when wing drop tanks are installed or during a wing drop tank pressurization failure. After engine start the caption extinguishes, indicating wing drop tank pressurization.

Illumination of WDT TEST caption indicates a valid system check when the TEST WDT button on the control and test panel is pressed.

The FEEL UNIT OK caption replaces the identical caption removed from the control and test panel.

Warning Light Controls

A photodiode automatically adjusts the brightness of the lights according to environmental conditions. A rheostat on the lighting panel provides for manual adjustment of brightness.

WARNING AND INFORMATION EQUIPMENT

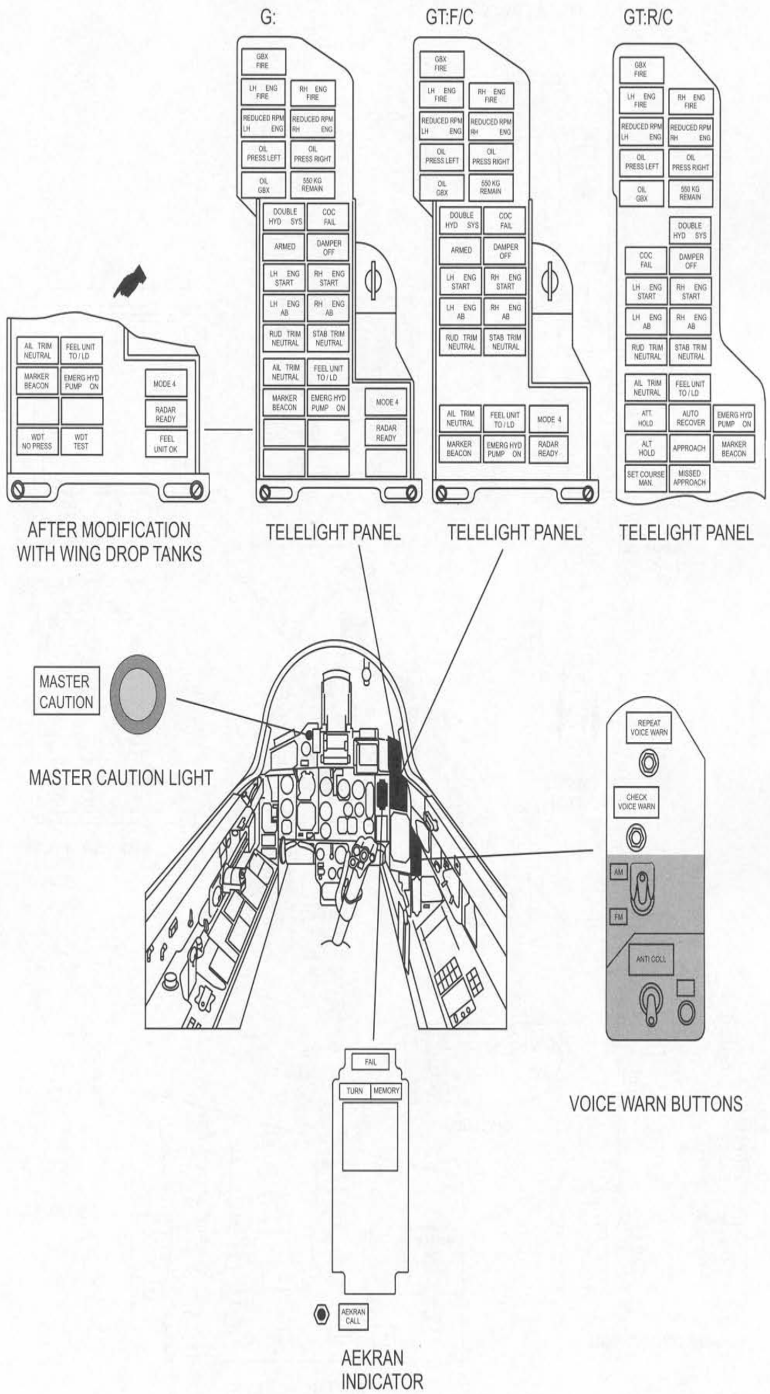


Figure 1-67

WEAPON AND ARMAMENT CONTROLS (FRONT SIDE)

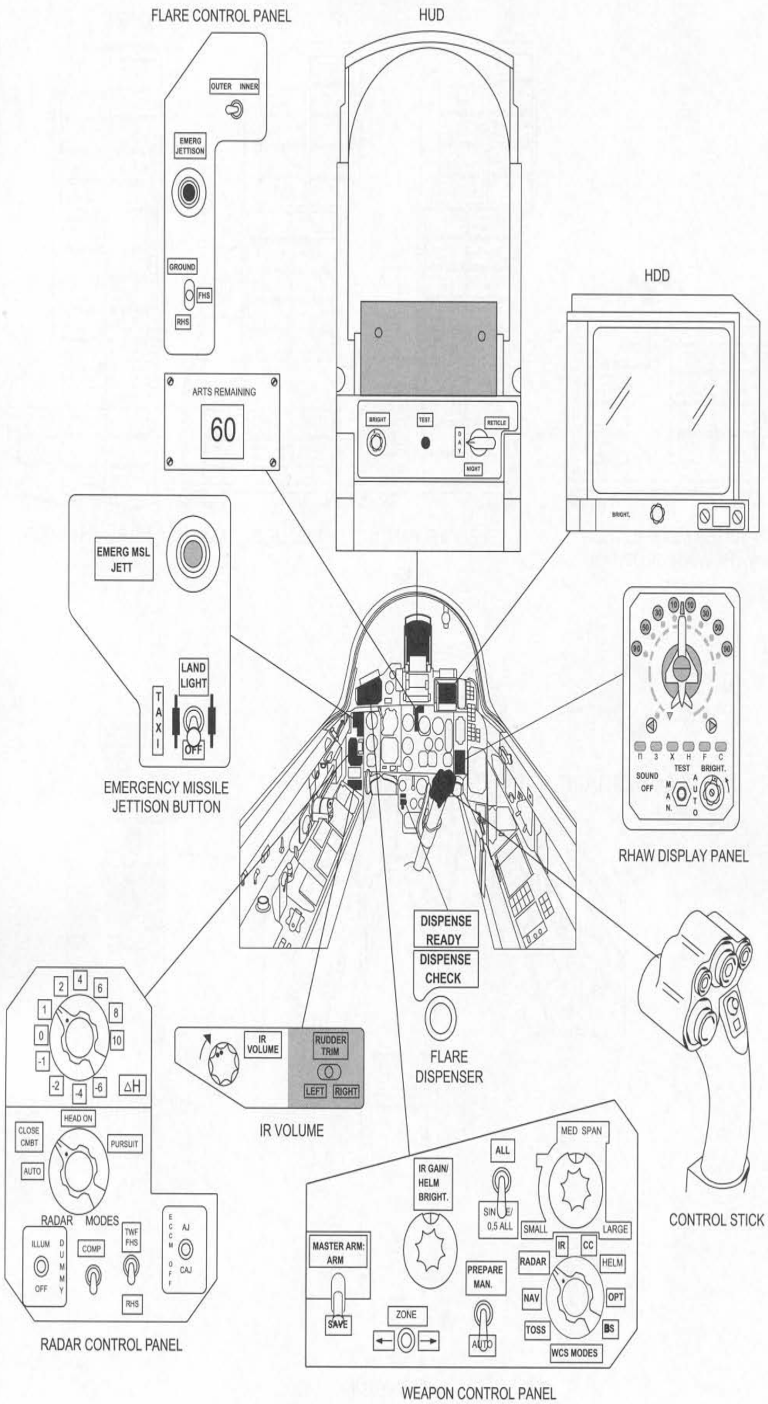


Figure 1-67A

WEAPON AND ARMAMENT CONTROLS (LH / RH SIDE)

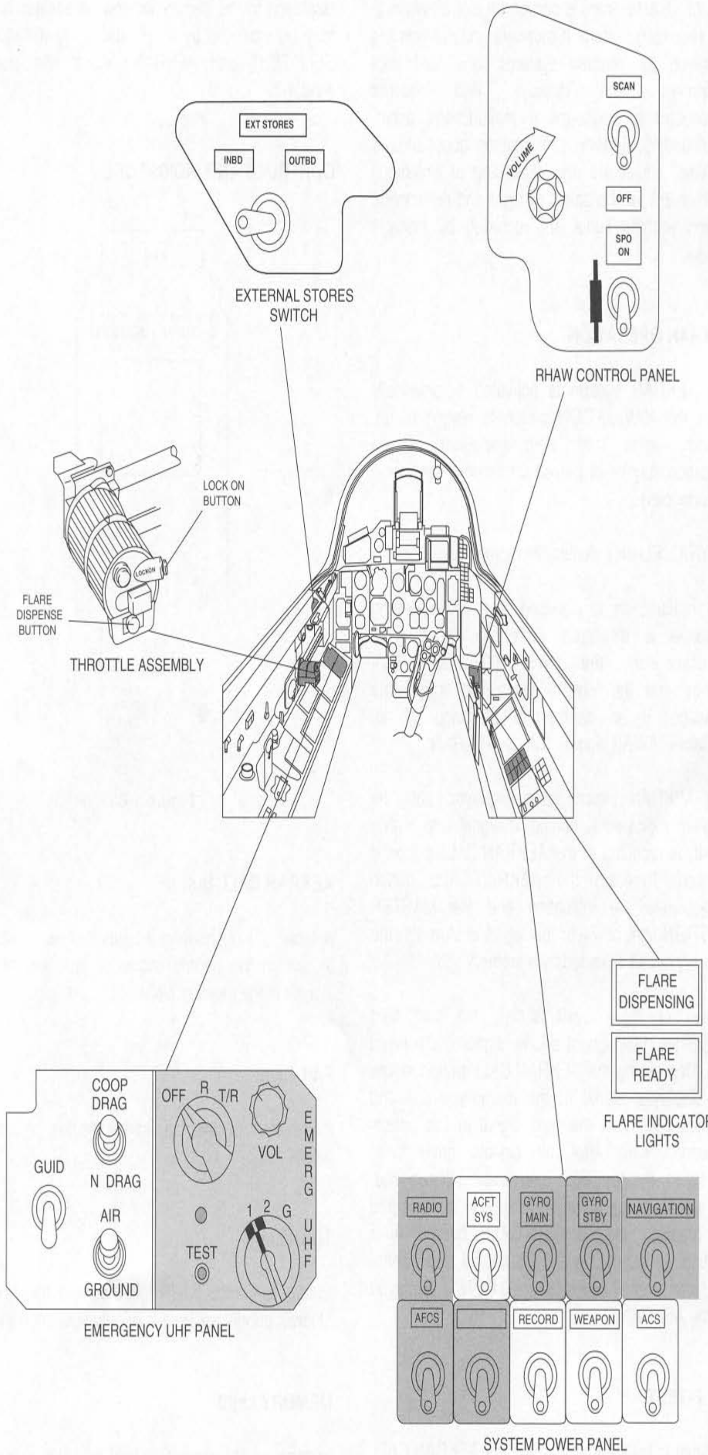


Figure 1-67B

AEKRAN

The AEKRAN system is part of the aircraft warning and recording system. It monitors and controls the operation of aircraft systems and self test equipment, and displays and records corresponding messages if malfunctions occur. After landing, additional information about aircraft systems, equipment and exceeding of limitations not relevant for the safety of flight and illumination of red warning lights are recorded by discrete signals.

AEKRAN OPERATION

The AEKRAN system is activated automatically when the NAVIGATION switch is placed to on. During engine start, both generators failure indication may be displayed until external power is disconnected.

After T/O, FLIGHT illuminates momentarily.

If a malfunction is detected, the corresponding message is displayed. Refer to figure 1-69. Simultaneously, the MASTER CAUTION light flashes and the VIWAS gives the appropriate message. If an appropriate message is not available, VIWAS signals: 'Check AEKRAN'.

The AEKRAN indication is displayed until the problem indicated is solved, a signal with higher priority is received or the AEKRAN CALL button is pressed. Pressing the AEKRAN CALL button extinguishes the indication and the MASTER CAUTION light however the signal is stored in the memory circuit indicated by a memory light.

If two or more systems fail, the turn light illuminates, the highest priority signal is displayed first. Depressing the AEKRAN CALL button stores the displayed signal in the memory circuit and permits display of the next signal in the priority sequence line. After all signals have been displayed, the turn light extinguishes. If required, the signals in the memory circuit can be repeated by pressing the AEKRAN CALL button. After landing, all stored signals are copied to a control slip, after engine shut-down, AC GEN is displayed on the AEKRAN.

SELF-TEST

Self-test is initiated by pushing the AEKRAN CALL button. The fail light must not illuminate. After 15 seconds, the SELF TEST followed by OK are displayed in the display window. A system failure may be indicated by a fail light or by a distorted SELF TEST and AEKRAN FAIL in the display window.

CONTROLS AND INDICATORS

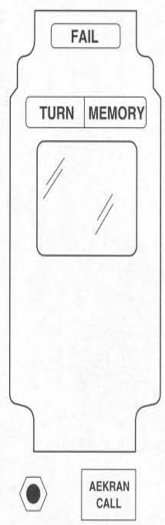


Figure 1-68

AEKRAN CALL Button

A triple use pushbutton initiates self-test, calls up signals in the priority sequence line and recalls signals in the memory circuit.

FAIL Light

Illumination of the fail light indicates a system failure.

TURN Light

Illumination of the TURN light indicates, that signals of lower priority are held in priority sequence line.

MEMORY Light

Illumination of the memory light indicates signals in the memory circuit.

AEKRAN INDICATIONS

PRIORITY	SIGNAL	PRIORITY	SIGNAL
1	START TURB CRIT CONDITNS	31	AC GEN
2	EXTEND LANDING GEAR (in air) L GEAR INDIK (on ground)	32	DISCON GEN DRIVE
3	ALT ALERT	33	LEFT AIR INTK
4	OVERHEAT LEFT	34	RIGHT AIR INTK
5	LEFT OVER SPEED	35	UPPER INLET
6	VIBR LEFT	36	LOCK CANOPY
7	FUEL PRESSURE LEFT	37	LEFT ENG STBY SYS
8	OIL PRESS LEFT	38	RIGHT ENG STBY SYS
9	OIL TEMP LEFT	39	AIR DATA SYS
10	CHIP LEFT	40	FEEL CONT UNIT
11	OVERHEAT RIGHT	41	FEEL UNIT SET EASY
12	RIGHT OVER SPEED	42	NO COOLING
13	VIBR RIGHT	43	SKIN OVERHEAT
14	FUEL PRESS RIGHT	44	COC 3 STOP
15	OIL PRESSURE RIGHT	45	EMERG OXYGEN RESERVE USE OXY (on ground)
16	OIL TEMP RIGHT	46	-
17	CHIP RIGHT	47	-
18	OIL PRESS ACCRY GBX	48	DROP TANK NO USAGE
19	ACFT ACCRY GBX VIBR	49	EXTEND FLAPS
20	TWO GENER WATCH TIME	50	LEAD EDGES NOT EXTEND
21	NO BOOST	51	NAVIG COMPUTER
22	(FUEL RETURN)	52	-
23	CHECK FUEL AMOUNT	53	RADAR NOT READY
24	CABIN LIMIT PRESS DESCEND	54	RADAR
25	BOOST HYD SYST	55	OPT SIGHT NAV SYS
26	MAIN HYD SYST	56	WEAPON CONT SYS (WCS)
27	TWO DIR VERT GYRO	57	GUN
28	MAIN DIR VERT GYRO	58	HELMET MOUNTED SIGHT
29	STBY DIR VERT GYRO	59	IR SEEKER
30	DC GEN WATCH TIME		

Figure 1-69

VOICE INFORMATION AND WARNING SYSTEM

The VIWAS provides voice warning to focus the pilots attention to a problem indicated on the warning light panel or AEKRAN. Depending on the type of emergency, advisory for initial action to be taken is added. The system is powered by 28.5 VDC.

In case of multiple malfunctions, the voice warnings are realized according to the priority list. Refer to section 3.

Warnings No. 1, 2, 3 and 5 are simultaneously transmitted over the radio.

Voice Warning Operation

The VIWAS is switched-on with the battery. Two pushbuttons are provided for operation on the RH console.

The CHECK VOICE WARN button is used to initiate a self-test. Pressing the REPEAT VOICE WARN button repeats the last warning.

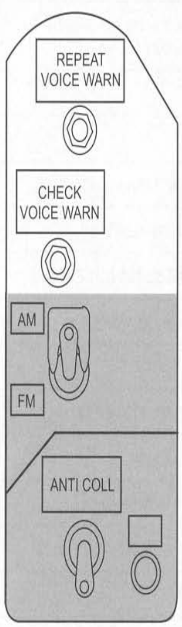


Figure 1-70

WARNING LIGHT TEST

To ensure utmost reliability of the warning system, the light bulbs of all warning and indicator lights are function tested. Pressing the LAMP TEST button on the lighting panel illuminates all lights.

SERVICING DIAGRAM

ITEM NO.	ITEM DESCRIPTION	SPECIFICATION	
1	ENGINE OIL	IPM-10	
2	GEARBOX OIL	IPM-10	
3	NITROGEN HYDRAULIC FLUID	Degree of purity 98 % Dew-point -65° C at 150 bar (15 MPa) $CO_2 < 0.03$ % total volume Operating pressure 150 +5 bar (15 +0.5 MPa) AMG-10 or H-515 (FH 51)	
4	RADAR COOLING	LENA-65	
5	OXYGEN, GASEOUS	GAF T.O. 15X-0-1-1000 Pressure 150 +5 bar (15 +0.5 MPa)	
6	GROUNDING CABLE	Connected	
7	COMPRESSED AIR	Pressure 150 +5 bar (15 +0.5 MPa) Temperature max +40° C Dew-point -55° C at 150 bar (15 MPa) Free of oil and grease	
8	EXTERNAL AC-POWER	117.5 / 202 VAC, 400 Hz, 3-phase	
9	EXTERNAL DC-POWER	28.5 ±0.5 VDC, 15 kW	
10	ENGINE FUEL	 JP8 / NATO F-34 RT TS-1 T-1	FUEL SELECT Position I II II I
11	GUN COOLING	H_2O (distilled water)	

Figure 1-71

SERVICING DIAGRAM

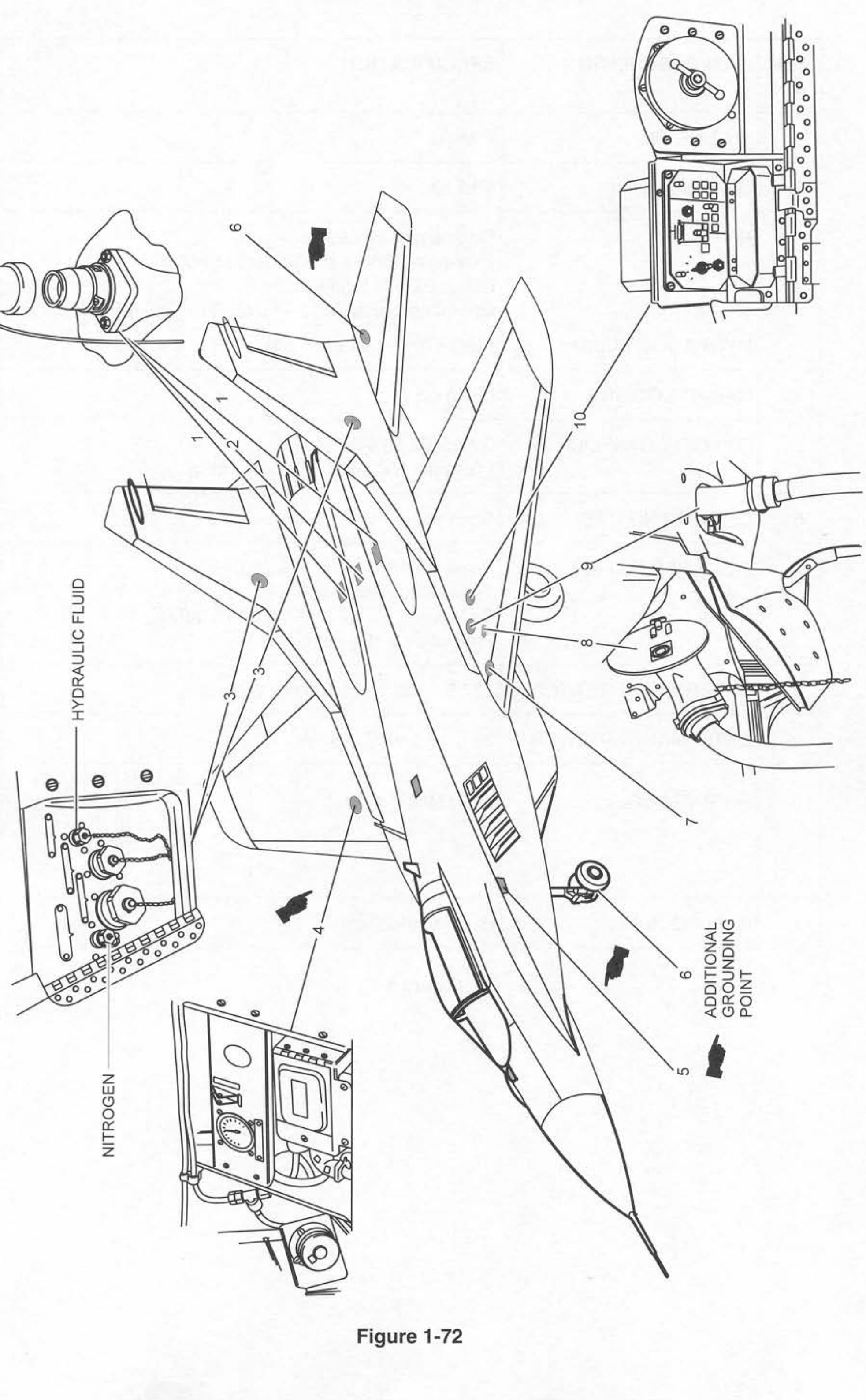


Figure 1-72

SECTION 2

NORMAL PROCEDURES

TABLE OF CONTENTS

	Page
GROUND	
Preparation for Flight	2-3
Preflight Check	2-3
Before Exterior Inspection	2-3
Exterior Inspection	2-4
Interior Check	2-6
Before Starting Engines	2-8
Starting Engines	2-9
TAXI CHECKS	
Before Taxiing	2-12
Taxiing	2-14
Last Chance	2-14
Before Takeoff	2-14
TAKEOFF	
General	2-14
Military Takeoff	2-15
After Takeoff	2-16
Afterburner Takeoff	2-16
Crosswind Takeoff	2-16
FLIGHT	
Climb / Cruise	2-17
Decent / Recovery	2-17
Before Landing	2-17
LANDING	
Normal Landing	2-18
Crosswind Landing	2-18
Touch and Go	2-20
Go Around	2-20
Landing Roll	2-22
Taxiing Back	2-23
Engine Shut Down	2-23

Page

GYRO ALIGNMENTS
Fast Alignment Before Engine Start 2-24
Fast Alignment After Engine Start 2-24
Long Alignment Before ENG Start 2-25
Long Alignment After ENG Start 2-25

TRAINER VARIANT (GT) CHECKS
Before Exterior Inspection 2-26
Rear Cockpit Interior Check 2-26
Before Starting Engines 2-27

PREPARATION FOR FLIGHT

FLIGHT RESTRICTIONS

Refer to section 5 for detailed aircraft operating limitations.

FLIGHT PLANNING

Refer to GAF T.O. 1F-MIG 29-1 Appendix A, Performance Data.

WEIGHT AND BALANCE

For maximum gross weight and CG limitations, refer to section 5, Operating Limitations. For detailed information, refer to GAF T.O. 1F-MIG29-5.

PREFLIGHT CHECK

1. Check aircraft status and release

BEFORE EXTERIOR INSPECTION

1. Ejection seat .... Safe for parking

Check safety pin installed and connected through safety line.
Check ejection handle tipped forward in the safe position and locked.

2. CB panels .... Check
3. Bat GND supply .... OFF
4. Throttles .... OFF
5. Camera magazine ...... Installed, if required
6. Safety wired switches Check secured

- Cabin emerg decomp lever .... PRESSURE and secured
- Feel unit sw .... AUTO and secured
- MRK emerg sw .... ON and secured
- Emerg hyd pump .... OFF and secured
- AB emerg off .... AB and secured
- Air relight switches ..... OFF and secured
- GEN drive emerg sw .. ON and secured
- Fuel shut-off valves .... OPEN and secured
- Fire extinguisher .... OFF and secured
- Ramp emerg retraction LH/RH secured
- EMERG gear handle IN and secured
- EMERG BRAKE handle IN and secured
- Emerg release button Cover secured
- Canopy jettison handle Secured
- AM / FM selection sw AM and secured
- APU mode sw .... START and secured
- CL tank release button Covered and secured

AFTER MODIFICATION WITH WING DROP TANKS

7. BINGO fuel .... Set as required
8. Fuel load .... Check correct indication

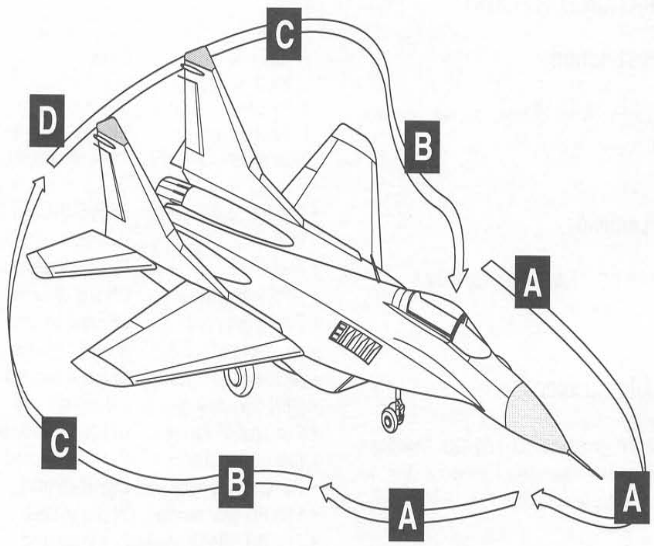


Figure 2-1

EXTERIOR INSPECTION

NOTE

Be alert for loose fasteners, cracks, dents, leaks and other discrepancies.

A. FRONT FUSELAGE AND NOSE GEAR

1. AOA vanes .... Covers removed
2. Laser / infrared sys ..... Check
3. Radome .... Secured, lockings flush
4. Pitot boom and emerg pitot boom .... Covers removed, ports clear

Nose gear area

1. Ampere counter .... Min 40 Ah

NOTE

For an engine start with battery power, the ampere counter should read min 42 Ah

2. Nitrogen press gage ... As required
3. Nose gear .... No leaks, wires connected
4. Tierod .... Proper clearance
5. Tires .... Condition
6. Wheel well .... Condition
7. Gear door .... Check
8. Taxi light .... Condition

Engine intake area

1. Intake ducts:
   a. Ramps .... Check
   b. Intakes .... Clear of FOD
   c. ENG compressors Check

B. MAIN GEAR AND WHEEL WELL

1. Wheel and tire .... Condition
2. Landing shock detector plate .... Check undamaged

CAUTION

A damaged shock detector plate indicates a hard landing. The plate must be replaced prior to flight.

3. All links .... Connected
4. Gear strut .... No leaks, wires connected
5. Pneumatic sys gage (RH side) .... Check 150 ±5
6. Gear door unlock cable .... Condition
7. Wheel well doors .... Free to move
8. Refueling panel (LH side) .... Closed
9. Ext DC pwr access (LH side) .... Closed
10. Pneumatic sys gage.... Check 150 ±5
11. Landing lights .... Condition

C. CENTER FUSELAGE AND WING

General

1. Access doors .... Closed
2. CL tank .... Check
3. CL tank front dome .... Secure
4. APU exhaust door ...... Open

Wing

1. Louvers (upper inlets) Closed
2. LEF .... Condition
3. Antennas .... Condition
4. Armament pylons .... Condition
5. Wing tip:
   a. Position light .... Condition
   b. Antennas .... Condition
   c. Static dischargers .. Condition
6. Aileron, flap .... Condition
7. Chaff / Flare dispenser cover .... Installed

IF WING DROP TANKS ARE INSTALLED

8. Filler cap .... Closed and safety wired
9. Tank .... Properly attached
10. Safety pin .... Installed

CAUTION

Wing tank safety pins should not be removed prior to the last chance position.

D. AFT FUSELAGE

1. Access doors .... Closed
2. ENG static pitot tube Cover removed
3. Drain pipes .... Tubes removed

CAUTION

Dripping or puddled fuel or evidence of recent leakage in the area of these drains may indicate a fuel cell leak and is sufficient cause for abort.

4. Taileron .... Condition
5. Static dischargers ...... Condition
6. Vertical stabilizers, rudders, antennas ...... Condition
7. Inner / outer nozzles .. Check
8. Drag chute .... Cover secure, indicator pin retracted
9. Speedbrakes .... Check

INTERIOR CHECK

1. Seat initiator cable ..... Connected

WARNING

Exercise caution in the vicinity of the seat initiator cable. Failure to comply could result in premature seat firing during ejection.

2. Canopy condition .... Check

Check for cracks in the canopy and windshield. Check condition of canopy pressure seals.

3. Cockpit .... Check no FOD

4. .... *Deleted*

5. Leg restraints .... Check proper pos

The leg restraints are properly installed in the spring clips on the main instrument panel and routed through the leg guards.

6. Canopy jettison handle Check secured

The handle is labeled CANOPY EMERG JETTISON. It should be safety wired and lead sealed.

7. Combined harness ..... Fasten

Check quick-release box in position locked. Recheck inertia reel unlocked.

Insert right shoulder harness with its fitting into the upper anchor bolt of the quick-release box.

Route both leg loops through the rectangular openings of the rings on the main suspension strap and with a quarter of a turn to the quick-release box. Insert fittings into respective anchor bolts and tighten leg belts.

Tighten leg loops with the lap retraction handle on the right side of the seat bucket. Lock inertia reel and tighten shoulder harness.

WARNING

The combined harness must be fastened as tightly as compatible with safe aircraft operation and comfort.

8. Shoulder harness release handle .... Forward

Freedom to lean forward is obtained by moving the handle forward. Violent movement brings the inertia mechanism into operation, locking the shoulder harness. Leaning back, the harness mechanism reels in.

9. Shoulder harness reel lock .... Check operation

Moving the shoulder harness release handle aft, locks the reel mechanism.

10. Cockpit safety pins ..... Out and stowed

11. Pers service lines .... Connected

- Radio cord
- Anti-g suit
- Dinghy lowering line
- Helmet mounted sight

12. PEC .... Check connected

13. Pressure regulator:
    G-suit .... MIN
    Pressure suit .... MAX

14. Suit vent .... As required
15. Oxygen flow valve ...... OPEN
16. Oxygen supply sys ..... Check and set
17. Oxygen .... MIXT
18. Emerg oxygen .... OFF
19. Helmet vent .... OFF
20. Cabin emerg decomp PRESSURE and secured

21. Feel unit sw .... AUTO and secured
22. MRK emerg sw .... ON and secured
23. Emerg hyd pump .... OFF and secured

24. VHF / UHF Radio:
    a. GUARD RCVR .... ON
    b. ADF .... OFF
    c. Squelch .... ON

25. AB emerg off sw.......... AB and sucured
26. Air relight switches ..... OFF and secured
27. GEN drive emerg sw Fwd pos and secured
28. Fuel shut off valves .... OPEN and secured
29. Fire extinguishers .... OFF and secured
30. Ramp emerg retraction LH / RH secured
31. XT - 2000 .... Set as required

32. Weapon contr panels Set as required

Refer to GAF T.O. 1F-MIG29-34-1 for details.

33. Ldg gear handle .... EXTEND
34. Landing light sw .... OFF
35. Master Arm .... SAFE
36. WCS modes sel .... NAV
37. Emerg release button Cover secured
38. Emerg brake handle ... IN and secured
39. Nose wheel brake .... ON
40. Emerg gear handle ..... IN and secured
41. Set course sw .... AUTO
42. Clock .... Wind and set
43. Pitot sel .... MAIN
44. Cabin temp control ..... As required
45. Ramps pos indicator ... Check 0 %
46. RHAW .... OFF

47. NAV panel:
    a. Gyro sw .... MAIN
    b. Channels sw .... AUTO
    c. WP - A / D sw .... As required
    d. Rel bearing sw .... RSBN
    e. Course sw .... As required
    f. Circle sw .... As required
    g. Landing sw .... OFF
    h. Navigation channels As required
    i. Landing channels .. As required

48. Cabin temp sw .... AUTO
49. Pitot heat .... OFF
50. NAV lights .... Set as required
51. Cockpit lighting .... Set as required
52. Anti coll light sw .... OFF
53. Defog / footheat .... As required

54. ADF:
    a. Channel ADF .... As required
    b. COMP / ANT sw .... COMP
    c. VOICE / CW sw ..... VOICE
55. APU mode sw .... START and secured
56. Start up sel sw .... As required
57. RSBN / TACAN sw ..... As required
58. Cabin air lever .... OPEN
59. TACAN .... OFF
60. IFF .... OFF
61. Electric pwr panel .... All OFF

- BAT GND SUPPLY
- DC GEN
- AC GEN
- PTO
- ENG SYS
- FUEL PUMP
- ANTI SURGE

62. System pwr panel .... All OFF

- RADIO
- ACFT SYS
- MAIN GYRO
- STBY GYRO
- NAVIGATION
- AFCS
- RECORD
- WEAPON
- ACS

63. FKP sw .... OFF
64. Operate / Prepare sw PREPARE

AIRCRAFT BATTERY CHECK

1. Bat GND supply .... ON

Battery voltage is 27.6 V under unloaded condition.

2. Fuel pump sw .... ON
3. PTO sw .... ON
4. Voltmeter .... Check min 22 V for 2 sec
5. PTO sw .... OFF
6. Fuel pump sw .... OFF
7. Bat GND supply .... OFF

BEFORE STARTING ENGINES

1. External DC pwr .... ON

The battery GND supply switch must be in the OFF position when connecting external power.

2. Canopy .... As required
3. Bat GND supply .... ON
4. Anti coll light sw .... ON
5. Recorder sw .... ON
6. Electric pwr panel .... All ON

- DC GEN
- AC GEN
- PTO
- ENG SYS
- FUEL PUMP
- ANTI SURGE

7. ACFT sys sw .... ON
8. Navigation sw .... ON
9. Instrument check:
   a. Speed indicators .... Check

IAS 0, M 0.2 to 0.29, TAS 110 to 190

   b. Rad alt .... Press to test

Check pointer to swing inside marker

   c. Hydraulic pressure Check P_{AK}
   d. Pneumatic pressure Check in the green
   e. Fuel quantity .... Check counter (2 500) and quantity
   f: Voltmeter .... Check 28 V ±0.5 V
   g. AEKRAN .... Press to test

Check AEKRAN OK is displayed after 15 sec

   h. Lamp test .... Press to test
   i. Throttles .... Check full travel, no bindings

Check for free movement throughout the entire range from IDLE to MAX AB. Check stops in IDLE, MIL, MIN AB and MAX AB. Adjust throttle friction as required.

10. Seat position .... Adjust
11. Rudder pedals .... Adjust
12. Oxygen supply sys...... Check and set

- Check oxygen pressure 100 ±10 %
- Fasten oxygen mask
- Inhale and exhale two or three times and check for easy respiration.
- Oxygen press indicator, check index not or barely moving.
- Set the mixture switch to 100 %.
  Inhale and exhale two or three times and check for movement of the oxygen flow indicator.
- Set the mixture switch to MIXT and the Emer gency switch to EMERG ON.
  Check for continuous flow of oxygen into the mask.
- Switch emergency oxygen to OFF.
  Check cessation of continuous flow of oxygen into the mask.

For flights above 48 000 ft, additional checks are required:

- Set oxygen to 100 % and emergency switch to EMERG ON.
  Oxygen pressure should not increase within 15 to 20 sec.
- Have ground crew press the oxygen test button on the left side wall.
- Check for a pressure peak in the pressure suit.
- After pressure reduction, manually block off the opening on the PEC.
  Check for a pressure build-up of approximately 0.05 kg/cm^2 in the oxygen mask.
- Inhale and exhale two or three times.
  Check for movement of the oxygen flow indicator and pressure build-up in pressure suit.
- Have ground crew release the oxygen test button, release the opening on the PEC and check for pressure relief.
- Set oxygen back to MIXT and emerg oxygen to OFF.

WARNING

Flying with a defective oxygen system is prohibited.

IF WING DROP TANKS ARE INSTALLED

13. TEST WDT button....... Press

If the external wing drop circuitry test was successful, the WDT TEST caption on the telelight panel must illuminate. In case of failure, execute a lamp test and report to maintenance.

STARTING ENGINES

The engines can be started separately or in sequence utilizing electrical power from an external power source or the aircraft batteries. During sequential start, RH engine is started first. For single start, sequence is LH engine first.

CAUTION

During manual start, at least 40 sec must elapse with the first engine running in IDLE before starting the second engine.

REPORT

1. Throttles .... IDLE
2. AEKRAN .... Checked
3. Recorder .... ON
4. Start up mode sw .... START BOTH
5. Intakes .... Check clear

Ensure the wheels are chocked and the flaps, speed brake and APU doors, engine intakes, louvers and exhaust areas, cockpit and canopy rail areas are clear of personnel and equipment, and confirmed by ground crew. Refer to danger areas illustration figure 2-2.

6. Fireguard .... Posted

GROUND START

CAUTION

The engine start procedure should be aborted when any of the following fail conditions are observed:

- RH/LH ENG START on the TLP fails to illuminate.
- RPM and EGT fail to increase within 10 sec after pressing GND START button.
- EGT increases without RPM increase.
- RPM of both engines increases simultaneously.
- EGT exceeds computed limit.
- Any of the following red captions on the TLP illuminates:

GBX FIRE
LH/RH ENG FIRE
REDUCE RPM LH/RH ENG
OIL PRESS LEFT/RIGHT
OIL GBX
DOUBLE HYD SYS

- Any of the following warning signals are displayed on the AEKRAN:

START TURBO CRIT CONDITNS
ACFT ACCRY GBX VIBR
VIBR RIGHT/LEFT
OIL PRESS RIGHT/LEFT
OIL PRESS ACCRY GBX

1. GND START button ... Press
2. TLP .... Check RH / LH ENG START light on
3. RPM 15 %
   AEKRAN signal .... START TURB CRIT CONDITIONS check out
4. RPM 20 %
   Hydraulic pressure ..... Check increasing
5. RPM 35 %
   a. Ramp .... Check closed
   b. ENG START light .. Out

The light extinguishes between 34 % and 36 % RPM.

6. RPM 50 %
   EGT .... Check within limits
7. Idle RPM .... Check within limits
8. Second ENG start Monitor in accordance with steps 2. thru 6.

CAUTION

During engine start cycle or when engines are running, pressing the GND START button is prohibited.

ENGINE COLD CRANK

If fuel fails to ignite during ground start, another start may be attempted after cold cranking the engine.

1. Throttles .... OFF
2. APU mode sw .... ENG COLD CRANK
3. Start up mode sw .... As required
4. GND START button .... Press

CAUTION

At least 3 min must elapse between two consecutive starts or cold cranking and start.

DANGER AREAS
ENGINE INTAKE AND EXHAUST DANGER AREAS IN MAX AB

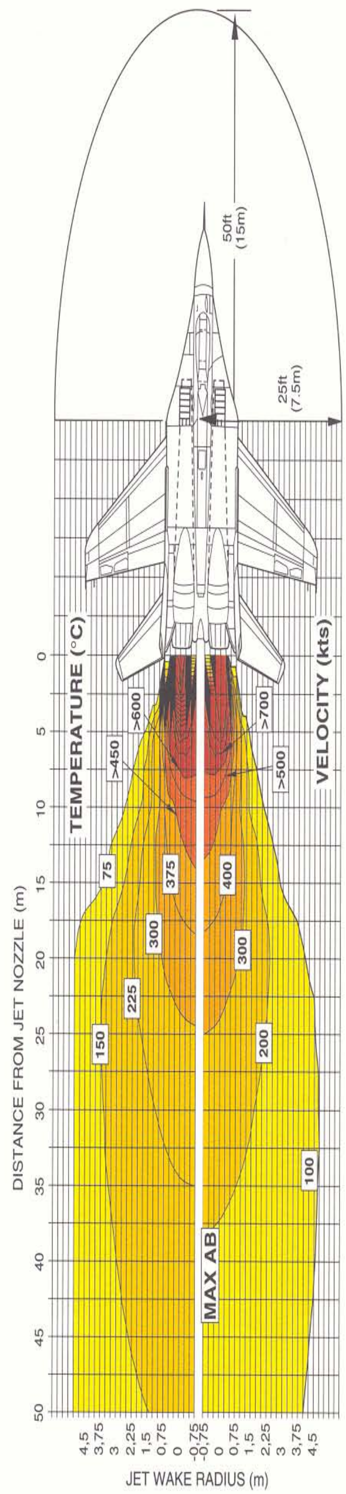


Figure 2-2

DANGER AREAS
ENGINE INTAKE AND EXHAUST DANGER AREAS IN MIL

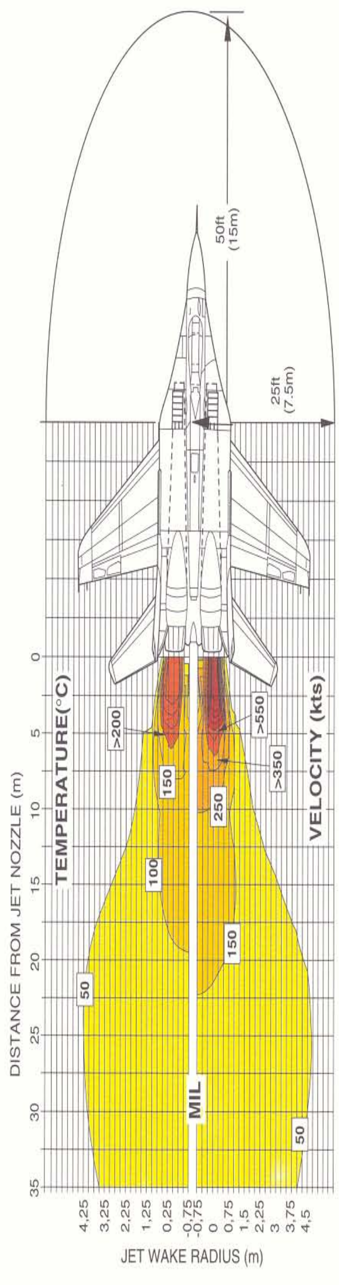


Figure 2-2A

DANGER AREAS

ENGINE INTAKE AND EXHAUST DANGER AREAS IN IDLE

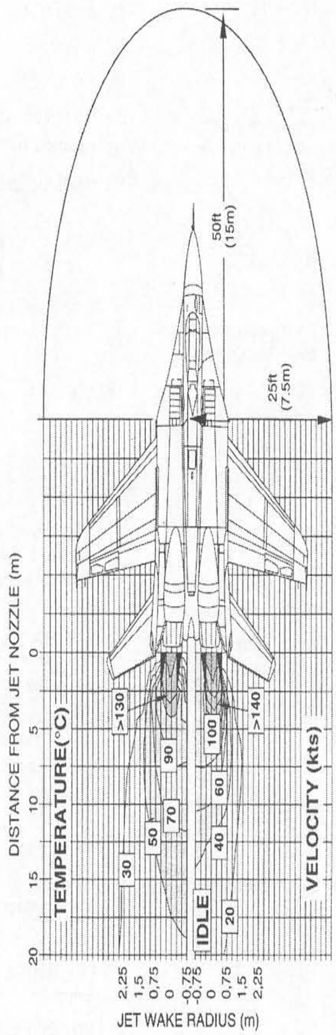


Figure 2-2B

TAXI CHECKS

BEFORE TAXIING

1. External power .... Disconnected
2. Voltmeter .... 28 V ± 0.5 V
3. ACS sw .... ON

NOTE

With high outside air temperatures and/or long ground times this step should be delayed until just prior to takeoff.

4. Gyro alignment:
   a. GYRO MAIN sw .... ON
   b. GYRO STBY sw .... ON
   c. WP - A / D button .... Select as required, check button light on
   d. Clock .... Hack
   e. GYRO sel sw .... STBY
   Check gyro fail light not illuminated.

   After 30 - 40 seconds for gyro / HDG alignment:

   f. MAG HDG SLAVE button and COURSE CMPTR ZERO button .... Press simultaneously for 10 - 15 seconds
   g. HSI - HDG .... Check correct indication
   h. Operate / Prepare sw ... OPER
5. FAST PREP light or NAV READY light .... Check on

CAUTION

Wait until gyro alignment is complete before continuing with step 6.

6. WEAPON sys sw .... ON
7. Trim lights .... On
8. AFCS sw .... ON
9. AFCS self test .... Damper lights blinking

NOTE

- During the AFCS self test, no forces should be applied to the control stick or rudder pedals.
- Continuous flashing of all AFCS captions except RETURN indicates a failed self test. After neutralizing the control stick, the self test can be reinitiated by pressing the AFCS MODES button for less than three seconds.

During AFCS self test, complete the following checks:

10. ANTI-SURGE sw .... Recycle to ON
11. IFF .... Check, STBY
12. TACAN .... Check, set as required
13. ADF / Radio compass .... Check
14. RHAW .... On and set
15. Flaps / LEF .... Check

If AFCS self test successful:

16. DAMPER OFF light .... Out
17. DAMPER light .... On

CAUTION

All flights have to be conducted with the AFCS system in mode DAMPER.

18. Trim .... Neutral, check trim lights on

WARNING

To prevent unintended stickforces during takeoff, the following sequence must strictly be adhered to.

- Pitch trim full forward, check for corresponding stick movement, trim aft until STAB NEUTRAL light on the TLP illuminates.
- Aileron trim full right, check for corresponding stick movement, left until AIL NEUTRAL light on the TLP illuminates.
- Rudder trim to the right until RUD NEUTRAL light on the TLP extinguishes. Trim back to neutral.
- Have ground crew confirm positions of flight control surfaces.

19. LH / RH INLET CHECK lights .... Out
20. NO COC RESERVE light... Out
21. GYRO select switch .... Recheck STBY
22. Radar .... DUMMY

Check for illumination of the RDR ready light after three minutes.

WARNING

To prevent possible RF radiation and subsequent injury to personnel, the radar must be switched to OFF immediately if the indication РЛ (RADAR) appears on the HUD / HDD.

23. Flight controls .... Check
    - Cycle flight controls three to four times. Movement should be smooth and free of restrictions. Stick must return to the neutral position upon release.
    - Rapidly move control stick diagonally several times.

24. Brake pressures .... Check 8.0 ± 0.5 and 11.0 ± 1.0

Upon brake release, check for pressure drop to zero

25. Ramps check:
    a. LH / RH throttle .... 80 - 90% RPM, check
    b. LH / RH INLET CHECK lights .... On

CAUTION

The green captions STAB NEUTRAL, AIL NEUTRAL and RUD NEUTRAL should remain lit at all times and no warnings should appear on the AEKRAN. Hydraulic pressure should not drop below the Q_M marking.

26. AEKRAN .... Check
27. XT - 2000 .... On, set as required
28. RADIO sw .... ON
29. Altimeter .... Set and check
30. Canopy .... As required
31. Flaps / LEF .... Up and in

TURNING RADIUS AND GND CLEARANCE

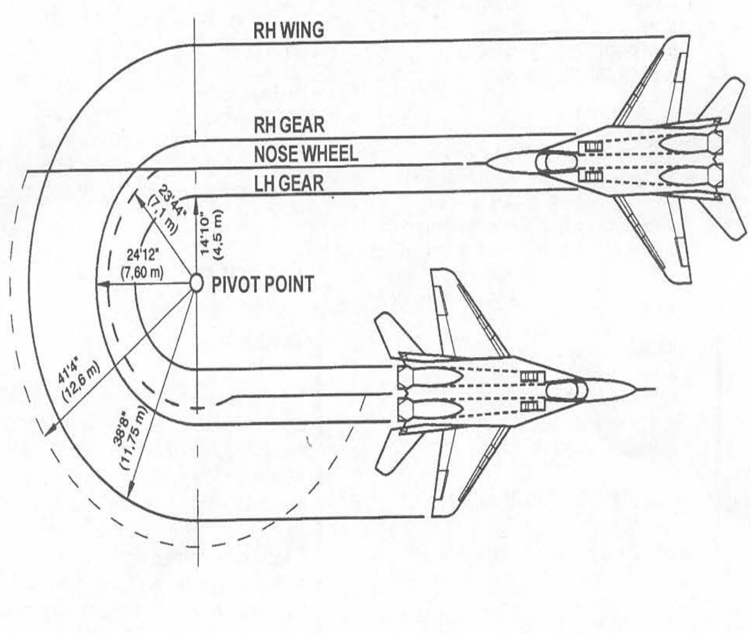


Figure 2-3

TAXIING

1. NWS .... Check

Press LOCK-ON button and check for high deflection mode available.

WITH WING DROP TANKS INSTALLED:

Particularly when taxiing on slightly uneven surface, a noticeable oscillation may be set off by the full WDT. The additional weight has a significant effect on stopping distance, which is approximately 20 % with 3 full external tanks.

CAUTION

With 3 full external tanks, stopping distance is significantly increased and extra caution must be used during taxiing.

LAST CHANCE

1. Canopy .... Closed and locked
   - a. Pin .... Flush
   - b. AEKRAN .... No signal
   - c. LOCK CANOPY light Out
2. NAV-panel:
   - a. Course sw .... As required
   - b. Channels sw .... Check MAN, then back to AUTO
   - c. Beacon buttons ..... Select as required
   - d. WP - A / D buttons . Select as required, check correct BRG / RNG indication
3. RADAR:
   - a. Radar ready light.... Recheck ON
   - b. Radar power sw ..... ILLUM
   - c. Four bar scan .... Check
   - d. Radar power sw...... Dummy

IF WING DROP TANKS ARE INSTALLED

4. WDT safety pins.......... Check removed

BEFORE TAKEOFF

CAUTION

Exercise care in positioning the aircraft on the runway for the engine check. Stagger the aircraft positions so that no aircraft is directly behind another. Recheck canopy closed and sealed.

After rwy line up

1. Ejection seat .... Armed
2. Pitot heat .... ON
3. Flaps / LEF .... Down and out
4. Compass .... Check

NOTE

If a heading difference of more than 5 ° exists between HSI and actual runway heading, abort the mission.

5. IFF .... As required
6. Feel unit TO / LD light Recheck on
7. Brake pressures .... Check
8. Engines check:
   - a. Throttles .... 90 % RPM
   - b. All warning lights ... Recheck out
   - c. AEKRAN .... Blank, TURN light out
   - d. VIWAS .... No information

TAKEOFF

GENERAL

The decision whether a MIL power or an AB takeoff is performed must be based on an assessment of the actual circumstances (A/C, mass, OAT, pressure altitude, winds, rwy, lenght, barrier available). More than anything else, maximum abort speed and minimum go speed will give an indication whether AB should be used. The use of AB will always lead to an increase in performance and therefore constitutes a favourable effect on safety reserves. Pilots must be aware, however, that aircraft handling will be more difficult if an engine fails during an AB takeoff as opposed to a military power takeoff. Particularly in heavy weight configurations, it is essential that the pilot be mentally prepared for immediate action in case of emergency during the takeoff phase, refer to section 3, Takeoff Emergencies.

AFTER TAKEOFF

When reaching safe altitude:

1. Gear .... Retract

Check the green indicator lights extinguish. The red warning light illuminates while the gear is in transit and extinguishes as soon as the entire gear is retracted/locked and all doors are closed. In case of one of the locks fail or one of the doors remain open, the red light starts flashing.

CAUTION

- Landing gear and doors should be completely up and locked before the gear limit airspeed of 370 KIAS (GT 320 KIAS) is reached.
- Yaw must not exceed 2 ball widths on the slip indicator at airspeeds between 270 and 370 KIAS. If these limits are exceeded, excessive air loads may damage the landing gear doors, preventing subsequent operation.

2. Flaps / LEF .... Up and in
3. Trim .... Check
4. Hyd / Pneum press .... Check
5. Brake pressure .... Check zero

AFTERBURNER TAKEOFF

If an AB takeoff is desired, smoothly advance throttles to max AB after brake release. Maintain directional control with the rudder pedals. Wheel braking should not be used for directional control during takeoff roll.

Due to a nose-lowering tendency during intake duct opening delay rotation until it has occured. When reaching safe altitude retract gear and thereafter the flaps.

CAUTION

- Rapid full aft movement of the stick may result in the exhaust nozzles hitting the runway.
- Premature, aggressive rotation leads to early liftoff due to significant vertical component of thrust adding to aerodynamic lift. If the gear is then raised too early, the momentary loss of total lift associated with lower intake duct opening causes a momentary descent and possible contact of the A/C structure with the ground.

CROSSWIND TAKEOFF

Under crosswind conditions, the aircraft tends to weather-vane into the wind. This weather-vaning tendency can easily be controlled with nose gear steering and rudder. As speed increases, weather-vaning tendency decreases. Takeoff attitude should be slightly lower than normal to increase liftoff speed approximately 8 KIAS. After liftoff the aircraft should be crabbed into the wind, wings level, to maintain runway alignment.

CLIMB/CRUISE

1. Altimeter .... Set

Climbing through the transition altitude, set the altimeter to standard QNH.

2. Rad alt .... Set bug as required
3. Oxygen .... Check
4. Cabin pressure .... Check
5. Fuel transfer .... Check
6. Radar .... As required
7. RHAW .... As required

DESCENT/RECOVERY

1. Fuel quantity .... Check
2. Cabin temp .... Set as required
3. Pitot heat .... Recheck ON
4. NAV sys .... Set as required
5. Altimeter .... Set

Descending through the transition altitude, recheck the altimeter setting set to local QNH/QFE.

6. Rad alt .... Set bug as required
7. RHAW .... As required
8. GT - R / C switches ... Recheck for ldg

BEFORE LANDING

1. Shoulder harness ...... As required
2. Radar .... As required
3. Master Arm .... SAFE
4. Trim .... Check
5. Gear .... Extend

Check landing gear extended, red warning light off, hydraulic pressure in limits.

6. Feel unit TO / LD light Check on
7. Flaps / LEF .... Down and out

WARNING

When selecting the flaps, be prepared for immediate action. In case of a split flap condition, raise the flaps and plan for no flap landing.

8. Ldg / taxi light sw .... LAND
9. Hydraulic pressure .... Check
10. Pneumatic pressure .. Check
11. Brake pressure .... Check zero

LANDING

NORMAL LANDING

For a normal landing, fly the pattern as illustrated in figure 2-5. Enter the pattern as local procedures dictate. Adjust power, as necessary, to attain allowable gear lowering airspeed. Extend landing gear and flaps/LEF on downwind leg.

Ensure flaps/LEF down and out prior to initiating turn to base leg. Establish and maintain desired airspeed on the base leg or final approach, adjusting pitch attitude and power to maintain desired glide slope/rate of descent. When the aircraft reaches 20 to 30 ft altitude above ground, initiate flare. Round-out from descent to an acceptable touchdown sink rate requires nearly full aft stick application.

Reduce power during late round-out or thereafter to touchdown at approximately 140 KIAS at 11 ° AOA. During touchdown do not exceed 13 ° AOA. For landing with maximum landing weight add 5 to 10 kts to the touchdown speed. At touchdown, reduce power to idle, maintaining stick position and deploy chute. After nosewheel touchdown maintain directional control with rudder and NWS.

NOTE

At excessive touchdown speeds, the aircraft has a tendency to bounce. In this case, maintain/attain landing attitude and deploy chute immediately upon touchdown to prevent further bouncing.

CROSSWIND LANDING

Carefully compensate for crosswind in the traffic pattern to guard against undershooting or overshooting the final turn. At crosswinds up to 15 kts compensate with a 5 to 10 ° low wing and crab. Above 15 kts, wings-level crab should be used. Approximately 1 ° of crab is required per 3 kts of crosswind. Since use of the chute intensifies the weather-vane effect for any given deployment condition, consider a no chute landing at crosswinds near the limit. However for landing on a wet runway, chute deployment is mandatory.

Prior to touchdown assume wings level flight. Crab must be neutralized using rudder at touchdown. After nosewheel touchdown, deploy chute. Apply brakes upon reaching 115 KIAS. Counteract weather-vane effect by use of aileron into the wind, and rudder. If chute is used and excessive weather-vaning is encountered, jettison chute.

NORMAL LANDING PATTERN

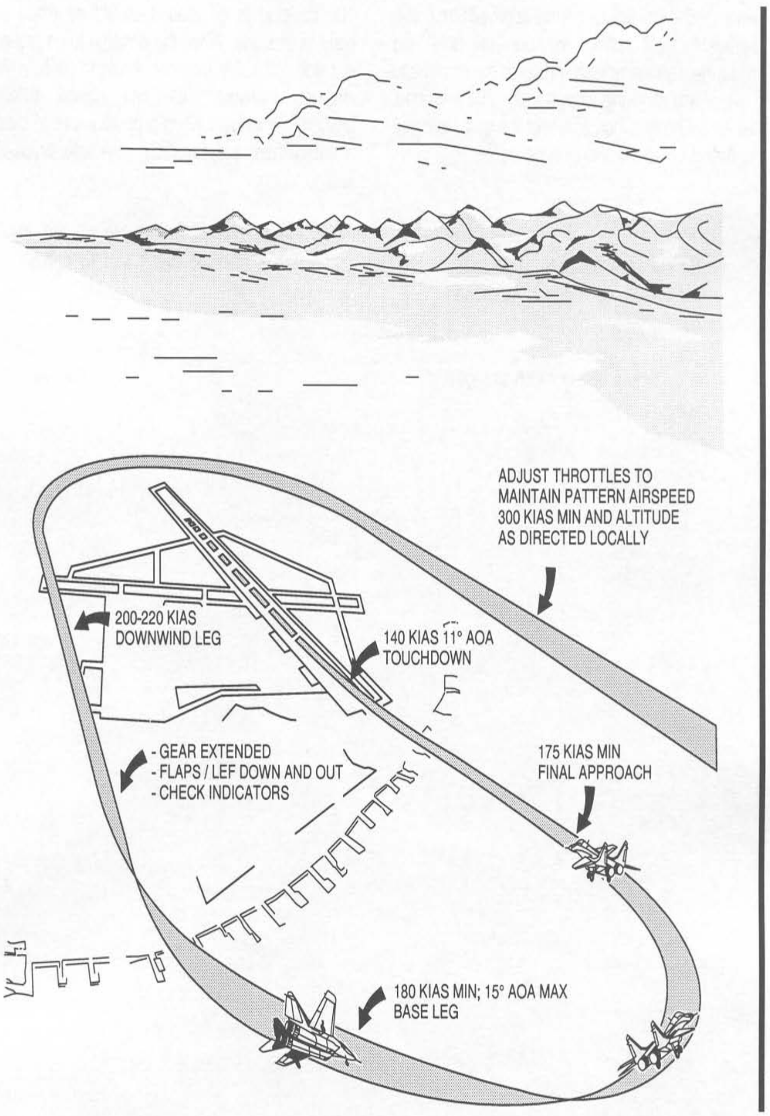


Figure 2-5

TOUCH AND GO

After touchdown from a normal approach, maintain sufficient back stick pressure to hold the nosewheel off the ground. Advance the throttles to military and allow the aircraft to fly off the ground. When definitely airborne, retract the gear, followed by flaps/LEF as the aircraft accelerates.

NOTE

- Do not allow airspeed to decrease below 108 KIAS during touch and go to prevent ramps closure.
- A maximum of four touch and go's is permissible.

GO AROUND

The decision to go around should be made as early as possible. When the decision to go around is made, smoothly increase thrust to military. As airspeed increases, establish normal takeoff attitude, retract gear when a positive rate of climb is established, and flaps/LEF at a safe airspeed, and go around.

For a closed pattern, accelerate to 250 KIAS, accomplish a climbing 180 ° turn to roll out on downwind.

GO AROUND

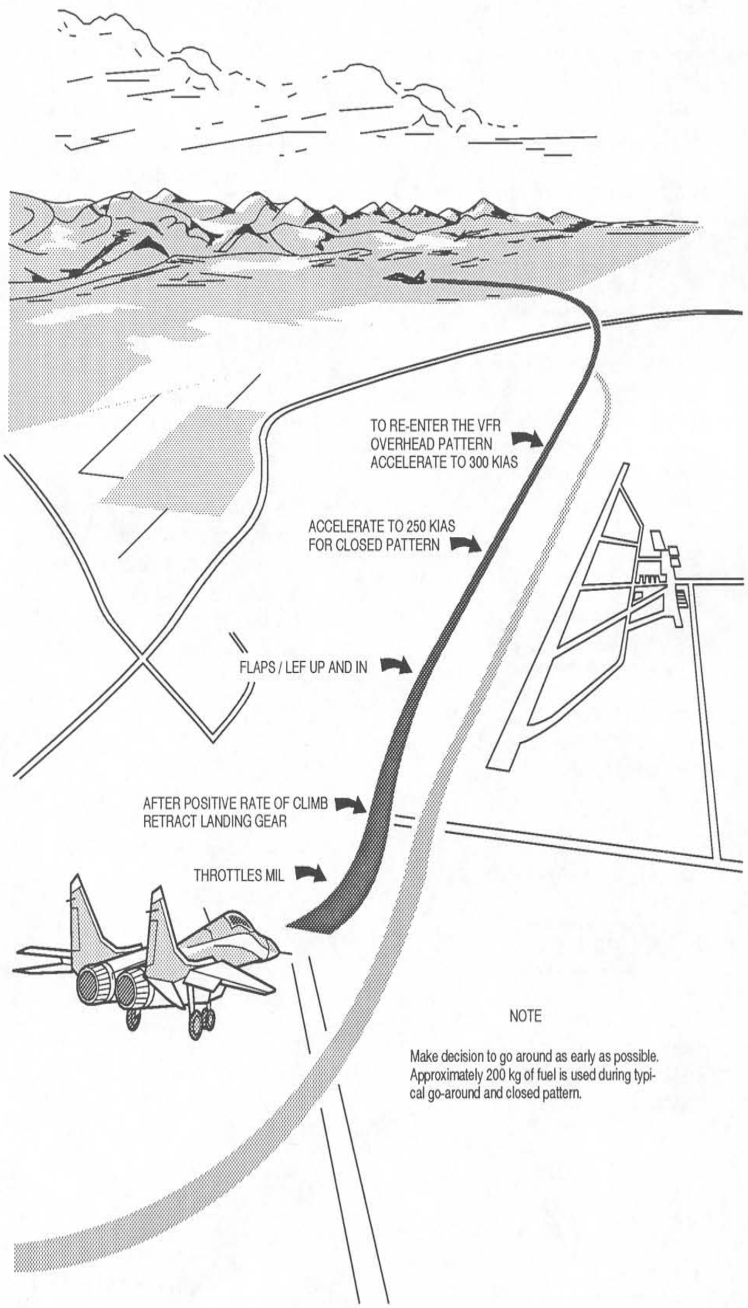


Figure 2-6

LANDING ROLL

1. Drag chute .... DEPLOY

Max deployment speed for the drag chute is 170 KIAS.

2. Brakes .... Apply

Max speed for braking is 120 KIAS, however, if required, brakes can be engaged after touchdown.

CAUTION

Applying brakes must be delayed until nosewheel is lowered to the runway. If the brakes are engaged prior to touchdown, a high probability exists for blown tires and is therefore prohibited.

3. Landing light .... As required
4. Flaps / LEF .... Up and in

WARNING

Nose wheel steering should not be engaged until the aircraft is slowed down to taxi speed.

5. AFCS modes .... OFF (press < 3 sec)

CAUTION

To prevent damage to the AFCS, ensure that all modes, except DAMPER, are deselected during taxiing.

6. Radar .... OFF

CAUTION

- Do not make sharp turns during taxiing with the chute deployed to prevent the chute from being damaged.
- Taxiing at high thrust settings with the chute deployed leads to a reduced service life of the chute. Avoid taxiing over chutes previously jettisoned to prevent the chute from causing damage to the tires.
- The chute should be jettisoned before taxiing downwind in winds exceeding 15 knots because of the possibility of the chute collapsing and burning upon contact with hot areas of the engine exhaust nozzles.

TAXIING BACK

1. Drag chute .... Release
2. Pitot heat .... OFF
3. Trim .... Neutral
4. Landing sw .... OFF
5. Canopy .... As required

CAUTION

Account for all loose items before opening canopy. If all known loose items cannot be accounted for, leave the canopy closed after flight until the engine is shut-down.

6. RHAW .... OFF

ENGINE SHUT DOWN

1. Radio sw .... OFF
2. XT - 2000 .... OFF
3. AFCS sw .... OFF
4. Weapon sw .... OFF
5. ACS sw .... OFF
6. Navigation sw .... OFF
7. MAIN gyro sw .... OFF
8. STBY gyro sw .... OFF
9. ACFT sys sw .... OFF
10. Operate / Prepare sw PREPARE
11. IFF .... OFF
12. TACAN .... OFF
13. Anti-Surge sw .... OFF
14. Fuel pump sw .... OFF
15. PTO sw .... OFF
16. DC GEN sw .... OFF

Upon signal of crew chief:

CAUTION

Do not move control stick and rudder pedals during engine wind-down.

17. Throttles in sequence of > 3 sec .... OFF
18. RPM .... Check 0 %
19. AC GEN sw................. OFF
20. Recorder sw .... OFF
21. ENG sys sw .... OFF
22. Bat GND Supply .... OFF
23. Ejection seat .... Safe for parking

GYRO ALIGNMENTS

FAST ALIGNMENT BEFORE ENGINE START

1. Interior check Complete
2. External AC / DC pwr ON
3. Bat GND supply .... ON
4. Recorder sw .... ON
5. ACFT sys sw .... ON
6. Navigation sw .... ON
7. MAIN gyro sw .... ON
8. STBY gyro sw .... ON
9. WP - A / D button .... Select as required, check button light on
10. Clock .... Hack
11. Gyro sel sw .... STBY GYRO check

After 30 - 40 sec for Gyro / HDG alignment:

12. Press MAG HDG SLAVE button and COURSE CMPTR ZERO button simultaneously for 10 - 15 sec

13. HSI - HDG .... Check correct indic
14. Operate / Prepare sw OPER
15. FAST PREP light .... Check on
16. Engines .... Start
17. Taxi checks .... As applicable

FAST ALIGNMENT AFTER ENGINE START

(No external power available)

1. Interior check .... Complete
2. Before start eng check Complete
3. LH engine start .... Complete
4. Main gyro sw .... ON
5. STBY gyro sw .... ON
6. WP - A / D button .... Select as required, check button light on
7. Clock .... Hack
8. Gyro sel sw .... STBY GYRO check

After 30 - 40 sec for Gyro / HDG alignment:

9. Press MAG HDG SLAVE button and COURSE CMPTR ZERO button simultaneously for 10 - 15 sec

10. HSI - HDG .... Check corect indic
11. Operate / Prepare sw OPER
12. FAST PREP light .... Check on
13. RH engine .... Start
14. Taxi checks .... As applicable

LONG ALIGNMENT BEFORE ENG START

1. Interior check Complete
2. External AC / DC pwr ON
3. Bat GND supply .... ON
4. Recorder sw .... ON
5. ACFT sys sw .... ON
6. Navigation sw .... ON
7. MAIN gyro sw .... ON
8. STBY gyro sw .... ON
9. WP - A / D button .... Select as required, check button light on
10. Clock .... Hack
11. Gyro sel sw .... STBY GYRO check

After 30 - 40 sec for Gyro / HDG alignment:

12. Press MAG HDG SLAVE button
    and
    COURSE CMPTR ZERO button
    simultaneously for 10 - 15 sec

13. HSI - HDG .... Check correct indic

After 10 - 20 min when NAV READY light is on:

14. Operate / Prepare sw OPER, check NAV READY light out
15. Engines .... Start
16. Taxi checks .... As applicable

LONG ALIGNMENT AFTER ENG START

(No external power available)

1. Interior check Complete
2. Before start eng check Complete
3. LH engine start .... Complete
4. MAIN gyro sw .... ON
5. STBY gyro sw .... ON
6. WP - A / D button .... Select as required, check button light on
7. Clock .... Hack
8. Gyro sel sw .... STBY GYRO check

After 30 - 40 sec for Gyro / HDG alignment:

9. Press MAG HDG SLAVE button
   and
   COURSE CMPTR ZERO button
   simultaneously for 10 - 15 sec

10. HSI - HDG .... Check correct indic

After 10 - 20 min when NAV READY light is on:

11. Operate / Prepare sw OPER, check NAV READY light out

12. RH engine .... Start
13. Taxi checks .... As applicable

TRAINER VARIANT (GT) CHECKS

BEFORE EXTERIOR INSPECTION

1. Safety wired switches Check secured
2. LG system sw .... F / C and secured
3. Ldg gear handle .... Neutral and secured
4. Throttles .... OFF

REAR COCKPIT INTERIOR CHECK

1. Seat initiator cable ..... Connected

WARNING

Exercise caution regarding hand movements in the vicinity of the seat initiator cable. Failure to comply could result in premature seat firing during ejection.

2. Cockpit .... Check no FOD
3. Ejection handle .... Check secured

Ejection seat handle tipped forward and locked, safety pin installed.

4. Leg restraints .... Check proper pos

The leg restraints are properly installed in the spring clips on the main instrument panel and routed through the leg guards.

5. Canopy jettison handle Check secured

The handle is labeled CANOPY EMERG JETTISON. It should be safety wired and lead sealed.

6. Combined harness ..... Fasten

Check quick-release box in position locked. Recheck inertia reel locked.

Insert right shoulder harness with its fitting into the upper anchor bolt of the quick-release box.

Route both leg loops through the rectangular openings of the rings on the main suspension strap and with a quarter of a turn to the quick-release box. Insert fittings into respective anchor bolts.

Tighten leg loops with the lap retraction handle on the right side of the seat bucket.
Tighten shoulder harness.

Insert safety pin.

WARNING

The combined harness must be fastened as tightly as is compatible with safe aircraft operation and comfort.

7. Shoulder harness
   release handle .... Forward

Freedom to lean forward is obtained by moving the handle forward. Violent movement brings the inertia mechanism into operation, locking the shoulder harness. Leaning back, the harness mechanism reels in.

8. Shoulder harness
   reel lock .... Check operation

Moving the shoulder harness release handle aft, locks the reel mechanism.

9. Cockpit safety pins ..... Out and stowed
10. Pers service lines .... Connected

- Radio cord
- Anti-g suit
- Dinghy lowering line
- Helmet mounted sight

11. PEC .... Check connected
12. Pressure regulator:
    G-suit .... MIN
    Pressure suit .... MAX
13. Suit vent .... As required
14. Throttle control lever .. F / C
15. Oxygen flow valve ...... OPEN
16. Oxygen .... MIXT
17. Emerg oxygen .... OFF
18. Helmet vent .... OFF
19. Cabin emerg decomp PRESSURE and secured

20. Feel unit sw .... AUTO and secured
21. MRK emerg sw .... ON and secured
22. Emerg hyd pump .... OFF and secured

23. VHF / UHF Radio:
    a. GUARD RCVR .... ON
    b. ADF .... OFF
    c. Squelch .... ON

24. AB emerg off sw.......... AB and secured
25. Air relight switches ..... OFF and secured
26. Fuel shut off valves .... OPEN and secured
27. Fire extinguishers .... OFF and secured
28. Ramp emerg retraction LH / RH secured
29. EGT (temp) sw .... F / C
30. Radio sel .... As required
31. Speedbrake sw .... F / C
32. Trim sw .... F / C
33. Feel unit control sw .... F / C and secured
34. Rudder trim .... Neutral
35. LG system sw .... F / C and secured
36. Ldg gear handle .... Neutral and secured
37. Periscope sw .... Retracted
38. Emerg brake handle IN and secured
39. AFCS FSP sw .... OFF
40. NAV FSP sw .... OFF
41. Emerg gear handle .... IN and secured
42. Ramps pos indicator Check 0 %

43. NAV panel:
    a. Gyro sw .... MAIN
    b. Channels sw .... F / C
    c. Rel bearing sw .... RSBN
    d. Landing sw .... Navigation
    e. NAV control sel sw F / C

44. Cockpit lighting .... Set as required

45. ADF:
    a. Channel ADF .... As required
    b. ADF beacon sw ..... OUTER
    c. COMP / ANT sw .... COMP
    d. VOICE / CW sw ..... VOICE

46. TACAN .... OFF
47. RADIO EMERG sw .... NORM

BEFORE STARTING ENGINES

1. Seat position .... Adjust
2. Rudder pedals .... Adjust
3. Oxygen supply sys ..... Check and set

- Check oxygen pressure 100 ±10 %.
- Fasten oxygen mask.
- Inhale and exhale two or three times and check for easy respiration.
  Oxygen press indicator, check index not or barely moving.
- Set the mixture switch to 100 %.
  Inhale and exhale two or three times and check for movement of the oxygen flow indicator.
- Set the mixture switch to MIXT and the Emergency switch to EMERG ON.
  Check for continuous flow of oxygen into the mask.
- Switch emergency oxygen to OFF.
  Check cessation of continuous oxygen flow into the mask.

For flights above 48 000 ft, additional checks are required:

- Set oxygen to 100 % and emergency switch to EMERG ON.
  Oxygen pressure should not increase within 15 to 20 sec.
- Have ground crew press the oxygen test button on the left side wall.
  Check for a pressure peak in the pressure suit.
- After pressure reduction, manually block off the opening on the PEC.
  Check for a pressure build-up of approximately 0.05 kg/cm^2 in the oxygen mask.
- Inhale and exhale two or three times.
  Check for movement of the oxygen flow indicator and pressure build-up in pressure suit.
- Have ground crew release the oxygen test button, release the opening on the PEC and check for pressure relief.
- Set oxygen back to MIXT and emerg oxygen to OFF.

WARNING

Flying with a defective oxygen system is prohibited.

4. RDR sim panel .... Check

SECTION 3

EMERGENCY PROCEDURES

TABLE OF CONTENTS

Page

INTRODUCTION
Critical Emergency Procedures 3-5
Criteria for Determining
Critical Emergency Procedures 3-5

DEFINITIONS
Land As Soon As Possible (ASAP) 3-5
Land As Soon As Practical 3-5

TAKEOFF
Abort 3-6
Ramps Remain Closed During Takeoff 3-6
Blown Tire During Takeoff Roll 3-6

AIRCRAFT ABANDONING
Emergency Ground Egress......................... 3-7
Before Ejection 3-7
Ejection G 3-8
Ejection GT 3-9
After Man / Seat Separation 3-9

ENGINE FIRES
Engine Fire on the Ground 3-11
Engine Fire During Takeoff Roll 3-11
Engine Fire During Flight 3-11

ENGINE FLAMEOUT
Double Engine Flameout 3-12
Single Engine Flameout 3-12

ENGINE RELIGHT
Automatic Relight (RPM < 50 %) 3-13
Semiautomatic Relight 3-13
Manual Relight 3-13

	Page
ENGINE FAILURES OR MALFUNCTIONS	
AB Failure During Takeoff	3-14
Engine Mechanical Failure	3-14
Engine Vibration	3-14
Engine Chips	3-15
Engine Surge	3-15
Engine Overheat During Flight	3-15
Engine Oil Pressure Low or Overtemp.	3-16
ENGINE CONTROL SYSTEM FAILURES	
Main Engine Control Failure	3-16
Engine Overspeed	3-16
AB Fails to Light	3-16
AB Fails to Shut Down or Blows out During Flight	3-17
Ramp Control Failure	3-17
FUEL SYSTEM FAILURES	
Fuel Control Failure	3-17
Fuel Boost Pump Failure	3-18
Fuel Transfer Failure	3-18
ELECTRICAL SYSTEM FAILURES	
Both Generator Failure	3-18
DC Generator Failure	3-19
AC Generator Failure or AC Generator Drive Failure	3-20
AC Transformer Failure	3-20
GEARBOX MALFUNCTIONS	
Gearbox Failure / Vibration	3-20A
Gearbox Fire	3-20A
HYDRAULIC SYSTEM FAILURES	
Both Hydraulic System Failure	3-21
Main Hydraulic System Failure	3-21
Hydraulic Boost System Failure	3-21
FLIGHT CONTROL MALFUNCTIONS	
Feel Control Unit Failure	3-22
COC Actuator Failure	3-22
COC Failure	3-22
Trim Failure	3-22
AVIONIC SYSTEM FAILURES	
Autopilot (AFCS) Failure	3-23
Air Data System Failure	3-23
Main or STBY Gyro Failure	3-23
Both Gyro Failure	3-24
Navigation System Failure	3-24

Page

APPROACH AND LANDING EMERG
Single Engine Approach and Landing 3-25
Ldg with Flap / LEF System Failures 3-25
Landing with a Known Blown Tire 3-25
NWS Failure After Landing 3-25
Wheelbrake Failure 3-25
Barrier Engagement 3-26

LANDING GEAR EMERGENCIES
Ldg Gear Indicator System Failure 3-26
Ldg Gear Retraction Failure 3-26
Ldg Gear Unsafe or Fails to Extend 3-26
Emergency Gear Extension 3-27
Landing Gear Emergency Chart 3-28

MISCELLANEOUS EMERG PROCEDURES
Oxygen System Failure 3-28
Rapid Decompression Above 40 000 ft 3-28
Air Conditioning System Failure 3-28
Lost Canopy 3-29
Pneumatic System Failure 3-29
Main Pitot Boom Failure 3-29
Cabin Icing 3-29
Smoke or Fumes in Cockpit 3-30
Moisture in Cockpit 3-30
Controllability Check 3-30
Out of Control 3-30
Spin Recovery 3-31

Caption Index G/GT 3-32
After Modification with Wing Drop Tanks ... 3-32
Additional Caption Index GT 3-32
VIWAS Reports and Advices 3-33
AEKRAN Signals 3-35

Intentionally left blank

INTRODUCTION

This section contains procedures to be followed to correct an emergency condition. These procedures will insure maximum safety for the pilot and/or the aircraft until a safe landing or other appropriate action is accomplished. The procedures are arranged in the most desirable sequence for the majority of cases. Therefore, the steps should be performed in the listed sequence unless the pilot can determine a good cause for deviation. Multiple emergencies, adverse weather, and other peculiar conditions may require modification of these procedures. The nature and severity of the encountered emergency will dictate the necessity for complying with the emergency procedure in their entirety. It is essential, therefore, that pilots determine the correct course of action by use of common sense and sound judgement. As soon as possible the other flight member and air traffic control (ATC) should be notified of an existing emergency and of the intended action.

Three basic rules are established which apply to most emergencies. They should be remembered by the pilot:

1. Maintain aircraft control
2. Analyze the situation
3. Take proper action

WARNING

- The canopy should be retained during all emergencies, that could result in a crash or fire, e.g. crash i.e. landings, aborted takeoffs, and barrier engagements.
- The risk of becoming trapped due to a canopy malfunction or overturn of the aircraft is outweighted by the protection given to the aircrew by the canopy.
- All odors not identifiable by the pilot shall be considered toxic. Immediately go to 100 % oxygen. Properly vent the aircraft and land as soon as practical. Do not take off when unidentified odors are detected.

CRITICAL EMERGENCY PROCEDURES

The critical emergency steps (boldface type) in a critical emergency procedure are the steps that must be performed immediately without reference to a written checklist. Critical emergency procedures are presented in boldface letters. The pilot must be able to apply correctly boldfaced procedures in the published sequence without directly referring to the checklist. Any other steps, when there is time to consult a checklist, are considered noncritical and are written in the standard type.

CRITERIA FOR DETERMINING CRITICAL EMERGENCY PROCEDURES

The criteria for determining a critical emergency procedure or step are as follows:

- It must be a serious emergency
- It must be acted upon immediately with no time to refer to the printed checklist
- It must have a reasonable frequency rate

DEFINITIONS

The terms LAND AS SOON AS POSSIBLE (ASAP) and LAND AS SOON AS PRACTICAL are used in this section. These terms are defined as follows:

LAND AS SOON AS POSSIBLE (ASAP)

A landing should be accomplished at the nearest suitable airfield, considering the severity of the emergency, weather conditions, airfield facilities, ambient lightning, aircraft gross weight and command guidance. The abbreviation ASAP is to be used only for as soon as possible.

LAND AS SOON AS PRACTICAL

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

ABORT

The decision to abort or continue the takeoff depends on type of emergency, length of runway remaining. Reference must be made to such factors as runway condition, pressure altitude, OAT, winds and barrier available. When external tanks are carried (and particularly so with 3 full tanks), takeoff abort criteria must be carefully considered. Maximum abort speed and minimum go speed should be the primary criteria for the abort decision.

If decision to stop is made:

1. Throttles .... IDLE
2. Drag chute .... Deploy
3. Flaps / LEF .... Up and in
4. Prepare for barrier engagement

If barrier engagement expected:

1. Throttles .... OFF
2. ENG SYS .... OFF
3. Periscope (GT) .... Retract prior barrier engagement
4. Shoulder harness ...... Recheck locked

RAMPS REMAIN CLOSED DURING TAKEOFF

VIWAS No.: 25 — UPPER INLET

If a ramp failure is indicated after gear retraction, the failed ramp can be identified by the ramps position indicator on the mark. If airspeed is increased above M 0.8, engine surge and subsequent failure may occur.

1. Airspeed .... Not above M 0.8
2. Land .... As soon as practical

A blown tire can be recognized by severe vibrations and/or yaw movement and wing dip to the side of the blown tire. The decision to abort or continue the takeoff will depend on the speed at the time of failure, stopping distance required and barrier available. Generally it is advisable to continue the takeoff if the tire blows after nose wheel lift off. A blown tire often results in damage to the pneumatic lines. Therefore, a pneumatic system failure should be anticipated.

BLOWN TIRE DURING TAKEOFF ROLL

CAUTION

In case of a blown tire, aircraft directional control is extremely critical. Therefore, immediate corrective action must be taken and all available means must be used to maintain directional control.

If decision to stop is made:

1. Abort .... Refer to ABORT checklist

If takeoff is continued:

1. Gear .... Do not retract
2. Flaps / LEF .... Do not retract

CAUTION

If the flaps/LEF hinges have been damaged as a result of a blown tire, retracting the flaps will increase the damage.

3. Wheel rotation .... Stop with brakes
4. Aircraft weight .... Reduce to min pract
5. For landing .... Refer to LANDING WITH A KNOWN BLOWN TIRE checklist

AIRCRAFT ABANDONING

EMERGENCY GROUND EGRESS

The decision to abandon the aircraft through manual egress or by ejection mainly depends on the severity of the emergency situation and aircraft speed. Generally, ejection should only be considered if the pilot's life is in imminent danger.

WARNING

A minimum speed of 40 KIAS (GT 80 KIAS) is mandatory for safe ejection.

1. Throttles .... OFF
2. Ejection handle ...... Secure
3. Quick-release box .. Open
4. Pressure regulator safety pin .... Pull
5. Dinghy lowering line Disconnect
6. Canopy .... OPEN

If canopy fails to open:

1. Canopy .... Jettison

GT:

Alert the other crewmember without any doubt as early as possible by voice or visual signals. If the order for an emergency ground egress cannot be given over the intercom or the VHF/UHF radio due to a failure, briefed or standard hand signals should be used.

EJECTION PROCEDURES

Ejection can be accomplished on the ground above 40 KIAS (GT 80 KIAS). Airborne, the design limit of the seat allows ejection at any altitude up to 700 KIAS.

The emergency oxygen equipment, the leg- and arm restraint devices along with a reliable ejection seat stabilizing system will adequatly protect the pilot during an ejection sequence.
An additional body wind blast protector will shield the occupant against excessive windloads when ejecting at airspeeds over 485 KIAS.

Before Ejection

WARNING

The risk of injury during ejection increases at speeds above 500 KIAS when wearing the HGU-55G helmet, or 700 KIAS when wearing the ZScha 5/ZScha 7 helmet.

If time and conditions permit:

- Speed .... 215 to 325 KIAS during climb or level flight.
- Height .... Climb to an altitude between 6 500 ft and 10 000 ft AGL, or descend to an altitude between 13 000 ft and 10 000 ft, if possible attain VMC.
- Aircraft........................ Head toward unpopulated area.
- IFF.............................. EMERG
- Harness...................... Tight and locked
- Oxygen mask............. Tight
- Visors .... Down
- Radio........................... Call MAYDAY
- Throttles .... OFF prior ejection
- Ejection position .... Assume
- Grasp the twinned ejection handle with both hands from behind.

NOTE

- In case one hand is incapacitated caused by injury, either side of the twinned ejection handle can be operated to initiate ejection.
- To adopt the correct posture, sit erect, buttocks back, shoulders against seat back, head against headrest, spine straight, feet off the rudder pedals and thighs on the seat.

GT:

Time and circumstances permitting, the AC will make the decision to eject. If the executive order for ejection cannot be given over the intercom due to a failure, the VHF/UHF-radio can be used as an alternate method. With both systems inoperative, rapidly move the control stick from side to side to gain the other crewmembers attention. Make hand signals either side of the head box to indicate the intention to initiate ejection. Either arm will be held up with forearms vertical, fist clenched, then moving the forearms briskly up and down three times. At night signal with vertical wave of flashlight over the left shoulder.

WARNING

If sequenced ejection is initiated from either cockpit without first alerting the other crewmember, incapacitation from improper body position on ejection could result.

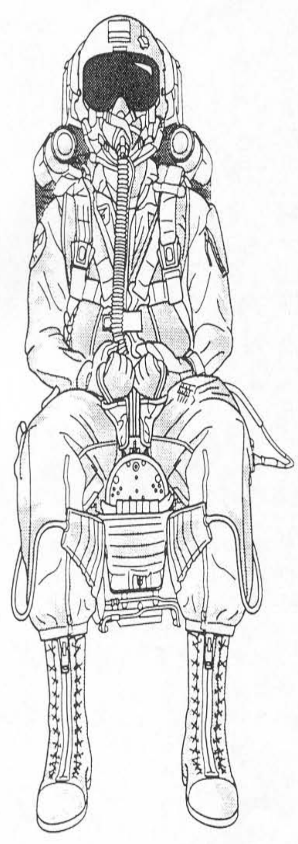


Figure 3-1

Ejection G

1. Ejection handle .... Pull

The ejection handle should be pulled and held forcefully in the upward position until seat is propelled up the guide rails.

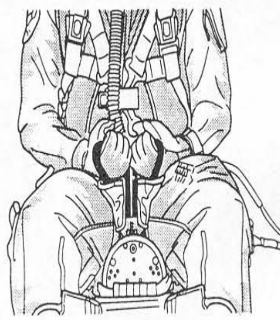


Figure 3-2

When the handle is pulled, the powered retraction units are activated to tighten the shoulder harness, lap belt, elbow guards and leg restraints. The canopy jettison system is activated. After the canopy has separated from the aircraft, the seat firing cable will be pulled allowing the twin barrel ejection gun to fire and raise the seat out along the guide rails.

If canopy fails to separate:

When a failure of the canopy jettison mechanism occurs, the shoulder harness, elbow guard and leg restraint units are actuated.

2. Ejection handle .... Hold without applying tension
3. Canopy .... Jettison with canopy emerg jettison handle

NOTE

- Hold on tightly to the ejection handle with left hand since high wind loads might cause serious difficulties reaching for the ejection handle again.

- Rotate the emergency canopy jettison handle until the grip points roughly towards the interior of the aircraft and pull forcefully downward until full travel is reached.

4. Ejection handle .... Pull again

If the canopy still fails to separate, a backup system will be activated which opens the canopy locks within 0.5 sec after the ejection handle is pulled again. The seat will be fired through the canopy glass after a delay of another 0.5 sec.

WARNING

Do not activate the ejection handle and canopy emerg jettison handle simultaneously.

The emergency oxygen system will be activated automatically as the seat rises along the guide rail.

Ejection GT

1. Ejection handle .... Pull

Upon the executive order for ejection, both crew-members should initiate ejection simultaneously.

If seats fail to eject:

A failure of the rear seat to fire interrupts the ejection sequence and prevents both seats from firing, despite canopy seperation.

2. Ejection handle .... Hold without applying tension
3. Canopy .... Jettison with F / C canopy emerg jettison handle
4. Double system rescue ... F / C pull

WARNING

After activation of the DOUBLE SYSTEM RESCUE handle, the front seat will eject after 1 sec, even if the rear seat has failed to eject.

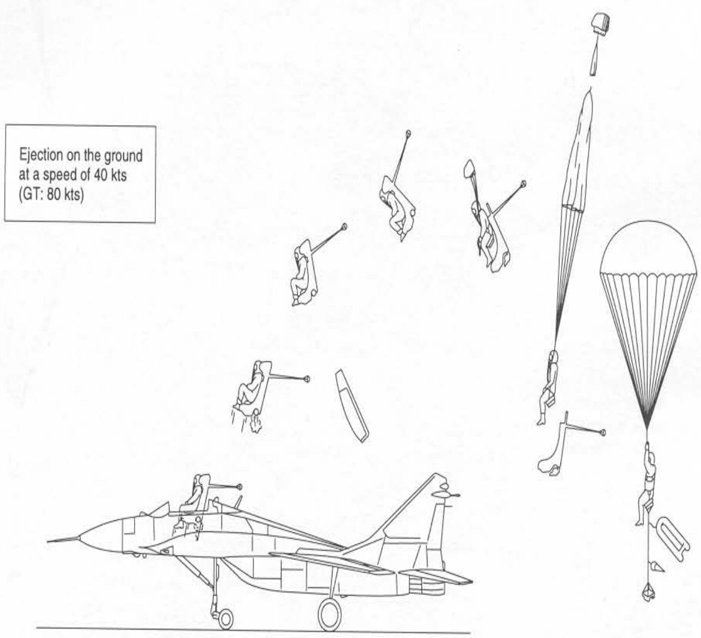
AFTER MAN / SEAT SEPARATION

1. Canopy .... Check

Check correct deployment of chute canopy

2. Mask .... Remove
3. Pressure regulator safety pin .... Pull
4. Survival pack .... Check open
5. Life vest .... Inflate
6. Canopy quick disconnect .... Upon touchdown open

EJECTION SEQUENCE



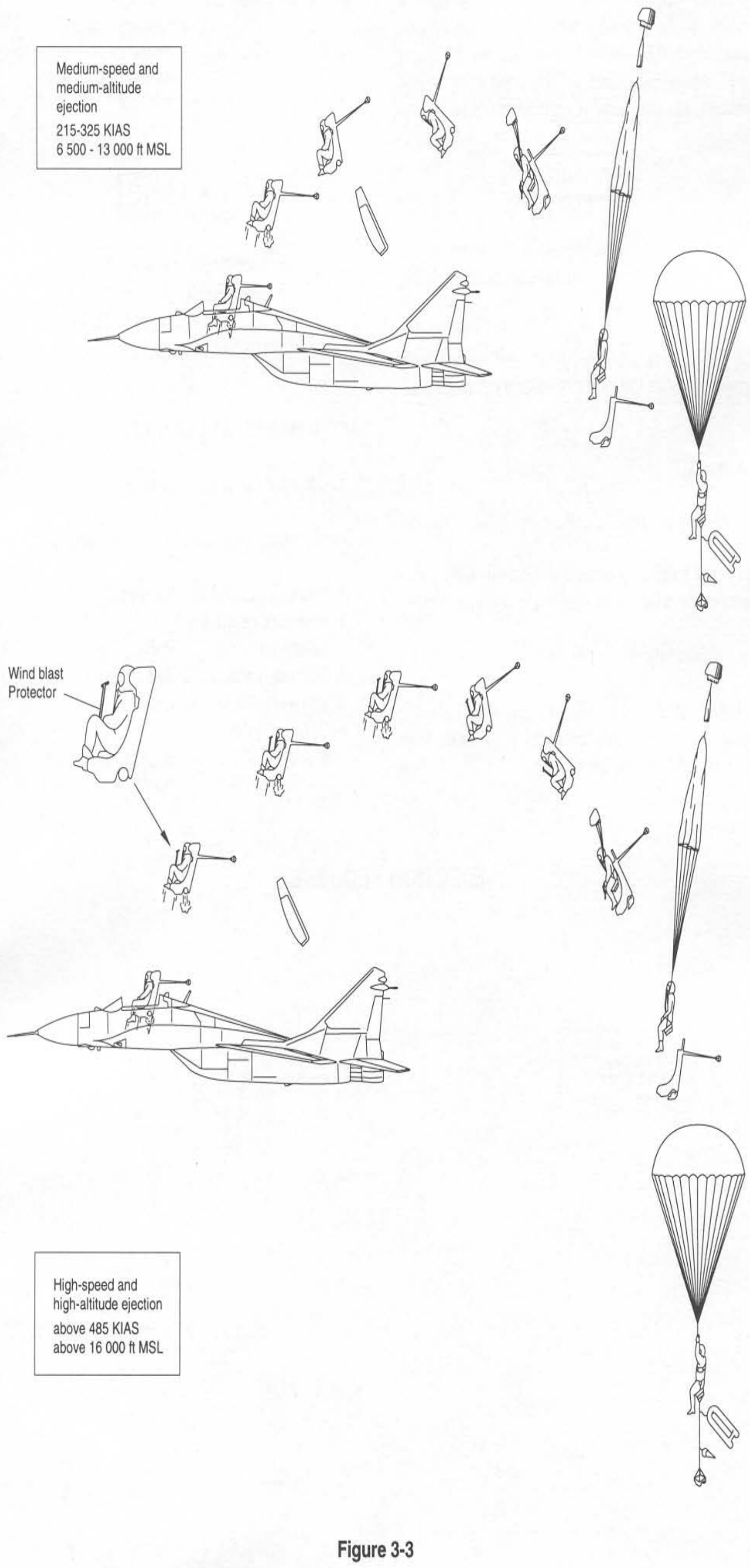

Medium-speed and
medium-altitude
ejection
215-325 KIAS
6 500 - 13 000 ft MSL
Wind blast
Protector
High-speed and
high-altitude ejection
above 485 KIAS
above 16 000 ft MSL

Figure 3-3

ENGINE FIRES

ENGINE FIRE ON THE GROUND

LH ENG FIRE	RH ENG FIRE	VIWAS No.: 1, 2

1. Throttles .... OFF
2. Fuel shut off valve
   bad engine .... OFF
3. Fire extinguisher
   bad engine .... Activate
4. Bat GND supply .... OFF
5. Continue with the EMERGENCY GROUND EGRESS checklist

CAUTION

Exercise care positioning the fire extinguisher selection switch, since the entire foam supply is distributed and only one extinguishing attempt is possible.

ENGINE FIRE DURING TAKEOFF ROLL

LH ENG FIRE	RH ENG FIRE	VIWAS No.: 1, 2

If an engine fire is indicated, the takeoff should be aborted if possible.

If decision to stop is made:

1. Abort .... Refer to ABORT checklist
2. Throttles .... OFF
3. Fuel shut off valve
   bad engine .... OFF
4. Fire extinguisher
   bad engine .... Activate
5. Bat GND supply .... OFF
6. Continue with the EMERGENCY GROUND EGRESS checklist

If takeoff is continued:

1. Throttles .... MIL

If refusal speed has been reached or exceeded, it is advisable to continue takeoff. Should the fire result in partial or total loss of thrust on one engine, the advice and actions applicable to engine failure should be followed.

When safe airborne:

2. Throttle bad engine ... OFF
3. Fuel shut off valve
   bad engine .... OFF
4. Fire extinguisher
   bad engine .... Activate

When the fire extinguisher bottle has been discharged and the fire warning lights are out, it may be assumed that the fire is extinguished. The fire warning elements continue to detect an overheat condition.

If fire is confirmed:

5. Throttles .... OFF
6. Eject

If fire is extinguished:

5. Land .... ASAP
6. For single engine ldg .. Refer to SINGLE ENGINE APPROACH AND LANDING checklist

ENGINE FIRE DURING FLIGHT

LH ENG FIRE	RH ENG FIRE	VIWAS No.: 1, 2

Upon detection of a fire, immediately deselect AB operation of both engines.

1. Throttles bad engine OFF
2. Fuel shut off valve
   bad engine .... OFF
3. Fire extinguisher
   bad engine .... Activate
4. AFCS modes .... OFF (press < 3 sec)

If fire is confirmed:

5. Throttles .... OFF
6. Eject

If fire is extinguished:

5. Land .... ASAP
6. For single engine ldg .. Refer to SINGLE ENGINE APPROACH AND LANDING checklist

ENGINE FLAMEOUT

DOUBLE ENGINE FLAMEOUT

Engine flameout is indicated by loss of thrust, RPM will drop rapidly. Counteract any rolling motions and relight the engines.

WARNING

If neither engine relights passing 6 500 ft AGL, an immediate ejection is recommended.

1. Damper / AFCS modes or AFCS sw .... OFF (press > 3 sec) OFF

After RPM drops below 45 %

2. Throttles .... OFF
3. Both engines .... Continue with the ENGINE RELIGHT checklist
4. Throttles .... Between IDLE and MIL
5. Engine relight .... Monitor
6. Land .... ASAP

SINGLE ENGINE FLAMEOUT

During takeoff roll

a. Gross weight below 16 500 kg

An engine failure during takeoff will lead to a loss in total thrust, a yawing motion with subsequent sideslip and a moderate rolling tendency of the A/C away from the good engine. Usually, control margins are sufficient for the pilot to counteract adverse A/C motions if the aircraft remains above stall speed, but the ability to climb depends on gross weight, configuration, altitude and temperature. Since both controllability and climb performance improve drastically with airspeed, establish a single engine climb rate of 200 ft/min to 400 ft/min until reaching 190 KIAS. Then increase the climb rate to 900 to 1 500 ft/min. Flaps/LEF should not be raised until an altitude of 300 ft is reached. External stores should be jettisoned if required. If turns are necessary, they should be made with minimum angle of bank. All control movements should be made smoothly co-ordinated.

If decision to stop is made:

1. Abort .... Refer to ABORT checklist

Takeoff should be aborted at airspeeds below 110 KIAS if circumstances permit.

2. Throttle bad engine .... OFF

If takeoff is continued:

1. Throttles .... MIL

If an engine fails immediately after becoming airborne and the decision to continue the takeoff is made, it may be necessary to allow the aircraft to settle back on the runway until takeoff speed is attained.

2. Gear / Flaps .... Up at safe airspeed and altitude

b. CARRYING WING DROP TANKS (gross weight above 16 500 kg)

Since airspeed is very critical at high gross weights, use of AB is highly recommended for acceleration. However, yawing motion with subsequent sideslip and rolling tendency of the A/C away from the good engine are much more pronounced in AB than in MIL power. Particularly foot loads are very high if the yaw and sideslip from asymmetric AB thrust are to be compensated. If rudder pressure is reduced and some degree of sideslip accepted (at the expense of climb rate), the heading can be held constant with moderate bank into the good engine. If a military takeoff was performed, the pilot should not hesitate to select maximum AB on the good engine.
Both, controllability and climb performance improve drastically with airspeed, therefore it is mandatory to keep the airspeed above approximately 190 KIAS. Control inputs should be made smoothly and turns should be avoided. If single engine climb performance is insufficient even in maximum AB, the pilot must not hesitate to jettison the external tanks.

If takeoff is continued:

1. Throttles .... Afterburner
2. External tanks .... Jettison if required
3. Gear .... Up at safe airspeed and altitude
4. Flaps / LEF .... Up at safe airspeed and altitude

WHEN ESTABLISHED AT SAFE ALTITUDE

After RPM drops below 45 %

1. Bad engine .... Relight if practical according to the ENGINE RELIGHT checklist
2. Land .... ASAP

No relight

1. Throttle bad engine .... OFF
2. Land .... ASAP

During Flight

If an engine flameout occurs during flight, external stores should be jettisoned if required. Turns should be made with minimum angle of bank. Control movements should be smooth and co-ordinated.

Airspeed should be maintained between 215 and 325 KIAS. Counteract yaw movement by smoothly applying opposite rudder.

1. AB .... OFF
2. AFCS modes .... OFF (press < 3 sec)

After RPM drops below 45 %

3. Bad engine .... Relight according to the ENGINE RELIGHT checklist
4. Land .... ASAP

ENGINE RELIGHT

If engine flameout occurs during flight, relight is initiated automatically. However, if the automatic relight fails, the semiautomatic and the manual relight are available as alternate methodes. After successfull relight, check engine operation. If engine is not controllable in the entire RPM-range, retard throttle to OFF and relight at higher airspeed.

NOTE

> Time required for engine relight during flight must not exceed 70 sec. When the time limit is exceeded, an entry into form 781 has to be made.

AUTOMATIC RELIGHT (RPM < 50 %)

Automatic relight sequence is initiated when engine RPM drops below 50 %, provided the throttles are set between IDLE and AB.

The corresponding green ENG START caption on the TLP is illuminated and the EGT increases to values corresponding to throttle position.

1. Throttle .... Between IDLE and AB
2. ENG START light ...... Check on
3. RPM and EGT .... Monitor

SEMIAUTOMATIC RELIGHT

Semiautomatic relight should be used if an engine drops below 50 % RPM and the automatic relight functon has failed.

Upon execution of the procedure, the corresponding green ENG START caption on the TLP is illuminated and the EGT increases to values corresponding to throttle position.

1. Throttle .... OFF (for 2 - 3 sec)
2. Throttle .... Between IDLE and MIL
3. ENG START light ...... Check on
4. RPM and EGT .... Monitor

MANUAL RELIGHT

Manual relight may be required if automatic and semiautomatic relight functions have failed.

1. Throttle .... OFF
2. AIR RELIGHT sw .... ON (max 100 sec)

CAUTION

> To prevent damage to the ignition coils, the AIR RELIGHT switches must not be set to ON for more than 100 sec.

3. Throttle .... Between IDLE and MIL

After engine relight:

4. AIR RELIGHT sw .... OFF

NOTE

- If engine is not controllable in the entire RPM-range, repeat engine relight at higher airspeed.
- At least 5 relight attempts with O_2 are possible.

Relight envelope for all relight types

ALT	KIAS	RPM
below 40 000 ft	220 - 540	≥ 12 %
40 000 - 56 000 ft	300 - M 1.8	≥ 50 %

ENGINE FAILURES OR MALFUNCTIONS

AB FAILURE DURING TAKEOFF

In case of an engine malfunction beyond minimum go speed and before max abort speed, takeoff may either be aborted or continued.

a. All gross weights

If decision to stop is made:
1. Abort .... Refer to ABORT checklist

Takeoff must be aborted if an engine fails before reaching minimum go speed.
Once the max abort speed is reached, takeoff must be continued.

b. Gross weight below 16 500 kg

If takeoff is continued:
1. Throttles .... MIL
2. Gear .... Up at safe airspeed and altitude
3. Flaps / LEF .... Up at safe airspeed and altitude
4. Throttle bad engine ... IDLE and monitor

c. CARRYING WING DROP TANKS (gross weight above 16 500 kg)

Since airspeed is very critical at high gross weights, use of AB is highly recommended for acceleration. Refer to single engine flameout this section.

If takeoff is continued:
1. Throttle bad engine ... MIL
2. External tanks .... Jettison if reqired
3. Gear .... Up at safe airspeed and altitude
4. Flaps / LEF .... Up at safe airspeed and altitude
5. Throttle bad engine ... IDLE and monitor

ENGINE MECHANICAL FAILURE

An engine mechanical malfunction is usually accompanied by engine vibrations, explosions, surges, or engine seizure. At the first indication of mechanical engine failure, shut down failed engine and advance throttle of the good engine to obtain the required thrust. Compensate roll and pitch moments.

1. Throttle bad engine .... OFF
2. Land .... ASAP
3. For single engine ldg .. Refer to SINGLE ENGINE APPROACH AND LANDING checklist

ENGINE VIBRATION

REDUCE RPM LH ENG	REDUCE RPM RH ENG

VIWAS No.: 19, 20

VIBR LEFT
VIBR RIGHT

When the preset vibration limit of an engine is exceeded, the corresponding warning signals illuminate.

1. AB .... OFF
2. RPM bad engine .... Reduce

Reduce RPM until warning signals disappear.

3. Land .... As soon as practical

If warning light or AEKRAN still on:
3. Throttle bad engine .... OFF
4. Land .... ASAP
5. For single engine ldg .. Refer to SINGLE ENGINE APPROACH AND LANDING checklist

ENGINE CHIPS

OIL PRESS LEFT	OIL PRESS RIGHT

VIWAS No.:31, 32

CHIP LEFT
CHIP RIGHT

If the oil pressure is low for more than 20 sec or a magnetic sensor detects abbrasions in the engine oil, engine chips are indicated.

1. AB .... OFF
2. RPM bad engine .... Reduce

Reduce RPM until warning signals disappear.

3. Land .... As soon as practical

If warning light or AEKRAN still on:

3. Throttle bad engine ... OFF
4. Land .... ASAP
5. For single engine ldg .. Refer to SINGLE ENGINE APPROACH AND LANDING checklist

ENGINE SURGE

REDUCE RPM LH ENG	REDUCE RPM RH ENG
LH ENG START	RH ENG START

VIWAS No.: 6, 7

OVERHEAT LEFT
OVERHEAT RIGHT

An engine surge is an aerodynamic disruption of airflow through the compressor. It is caused by subjecting the LP and/or HP compressor to a pressure ratio above its capabilities at the existing conditions.

The compressor capability may be reduced by FOD, corrosion, missile or gun exhaust gases, misrigged or malfunctioning IGV's. In addition, the compressor may also be subject to abnormal operating conditions as a result of a malfunction of the ramp system. Engine surges may be self-clearing or may result in a locked-in-surge.

The engine surge can be recognized by the simultaneous existence of high EGT, low RPM, closed intake ramps, pulsating thrust or loss of thrust, and lack of engine response to throttle. Surges may be accompanied by bangs. The most positive stall clearing procedure is to shutdown the engine and perform a relight. In the event of a double engine locked-in-surge, shut down and restart one engine at a time.

1. AB .... OFF
2. Throttle bad engine ... IDLE
3. ANTI SURGE .... Recheck ON

If unsuccessful after 5 to 8 sec:

4. Throttle bad engine ... OFF
5. Ramp .... Check
6. Bad engine .... Continue with the ENGINE RELIGHT checklist
7. Land .... As soon as practical

If ramp in 100 % and airspeed above M 1.15:

6. Airspeed .... Below M 1.15
7. Ramp .... Emerg retraction
8. Bad engine .... Continue with the ENGINE RELIGHT checklist
9. Land .... As soon as practical

ENGINE OVERHEAT DURING FLIGHT

REDUCE RPM LH ENG	REDUCE RPM RH ENG

VIWAS No.: 6, 7

OVERHEAT LEFT
OVERHEAT RIGHT

Engine overheat during flight occurs, if EGT of LH/RH engine exceeds the scheduled value.

1. AB .... OFF
2. RPM bad engine .... Reduce
3. Land .... As soon as practical

If warning light or AEKRAN still on:

3. Throttle bad engine ... OFF
4. Land .... ASAP
5. For single engine ldg .. Refer to SINGLE ENGINE APPROACH AND LANDING checklist

ENGINE OIL PRESSURE LOW OR OVERTEMPERATURE

OIL PRESS LEFT

OIL PRESS RIGHT

VIWAS No.:12, 13, 15, 16

OIL PRESSURE LEFT

OIL PRESSURE RIGHT

OIL TEMP LEFT

OIL TEMP RIGHT

1. AB .... OFF
2. RPM bad engine .... Reduce
3. Land .... As soon as practical

If warning light or AEKRAN still on:

3. Throttle bad engine ... OFF
4. Land .... ASAP
5. For single engine ldg .. Refer to SINGLE ENGINE APPROACH AND LANDING checklist

ENGINE CONTROL SYSTEM FAILURES

MAIN ENGINE CONTROL FAILURE

VIWAS No.: 28, 29

LEFT ENG STBY SYS

RIGHT ENG STBY SYS

1. Throttle bad engine ... No rapid movement
2. RPM and EGT .... Monitor
3. Land .... As soon as practical

ENGINE OVERSPEED

REDUCE RPM LH ENG

REDUCE RPM RH ENG

VIWAS No.: 8, 9, 6, 7

LEFT OVER SPEED

RIGHT OVER SPEED

and / or

OVERHEAT LEFT

OVERHEAT RIGHT

Engine overspeed and/or overheat indications on the AEKRAN indicate a failure of fuel control, vibration and/or overtemperature.

1. AB .... OFF
2. RPM bad engine .... Reduce
3. Land .... As soon as practical

If warning light or AEKRAN still on:

3. Throttle bad engine .... OFF
4. Land .... ASAP
5. For single engine ldg .. Refer to SINGLE ENGINE APPROACH AND LANDING checklist

AB FAILS TO LIGHT

The green captions LH/RH ENG AB are not illuminated on the TLP when the AB failes to light.

1. Throttle .... MIL
2. Land .... As soon as practical

AB FAILS TO SHUT DOWN
OR
BLOWS OUT DURING FLIGHT

If AB fails to shut down when retarding the throttles out of the AB range, the corresponding ENG AB light on the TLP remains on.

When an AB blow out occurs, the corresponding ENG AB light on the TLP extinguishes with the throttle in AB range. Sudden roll and/or pitch movements are expierenced and loss of thrust is noticeable.

CAUTION

Loss of AB or shut down failure could be an early indication of an engine failure. Do not recycle AB.

1. Throttles .... MIL
2. AB EMERG sw .... If required, OFF
3. AB .... Do not use
4. Land .... As soon as practical

RAMP CONTROL FAILURE

VIWAS No.: 25, 26, 27

LEFT AIR INTK
RIGHT AIR INTK
UPPER INLET

Additional indications for a ramp failure are ramps in the open position, failure of either ramp to move during acceleration to M 1.6 or a difference of more than 15 % between the ramps.

1. Throttle bad engine ... IDLE
2. Airspeed .... Reduce to subsonic (430 - 480 KIAS)

If below 30 000 ft:

3. Ramp .... Emerg retraction
4. Land .... As soon as practical

If surges occur:

4. RPM............................ Increase
5. Airspeed .... Subsonic
6. Land .... As soon as practical

NOTE

Upon release of either RAMP EMERG RETRACTION switch, the ramp must not extend more than 8 %.

FUEL SYSTEM FAILURES

FUEL CONTROL FAILURE

REDUCE RPM LH ENG	REDUCE RPM RH ENG

VIWAS No.: 33, 34

FUEL PRESS LEFT
FUEL PRESS RIGHT

1. AB .... OFF
2. RPM bad engine .... Reduce till warning light and AEKRAN off
3. Land .... As soon as practical

If warning light or AEKRAN still on:

3. Throttle bad engine ... OFF
4. Land .... ASAP
5. For single engine ldg .. Refer to SINGLE ENGINE APPROACH AND LANDING checklist

FUEL BOOST PUMP FAILURE

VIWAS No.: 5

NO BOOST

Provision is made for gravity feed to the bad engine in case of a boost pump failure. This provision allows engine operation at low power settings at or below 16 000 ft.

NOTE

Above 16 000 ft, at high power settings or during near zero and negative g-flights, engine flameout or unstable RPM indications may occur. Therefore, near zero and negative g-flights are prohibited.

1. AB .... OFF
2. RPM .... Reduce to min practicable
3. Altitude .... Descend < 16 000 ft
4. Zero / negative g .... Prohibited
5. Land .... As soon as practical

CENTERLINE TANK TRANSFER FAILURE

VIWAS No.: 42

1. Fuel T / P sw .... T
2. Fuel contents .... Monitor
3. Land .... As soon as practical

WING DROP TANK TRANSFER FAILURE

WDT NO PRESS

VIWAS No.: 38

If there is a pressure loss in the system, none of the WDTs will be emptied. Therefore the pilot must be aware of the actual fuel amount available, which is indicated fuel minus external wing fuel (1 800 kg). The BINGO warning will not reflect actual fuel available. Caution should be used not to exceed the maximum allowable landing weight.

1. Fuel T / P sw .... T
2. Fuel calculation .... Modify
3. Land .... As soon as practical

CAUTION

Consider jettisoning of the wing drop tanks if range is the critical factor in reaching the next suitable airfield.

NOTE

Although unlikely, a WDT NO PRESS indication may be the first indication for a single WDT transfer failure and an impending weight asymmetry.

ELECTRICAL SYSTEM FAILURES

BOTH GENERATORS FAILURE

Check TURN light

DC GEN WATCH TIME
AC GEN
TWO GENER WATCH TIME

VIWAS No.: 21

GT:

A both generators failure can be determined by illumination of the DC GEN WATCH TIME on the AEKRAN. The failure of the AC GEN is notindicated. Illumination of the TURN light is the only hint for the AC GEN indication in store. DC voltage drops to 21 to 22 V.

The fire control system, roll and pitch trim, the speedbrakes, the drag chute and the anti skid fail immediately. Ramp control becomes inoperative with the flaps remaining in the position at time of failure. The fail flags on the HSI appear.
As batterie power decreases below 20 V, lamp brightness decreases, engine intake ramps, UHF/VHF radio become inoperative. Other instruments may fail already.
Below 18 V, pitch, bank and HDG indications become unreliable.

CAUTION

When total electrical failure is be experienced the gear has to lowered pneumatically, and due to the failure of the main fuel control, rapid power changes should be avoided. Be prepared for a possible no flap landing.

1. Damper / AFCS modes OFF (press > 3 sec) or AFCS sw .... OFF
2. AB .... OFF
3. Nav system .... Manual
4. PTO .... Check ON
5. Voltmeter .... Monitor
6. Land .... ASAP

CAUTION

In case of both generator failure, battery power will be available for 10 to 25 minutes.

DC GENERATOR FAILURE

VIWAS No.: 21

DC GEN WATCH TIME

A DC generator failure results in nonavailability of the same systems as a both generator failure. Since the AC generator is still available, PTO (DC / AC converter) is not used, resulting in increased battery power availability.

1. Damper / AFCS modes .... OFF (press > 3 sec)
   or AFCS sw .... OFF
2. AB .... OFF
3. PTO .... Check ON
4. Nav system .... Manual
5. Land .... ASAP

SERVICES LOST CHART BOTH GEN OR DC GEN FAILURE, BAT POWER > 18 V	
Weapons:	**Navigation:**
- Opto electronic	- Mode AUTO
- Weapon Control System	
- IRSTS / LRF	
- Helmet Mounted Sight	
- RADAR	

CAUTION

In case of DC generator failure, battery power will be available for 15 to 35 minutes.

SERVICES LOST CHART BOTH GEN OR DC GEN FAILURE, BAT POWER ≤ 18 V	
Flight Instruments:	**Engine:**
- HUD / HDD	- Inlet ramp control
- Attitude indicator	
- Pressure altimeter (except GT, R/C)	**Airframe:**
- HSI	- Gear
- Turn needle in the VVI	- Flaps / LEF
- Rad alt	- Speedbrakes
	- Aileron trim
Navigation:	- Stab trim
- MAIN / STBY GYRO	- Artificial feel system
- TACAN	- Anti-skid
- ADF	- NWS
Communications:	**Weapons:**
- UHF / VHF Radio	- Fire control system
- XT - 2000	
- IFF / SIF	**Miscellaneous:**
	- Drag Chute
Fuel:	- VIWAS
- Fuel quantity indication	- AEKRAN
	- TLP
	- MASTER CAUTION

CAUTION

If total electrical failure is experienced the gear has to be lowerd pneumatically. Due to the failure of the main fuel control, rapid power changes should be avoided. Be prepared for a possible no-flap landing.

AC GENERATOR FAILURE
or
AC GENERATOR DRIVE FAILURE

AC GEN

In case of a AC generator failure, the PTO supplies AC power to the systems critical for flight.

CAUTION

Do not reset AC GEN switch to ON.

DISCON GEN DRIVE

If the oil pressure in the constant speed drive drops below permissible values or the oil temperature is to high or the AC frequency increases above limits due to generator drive shaft overspeed, the DISCON GEN DRIVE illuminates on the AEKRAN. In case of a generator drive shaft overspeed, the generator is disconnected automatically. Cut-off is indicated by illumination of the AC GEN on the AEKRAN. When the AC GEN does not illuminate, proceed as follows:

1. Damper / AFCS modes .... OFF (press > 3 sec)
   or AFCS sw .... OFF
2. GEN DRIVE EMERG OFF .... Hold for max 25 sec
3. PTO .... Check ON
4. Land .... ASAP

SERVICES LOST CHART AC GENERATOR FAILURE / DRIVE FAILURE	
Flight Instruments: - HUD / HDD **Weapons:** - RADAR - Fire Control System - MSL firing / release - IRSTS / LRF - Weapon Control System - Flare - Helmet Mounted Sight	**Airframe:** - Aileron trim - Stab trim - LH AOA probe heater - AFCS **Navigation:** - MAIN / STBY GYRO heater elements **Communications:** - IFF altitude encoder

AC TRANSFORMER FAILURE

Control and Test Panel: TRANSFM FAIL

SERVICES LOST CHART AC TRANSFORMER FAILURE
Weapons: - HUD - LRF

GEARBOX MALFUNCTIONS

GEARBOX FAILURE / VIBRATION

OIL GBX

VIWAS No.: 10, 14

OIL PRESS ACCRY GBX

and / or

ACFT ACCRY GBX VIBR

A complete GBX malfunction results in total loss of both hydraulic systems and subsequent loss of aircraft control. Therefore, in the event of a GBX failure during any flight phase, be prepared for immediate ejection. For this reason also, if the GBX fails during takeoff roll, abort.

On the ground

1. Throttles .... OFF

During takeoff or during flight

If decision to stop is made:

1. Abort .... Refer to ABORT checklist
2. Throttles .... OFF

If takeoff is continued and during flight:

1. Gear / flaps .... Do not retract
2. RPM .... Reduce if practical
3. Hydraulic pressure .... Check and moitor

If hydraulic pressure is in limits:

4. Land .... ASAP
5. Throttles after landing OFF

When hydraulic pressure depletes completely:

4. Throttles .... OFF
5. Eject

GEARBOX FIRE

GBX FIRE

VIWAS No.: 3

On the ground / taxi

1. Throttles .... OFF
2. Fuel shut off valves ... OFF
3. Fire extinguisher GBX Activate
4. Continue with the EMERGENCY GROUND EGRESS checklist

During takeoff

If decision to stop is made:

1. Abort .... Refer to ABORT checklist
2. Throttles .... OFF
3. Fuel shut off valves ... OFF
4. Fire extinguisher GBX Activate
5. Continue with the EMERGENCY GROUND EGRESS checklist

If takeoff is continued:

1. Throttles .... MIL

When safe airborne:

2. Gear / flaps .... Do not retract
3. Fire extinguisher GBX Activate

If fire is extinguished:

4. Hydraulic pressure .... Check
5. AEKRAN .... Check
6. Land .... ASAP

If fire is confirmed:

4. Throttles .... OFF
5. Eject

During flight

1. AB .... OFF
2. AFCS modes .... OFF (press < 3 sec)
3. Fire extinguisher GBX Activate

If fire is extinguished

4. Hydraulic pressure .... Check
5. AEKRAN .... Check
6. Land .... ASAP

If fire is confirmed:

4. Throttles .... OFF
5. Eject

Intentionally left blank

HYDRAULIC SYSTEM FAILURES

BOTH HYDRAULIC SYSTEM FAILURE

DOUBLE HYD SYS	EMERG HYD PUMP ON

VIWAS No.: 17, 18

BOOST HYD SYS
MAIN HYD SYS

When the main hydraulic system and the boost system fail, all flight control functions are lost unless the emergency hydraulic pump is operating. The emergency hydraulic pump is automatically activated when hydraulic pressure drops below 100 kp/cm^2 in both systems or when switched on manually. Even at engine speeds above 85 % RPM only severely degraded aircraft controllability is available.

If time and conditions permit, proceed to a bailout area and perform a controlled ejection.

1. Damper/AFCS modes OFF (press > 3 sec)
   or AFCS sw .... OFF
2. Emerg hydr pump ...... Recheck ON

If one hydraulic system is regained:

3. Throttles .... Above 85 % RPM
4. Prepare controlled ejection

When hydraulic pressures deplete completely:

3. Throttles .... OFF
4. Eject

MAIN HYDRAULIC SYSTEM FAILURE

VIWAS No.: 18

MAIN HYD SYS

If the main hydraulic system fails, all hydraulically operated systems will be lost except the ailerons, the rudders, the tailerons and the pitch kicker.

1. Damper/AFCS modes OFF (press > 3 sec)
   or AFCS sw .... OFF
2. Ramp .... Emerg retraction according to RAMP CONTROL FAILURE checklist
3. Gear .... Continue with the EMERGENCY GEAR EXTENTION checklist
4. Land .... ASAP
5. Perform a no flap landing according the LDG WITH FLAP/LEF SYSTEM FAILURE checklist

HYDRAULIC BOOST SYSTEM FAILURE

VIWAS No.: 17

BOOST HYD SYS

To prevent excessive strain on the double actuating hydraulic cylinders and the main hydraulic system, do not use speedbrakes, flaps and normal gear extension.

1. Damper/AFCS modes OFF (press > 3 sec)
   or AFCS sw .... OFF
2. Airspeed .... Not above 320 KIAS
3. Speedbrakes .... Do not use
4. Gear .... Continue with the EMERGENCY GEAR EXTENTION checklist
5. Land .... ASAP
6. Perform a no flap landing according to the LDG WITH FLAP/LEF SYSTEM FAILURE checklist

SERVICES LOST CHART
HYDRAULIC SYSTEM FAILURES

Systems affected:	Systems lost:
- Aileron	- Ramps
- Rudder	- Speedbrakes
- Taileron	- NWS
- Flaps / LEF	- Normal gear extension
- Pitch kicker	- APU doors
	- Artificial feel rudder

FLIGHT CONTROL MALFUNCTIONS

FEEL CONTROL UNIT FAILURE

VIWAS No.: 46 FEEL CONT UNIT

Stick forces easy

Stick forces easier than normal required for pitch control indicate a feel control unit failure in/or near the takeoff/landing position. Since the feel control unit remains in the TO/LD position at airspeeds up to 215 KIAS and altitudes below 3 000 ft MSL, normal control stick feeling is regained for landing if FEEL UNIT EMERG switch is positioned to EASY and FEEL UNIT TO/LD light illuminates on the TLP.

1. Pull up to reduce airspeed below 270 KIAS
2. Stick movement .... Minimize (PIO's!)
3. Damper / AFCS modes OFF (press > 3 sec)
4. Feel unit emerg sw ... EASY
5. Feel unit TO / LD light Check on
6. Land .... As soon as practical

Stick forces heavy

Stick forces heavier than normal required for pitch control indicate a feel control unit failure in the retracted position, equivalent to a stick feel force at airspeeds of 470 to 670 KIAS. Following the stick forces heavy procedure should result in normal stick forces for landing.

1. Damper / AFCS modes OFF (press > 3 sec)
2. Airspeed .... Below 270 KIAS
3. Feel unit emerg sw ... EASY
4. Feel unit TO / LD light Check on
5. Land .... As soon as practical

NOTE

If feel unit TO/LD light stays off, fly a shallow approach and add 25 kts to the computed approach speed.

COC FAILURE

COC FAIL

A complete COC failure is indicated on the TLP, when both AOA limiter channels of the AOA/G computer have failed. Automatic LEF operation is disabled.

A partial COC failure is indicated by a NO COC RESERVE light on the right console.

1. Land .... As soon as practical

CAUTION

With a complete COC malfunction, pitch kicker warning is not available. Extreme care should be used when operating near the allowable AOA limit.

COC ACTUATOR FAILURE

COC 3 STOP

A COC actuator failure is indicated by pitch down force on the control stick below M 0.45. After gear extension, the AEKRAN signal is displayed. Pitch down feel force cannot be trimmed away. During deceleration, the pitch down force increases up to 17 kp.

1. Trim .... Fully aft
2. Stick forward forces .. Override during approach and landing
3. After touchdown .... Stick maintain aft

To prevent a hard nosewheel touchdown, maintain stick aft after landing.

TRIM FAILURE

A runaway trim condition exists, when stick forces cannot be alleviated by trim. To reduce stickforces required for aircraft control, fly 320 to 375 KIAS, at or below M 0.8 with a nose-down out of trim condition, and approximately 270 KIAS with a nose-up out of trim condition. Stick forces increase with decreasing airspeed. Therefore, transient forces may require to fly the aircraft with both hands during landing approach.

1. AFCS modes .... OFF (press < 3 sec)
2. Airspeed .... Adjust as required
3. Land .... As soon as practical

AVIONIC SYSTEM FAILURES

AUTOPILOT (AFCS) FAILURE

AFCS failures can be differentiated as trim motor or damper failures, automatic pitch control system failure and AFCS computer failure.

Failures in the damper system may cause pitch changes up to 2 g, roll rates up to 60° per sec or up to 3° yaw. Feedback errors may cause aircraft oscillations. Interference with the trim motors causes slow down of aircraft reaction to control inputs.

A failure of the automatic pitch control system can cause pitch changes up to 2° AOA and 2 g.

An AFCS computer failure can cause a drift in aircraft attitude, sudden bank changes or pitch changes up to 5 g.

To counteract the malfunction, apply the following procedure

If aircraft oscillates or rotates around any axis:

1. Stick movement .... Minimize (PIO's!)
2. Damper / AFCS modes OFF (press > 3 sec) or AFCS sw .... OFF

When aircraft stops to oscillate or rotate:

3. Stick forces .... Trim away
4. Land .... As soon as practical

AIR DATA SYSTEM FAILURE

VIWAS No.: 30

AIR DATA SYS

1. AFCS modes .... OFF (press < 3 sec)
2. Airspeed .... Below 320 KIAS
3. Land .... As soon as practical

CAUTION

With air data system failure, the pressure altimeter and TAS indicator must not be used. The following methods may be used for altitude estimation:

Below 3 000 ft AGL - Use radar altimeter

3 000 - 6 500 ft - Use cabin pressure altimeter

Above 6 5000 ft - Double the cabin pressure indication

MAIN OR STBY GYRO FAILURE

MAIN DIR VERT GYRO

STBY DIR VERT GYRO

A gyro system failure is additionally indicated by appearance of the HSI OFF-flag and illumination of the gyro fail light on the ADI. The fail indications always indicate a failure of the selected gyro system. The failure results in false attitude and heading indications on ADI, HSI and HUD/HDD.

1. AFCS modes .... OFF (press < 3 sec)

If MAIN gyro unreliable:

2. Gyro mode sw .... STBY gyro
3. Gyro cage button .... Check light out

If STBY gyro unreliable:

2. Gyro mode sw .... MAIN gyro
3. Gyro cage button .... Check light out
4. Artificial horizon .... Check correct indic
5. HSI .... OFF-flag away
6. HSI / STBY comp hdg Compare

If in IMC:

7.Land .... ASAP

If in VMC:

7. Land .... As soon as practical

If gyro still unreliable:

7. Gyro mode sw .... MAIN gyro
8. Maintain straight and level unaccelerated flight
9. Gyro cage button .... Press
10. Maintain straight and level unaccelerated flight for 90 sec until AEKRAN light is out
11. Mag hdg slave button Press 10 - 15 sec
12. Nav system sw .... Manual
13. Nav channels .... Set as required
14. Gyro cage button .... Check light out
15. HSI .... OFF-flag away
16. HSI/STBY comp hdg .. Compare
17. Artificial horizon .... Check correct indic

If unsuccessful:

18. Follow above procedure with gyro mode sw in STBY gyro

If still unsuccessful:

19. Land .... ASAP

BOTH GYRO FAILURE

TWO DIR VERT GYRO

1. Gyro switches .... Recheck ON
2. AFCS modes .... OFF (press < 3 sec)
3. Follow the MAIN OR STBY GYRO FAILURE checklist from step 2. to 19. as required

NAVIGATION SYSTEM FAILURE

HSI RNG and BRG unreliable

1. Channels sw .... Manual
2. Nav channels .... Set as required
3. HSI .... OFF-flag away
4. HSI/STBY comp hdg .. Compare

APPROACH AND LANDING EMERG

An emergency landing pattern will be flown when engine thrust is available and an emergency exists or there is a malfunction which could result in an emergency.

The primary objective of the pattern is to land the aircraft safely in the first attempt with the least amount of risk. Because of the many variables involved, such as type of emergency, position, and altitude in relation to the field, gross weight, fuel remaining, weather, populated areas, runway length, availability of arresting gear, etc., a standard pattern cannot be prescribed.

Depending on the circumstances it might be desirable to utilize GCA, make a straight-in approach, enter the pattern from downwind or baseleg, or make a 360° overhead pattern. Because of the various circumstances, the AC's evaluation of all factors and his judgment will determine the type of landing pattern to be flown.

However, there are some general guidelines which are applicable regardless of approach selected. Reduce gross weight to minimum practical. Prior to establishing the landing configuration, maintain minimum maneuvering airspeed. The pattern should be planned to avoid abrupt, steep or hard turns and large or abrupt power changes especially with a flight control malfunction or a hydraulic system failure. Circumstances permitting, a long straight-in final should be planned and the landing configuration established when on final.

If the pattern must be entered on downwind, base or from an overhead pattern, the pattern should be expanded, the landing configuration established prior to final, and roll-out on final should be at least 2 to 3 NM out. A normal 2 to 3° glideslope should be flown. For most emergencies, final approach airspeeds are increased and AOA decreased to provide adequate aircraft handling characteristics.

SINGLE ENGINE APPROACH AND LANDING

During landing approach with single engine, fly a normal final and landing. Correct for yaw with rudder as required.

1. Gear .... Extend
2. Flaps/LEF .... Down and out
3. Airspeed .... Maintain 175 KIAS during final approach

NOTE

20 kts max crosswind are allowed from the bad engine side.

LDG WITH FLAP / LEF SYSTEM FAILURES

A no flap landing has to be performed, if a split-flap condition exists during flap lowering, flaps fail to extend, or if type of emergency dictates. Extend final approach. Add 10 kts to normal final speed. Fly a shallower than normal final. Delay power reduction until overflying RWY threshold.

1. Aircraft weight .... Reduce to min pract
2. Gear .... Extend

NOTE

Add 10 kts to the normal approach speed.

LANDING WITH ONE FULL WING DROP TANK

The effects of the weight asymmetry become rather pronounced during approach and landing. As speed decreases, an increasing amount of aileron and rudder away from the heavy tank is required to maintain straight and level flight. Trim authority is, however, sufficient to trim away control forces during the appraoch. AOA during approach should not exceed 10°. Considerable rudder and aileron deflections are required during the landing flare.

1. Wind conditions at airfield .... Consider
2. If feasible, plan approach so as to avoid significant crosswinds from the side of the empty tank

CAUTION

- If crosswinds are present, the approach direction should be chosen so as to avoid crosswinds in excess of 10 kts from the side of the empty tank.
- If landing conditions are critical, consider jettisoning of the wing drop tanks.

LANDING WITH A KNOWN BLOWN TIRE

A blown tire can be recognized by severe vibrations and/or yaw movement and wing dip to the side of the blown tire. After landing, shut-down engines if necessary.

1. Aircraft weight .... Reduce to min pract
2. Nose wheel brake ...... OFF
3. Gear .... Extend
4. Flaps/LEF .... Down and out
5. Drag chute.................. Deploy aft touchdown
6. Directional control ...... Maintain with differential braking and NWS

NOTE

- In case of extreme directional control problems, consider flaps/LEF retraction after touch-down. This engages the high mode of the NWS to improve directional control.
- In case of a blown tire during touch and go, do not change aircraft configuration.

NWS FAILURE AFTER LANDING

1. MRK emerg sw .... OFF
2. Directional control ...... Maintain with differential braking

WHEELBRAKE FAILURE

If the normal brake system fails, the emergency brake is used, considering that the anti-skid system is inoperative and NWS is not available. Differential braking is not possible.

1. Emerg brake handle .. Pull
2. Prepare for Barrier Engagement according to the BARRIER ENGAGEMENT checklist

BARRIER ENGAGEMENT

For barrier engagement, a touchdown point should be selected, based on enviromental factors such as barrier location, runway condition, crosswind, nature of emergency and anticipated difficulty in high speed directional control. Consideration should also be given to the barrier limit and the aircraft configuration. See field arrestment gear data chart below.

Utilize nose gear steering and/or brakes to engage barrier at 90° angle on the RWY centerline. If feasible, retard the throttles to OFF prior engagement.

1. Throttles .... OFF
2. ENG SYS .... OFF
3. Periscope (GT) .... Retract prior barrier engagement
4. Shoulder harness ...... Recheck locked

A / C Weight (kg)	MAX BARRIER ENGAGEMENT GND SPEED (kts)					
	MK-3 AAE	MK-4 BEFAB	MK-6 150 ps	MK-12 A/B	BEFA 24:2	Rollbar
14 000	165	145	90	115	145	165
14 200	165	145	90	115	145	165
15 700	-	135	85	110	140	155
17 000	-	135	80	105	135	-

A / C Weight (kg)	MAX BARRIER ENGAGEMENT GND SPEED (kts)					
	F-30	F-40 B 26	F-40 B 28	ATU -G/1A	SAFELAND 6:3F A	SAFELAND 12:3F
14 000	130	160	170	180	100	130
14 200	130	160	170	180	-	130
15 700	130	160	170	180	-	120
17 000	130	160	170	180	-	115

LANDING GEAR EMERGENCIES

LDG GEAR INDICATOR SYSTEM FAILURE

VIWAS No.:44 — L GEAR INDIC

One, two or three green gear down indications do not illuminate. The red light for intermediate/unsafe gear position is off.

1. Indicator lights .... Press to test

Turn lights to full bright and press LAMP TEST button to check light bulbs.

2. Hydraulic pressure ..... Check

NOTE

If main hydraulic pressure is within limits, let another aircraft or tower check the ldg gear down and locked.

If gear down configuration is confirmed:

3. Land .... As soon as practical

LDG GEAR RETRACTION FAILURE

Climb to a safe altitude while maintaining airspeed below gear lowering limit.

1. Gear .... Extend
2. Ldg gear indicator ...... Check three greens
3. Land .... As soon as practical

LDG GEAR UNSAFE OR FAILS TO EXTEND

NOTE

In case of an all gear up or unsafe configuration follow the main gear unsafe or fails to extend procedure first.

Main gear unsafe or fails to extend

Main gear extension failure is indicated by a flashing or steady gear unsafe indication and failure of one or both main gear down light to illuminate.

If main hydraulic system pressure is within limits, cycle gear two or three times at airspeeds below 370 KIAS (GT: 320 KIAS) allowing minimum 15 sec in the EXTENDED position. If main gear still fails to extend, heavily rock the wings with the landing gear handle down. If the main gear is still unsafe, retract all gear.

Refer to emergency gear extension for nose gear emergency lowering only. After nose gear is down and locked, refer to LANDING GEAR EMERGENCY CHART for landing.

1. Hydraulic pressure .... Check
2. Gear .... Cycle
3. Various g-loads and roll rates .... Apply

If main gear remains up or unsafe:

4. Gear .... Retract
5. Nose gear .... Emerg extension, refer to EMERGENCY GEAR EXTENTION checklist
6. Recommended action with final gear configuration, refer to LANDING GEAR EMERGENCY CHART

Nose gear unsafe or fails to extend

Nose gear extension failure is indicated by a flashing or steady gear unsafe indication and failure of the nose gear down light to illuminate.

If main hydraulic system pressure is within limits, cycle gear two to three times at airspeeds below 370 KIAS (GT: 320 KIAS) allowing minimum 15 sec in the EXTENDED position.

If the nose gear still fails to extend, refer to ermergency gear lowering.

In case the nose gear is down but not locked, apply various g-loads.

If nose gear still fails to extend, refer to LANDING GEAR EMERGENCY CHART for landing.

1. Hydraulic pressure .... Check
2. Gear .... Cycle
3. Various g-loads .... Apply

If nose gear remains up or unsafe:

4. Nose gear .... Emerg extension, refer to EMERGENCY GEAR EXTENTION checklist

If nose gear remains still up or unsafe:

5. Various g-loads .... Apply
6. Recommended action with final gear configuration, refer to LANDING GEAR EMERGENCY CHART

EMERGENCY GEAR EXTENSION

1. Airspeed .... Below 270 KIAS

For nose gear extension:

2. Emerg gear handle .... Pull
3. Nose gear .... Check extended

For main gear extension:

WARNING

An emergency gear extension of the main gear may result in a configuration with one main gear unsafe, making an ejection unavoidable. See LANDING GEAR EMERGENCY CHART.

4. Emerg gear handle .... Turn right and pull
5. Main gear .... Check extended

LANDING GEAR EMERGENCY CHART

FINAL GEAR CONFIGURATION	RECOMMENDED ACTIONS
1. UP (nose) UP UP (main)	- External load jettison - A/ C weight reduce to min pract. - Land on a foamed rwy **After touchdown:** - Deploy drag chute - Throttles OFF - Bat GND supply OFF - Emergency ground egress
2. UP (nose) DOWN DOWN (main)	- External load jettison - A/ C weight reduce to min pract. **After touchdown:** - Stick full aft - Deploy drag chute after nose has been lowered - Throttles OFF - Bat GND supply OFF
3. DOWN (nose) UP UP (main)	- External load jettison - A/ C weight reduce to min pract. - Land on a grass or foamed rwy - Deploy drag chute at touchdown **After touchdown:** - Throttles OFF - Bat GND supply OFF
4. DOWN (nose) DOWN UP (main)	Try to achieve all gear up - configuration otherwise EJECT
5. UP (nose) DOWN UP (main)	Try to achieve all gear up - configuration otherwise EJECT

MISCELLANEOUS EMERG PROCEDURES

OXYGEN SYSTEM FAILURE

EMERG OXYGEN RESERVE

If the oxygen supply system fails or depletes, or symptoms of hypoxia are noted, activate the emergency oxygen system. Perform an emergency descent below 10 000 ft MSL. When reaching an altitude below 10 000 ft MSL and an airspeed below 380 KIAS, remove the oxygen mask.

1. Red mushroom .... Pull
2. Emerg descent .... Below 10 000 ft
3. Airspeed .... Below 380 KIAS
4. Land .... ASAP

RAPID DECOMPRESSION ABOVE 40 000 FT

Rapid decompression is accompanied by canopy fogging and overpressurization in the pressure suit.

1. Emerg descent .... Below 25 000 ft
2. Air conditioning .... Full forward (OPEN)
3. Oxygen system .... Check

If oxygen contents is below 15 %:

4. Descent .... Below 10 000 ft
5. Land .... ASAP

AIR CONDITIONING SYSTEM FAILURE

WARNING

Extreme cockpit temperatures due to equipment malfunction may result in pilot disablement and permanent injury.

Try to solve the problem by bumping the spring loaded temperature switch to the desired HOT or COLD position. Allow the system to regain a comfortable cockpit temperature. When unsuccessful, repeat the procedure.

Start a descend while increasing RPM to reach warmer altitude layers if the temperature remains cold.

Abort the mission and land if cockpit temperatures remain extreme.

1. Cabin temp sw............ Adjust temperature

If cockpit temp remains high:
2. Descent .... Below 20 000 ft
3. Air conditioning .... Full back (CLOSED)

If cockpit temp remains still high:
4. Airspeed .... Reduce as required
5. Cabin .... EMERGENCY DECOMPRESSION
6. Canopy .... Jettison

LOST CANOPY

1. Airspeed..................... Below 250 KIAS
2. Ejection seat .... To lowest position
3. Land .... ASAP

PNEUMATIC SYSTEM FAILURE

1. Emerg descent .... Below 25 000 ft
2. Emerg pneumatic sys Check
3. Land .... ASAP
4. Emerg brake handle .. Pull after touchdown

SERVICES LOST CHART PNEUMATIC SYSTEM FAILURE
Systems lost: - Normal brakes - Anti-skid - Canopy operation - Cabin pressure - RDR pressurization - Fuel shut off valves

MAIN PITOT BOOM FAILURE

A main pitot boom failure can be recognized by erroneous airspeed/mach indications, false VVI and altimeter readings. Further symptoms can be malfunctions of ramp schedule, ECU, feel control unit, AFCS and navigation system.

To regain normal performance, proceed as follows:

1. Pitot heat .... Recheck ON
2. Pitot boom sw .... EMERGENCY
3. Pitot boom sw .... MAIN after 2 - 3 min
4. Airspeed .... Check

If failure persists in both modes:
5. Damper / AFCS modes OFF (press > 3 sec) or AFCS sw .... OFF
6. AB .... OFF
7. Airspeed .... Subsonic
8. Ramp .... Emerg retraction
9. Feel unit ermerg sw .. EASY
10. Feel unit TO / LD light Check on
11. Land .... As soon as practical

CAUTION

With pitot boom failure in both modes the pressure altimeter / speed indicators / VVI are not usable. The following methods may be used for:

Altitude estimation:
Below 3 000 ft AGL - Use radar altimeter
3 000 - 6 500 ft - Use cabin pressure altimeter
Above 6 500 ft - Double the cabin pressure indication

Airspeed estimation:
- RPM and AOA

Vertical velocity estimation:
- Flight Director

CABIN ICING

1. Cabin air lever .... Full forward (OPEN)
2. Cabin pressure .... Check
3. Air lever .... OPEN
4. Cabin temp sw .... HOT

Bump temperature sw to HOT, if required repeat several times.

If icing is disappeared:
5. Cabin temp sw .... AUTO

If icing is not disappeared:
6. RPM .... Increase
7. Airspeed .... Monitor

SMOKE OR FUMES IN COCKPIT

WARNING

All unidentified odors shall be considered toxic. Smoke and fumes in the cockpit may be the first indication of a serious fire. Be alert for a rapid deterioration in the situation and catastrophic failures of aircraft systems. Maintain safe ejection altitude until the situation is under control.

To eliminate smoke and fumes from the cockpit proceed as follows:

1. Oxygen .... 100 %
2. Cabin air lever .... Closed
3. Emerg descent .... Below 25 000 ft MSL

If smoke or fumes persist:

4. Land .... ASAP
5. Cabin .... EMERGENCY DECOMPRESSION

If smoke or fumes still persist:

6. Canopy .... Jettison, (consider E-38)

CAUTION

In case of an electrical fire, locate and shut-down the effected system, if possible.

WARNING

Be prepared for immediate ejection when the canopy is jettisoned. The wind blast and draft after the canopy is jettisioned may cause fumes or smoldering material to ignite with catastrophic and incapacitating effect.

MOISTURE IN COCKPIT

1. Cabin temp sw .... HOT
2. Cabin temp sw .... Neutral

Bump cabin temp switch to HOT momentarily, if required, repeat several times.
If moisture persists:

3. Repeat steps 1. and 2.
4. Cabin temp sw .... AUTO

CONTROLLABILITY CHECK

During any inflight emergency when structural damage or any other failure is known or suspected that may have an adverse affect on aircraft handling characteristics, a controllability check should be performed as follows:

1. Altitude .... Min 5 000 ft AGL
2. Aircraft weight .... Reduce to min pract
3. Flaps / LEF .... Down and out
4. Gear .... Extend
5. Aircraft .... Decelerate to determine safe appr and ldg speed

Slow aircraft to determine the airspeed, that produces acceptable approach and landing handling characteristics. Additionally check for adequate roll capability.

NOTE

Do not exceed 15 AOA.
Do not fly slower than 175 KIAS.

OUT OF CONTROL / SPIN PREVENTION

If an out of control condition is experienced without sufficient altitude to effect recovery, eject. The out of control / spin prevention procedure will recover the aircraft from nearly all out of control conditions including spins with a non specific spin rotation. A non specific spin rotation is characterized by irregular oscillation around the longitudinal and the horizontal axis with the aircraft swaying around the vertical axis.

Unless at low altitude, retard the throttle to IDLE to prevent engine flame out. If both engines flame out, relight at least one engine to preclude loss of hydraulic pressure.

When reaching 215 KIAS initiate a normal dive recovery with maximum allowable AOA. Use the following procedure at the first indication of departure from controlled flight:

1. **Controls .... Neutral**
2. **Throttles .... IDLE**
3. AFCS modes .... OFF (press < 3 sec)

WARNING

If the aircraft is still out of control, passing 7 000 ft AGL, eject.

SPIN RECOVERY / DEVELOPED SPIN

A developed spin is characterized by a rotation around the vertical axis. Yaw rates, bank and pitch oscillations are unpredictable since the severity and magnitude of the oscillations depend upon the entry conditions and the aircraft loading. Visual cues outside the cockpit and the turn needle should be used to verify a spin condition and spin direction. The following procedures will effectively recover the aircraft from most types of spin.

1. Throttles .... IDLE
2. Damper / AFCS modes OFF (press > 3 sec)
3. Stick .... Full aft
4. Ailerons .... Neutral
5. Rudders .... Full with spin (turn needle)

After 2 - 3 seconds:
6. Rudders .... Full opposite spin
7. Stick .... Neutral

When rotation stops:
8. Controls .... Neutral

After recovery:
9. Damper .... Engage

WARNING

- Above procedure will not be effective to recover from a flat spin.
- If not recovered when passing 7 000 ft AGL, eject.

SPIN RECOVERY / FLAT SPIN

Although a flat spin is rather unlikely to occur, especially if no pro-spin inputs are applied, the following method can be used to recover:

1. Throttles .... IDLE
2. Damper / AFCS modes OFF (press > 3 sec)
3. Stick .... Full aft
4. Ailerons .... Neutral
5. Rudders .... Full with spin (turn needle)

After 2 - 3 seconds:
6. Rudders .... Full opposite spin
7. Aileron .... Full with spin

When spin rotation slows down, or the nose is dropping further down:
8. Stick .... Forward (aileron maintain full with spin)

When rotation stops:
9. Controls .... Neutral

After recovery:
10. Damper .... Engage

WARNING

- If the aircraft is still in a spin, passing 7 000 ft AGL, eject.
- Engaging any AFCS mode (except damper) may give pro-spin inputs.
- In no case use aileron inputs opposite spin direction.
- When using the normal spin recovery procedure, transition to inverted spin is possible.

CAPTION INDEX G/GT

	Red	Green	
E-19	GBX FIRE		
E-4, 5	LH ENG FIRE	RH ENG FIRE	E-4, 5
E-9, 10 E-12, 14	REDUCE RPM LH ENG	REDUCE RPM RH ENG	E-9, 10 E-12, 14
E-9, 11	OIL PRESS LEFT	OIL PRESS RIGHT	E-11
E-18	OIL GBX	550 KG REMAIN	-/-
E-21	DOUBLE HYD SYS	COC FAIL	E-24
-/-	ARMED	DAMPER OFF	-/-
E-10	LH ENG START	RH ENG START	E-10
-/-	LH ENG AB	RH ENG AB	-/-
-/-	RUD TRIM NEUTRAL	STAB TRIM NEUTRAL	-/-
-/-	AIL TRIM NEUTRAL	FEEL UNIT TO / LD	-/-
-/-	MARKER BEACON	EMERG HYD PUMP ON	E-21
		MODE 4	-/-
		RADAR READY	-/-

AFTER MODIFICATION WITH WING DROP TANKS

-/-	WDT NO PRESS	WDT TEST	-/-

ADDITIONAL CAPTION INDEX GT REAR COCKPIT

-/-	ATT HOLD	AUTO RECOVER	-/-
-/-	ALT HOLD	APPROACH	-/-
-/-	SET COURSE MAN	MISSED APPROACH	-/-

Figure 3-4

VIWAS REPORTS AND ADVICES

No.	REPORT	ADVICE
1	LEFT ENGINE FIRE	E-4
2	RIGHT ENGINE FIRE	E-4
3	GEARBOX FIRE	E-19
4	550 KILOS REMAINING	AB OFF
5	NO FUEL BOOST	AB OFF, E-14
6	OVERHEAT LEFT	REDUCE RPM, E-10
7	OVERHEAT RIGHT	REDUCE RPM, E-10
8	OVERSPEED LEFT	REDUCE RPM, E-12
9	OVERSPEED RIGHT	REDUCE RPM, E-12
10	GEARBOX VIBRATION	E-18
11	ALTITUDE, ALTITUDE	-
12	LOW OIL PRESSURE LEFT	REDUCE RPM, E-11
13	LOW OIL PRESSURE RIGHT	REDUCE RPM, E-11
14	OIL PRESSURE GEARBOX LOW	E-18
15	HIGH OIL TEMPERATURE LEFT	REDUCE RPM, E-11
16	HIGH OIL TEMPERATURE RIGHT	REDUCE RPM, E-11
17	BOOST HYDRAULIC SYSTEM FAILURE	E-22, EMERGENCY GEAR EXTENSION BELOW 270
18	MAIN HYDRAULIC SYSTEM FAILURE	E-22, EMERGENCY GEAR EXTENSION BELOW 270
19	VIBRATION LEFT	REDUCE RPM, E-9
20	VIBRATION RIGHT	REDUCE RPM, E-9
21	DC GENERATOR FAILURE	WATCH TIME REMAINING, E-16
22	IFF FAILURE	-
23	SWITCH IFF MODE	-
24	LAUNCH, LAUNCH	-
25	UPPER INLET OPEN	AIRSPEED BELOW .8 MACH, E-13

Figure 3-5 (Sheet 1 of 2)

VIWAS REPORTS AND ADVICES

No.	REPORT	ADVICE
26	AIR INTAKE FAILURE LEFT	E-13, RETRACT RAMPS
27	AIR INTAKE FAILURE RIGHT	E-13, RETRACT RAMPS
28	ENGINE LEFT IN STANDBY SYSTEM	RPM AND EGT MONITOR, E-12
29	ENGINE RIGHT IN STANDBY SYSTEM	RPM AND EGT MONITOR, E-12
30	AIR DATA SYSTEM FAILURE	AIRSPEED BELOW 320, E-26
31	CHIPS LEFT ENGINE	REDUCE RPM, E-9
32	CHIPS RIGHT ENGINE	REDUCE RPM, E-9
33	FUEL PRESSURE LEFT HIGH	REDUCE RPM, E-14
34	FUEL PRESSURE RIGHT HIGH	REDUCE RPM, E-14
35	CHECK FUEL AMOUNT	SWITCH TO "TOP"
36	NO EQUIPMENT COOLING	REDUCE AIRSPEED
37	CHECK GEAR	-
38	WING DROP TANKS TRANSFER FAILURE	-
39	SKIN OVERTEMPERATURE	REDUCE AIRSPEED
40	-	-
41	CANOPY, CANOPY	-
42	CENTERLINE TRANSFER FAILURE	SWITCH TO "TOP"
43	OXYGEN SWITCH 100%	-
44	CHECK AEKRAN	-
45	AEKRAN FAILURE	-
46	FEEL CONTROL UNIT FAILURE	AIRSPEED BELOW 270, E-23
47	OXYGEN LOW	-
48	BINGO, BINGO	-

Figure 3-5 (Sheet 2 of 2)

AEKRAN SIGNALS

AC GEN	E-15, 17
ACFT ACCRY GBX VIBR	E-18
AIR DATA SYS	E-26
ALT ALERT	-
BOOST HYD SYS	E-21, 22
CABIN LIMIT PRESS DESCEND	-
CHECK FUEL AMOUNT	-
CHIP RIGHT / LEFT	E-9
COC 3 STOP	E-24
DC GEN WATCH TIME	E-15
DISCON GEN DRIVE	E-17
DROP TANK NO USAGE	-
EMERG OXYGEN RESERVE	E-37
EXTEND LANDING GEAR (IN AIR)	-
EXTEND FLAPS	-
FEEL CONT UNIT	E-23
FEEL UNIT SET EASY	-
FUEL RETURN	-
FUEL PRESS RIGHT / LEFT	E-14
GUN	-
HELMET MOUNTED SIGHT	-
IR SEEKER	-
L GEAR INDIC (ON GROUND)	E-33
LEAD EDGES NOT EXTEND	-
LEFT AIR INTK	E-13
LEFT ENG STBY SYS	E-12
LEFT OVER SPEED	E-12
LOCK CANOPY	-
MAIN DIR VERT GYRO	E-27
MAIN HYD SYS	E-21, 22
NAVIG COMPUTER	-
NO BOOST	E-14
NO COOLING 1)	-
OIL PRESS ACCRY GBX	E-18
OIL PRESSURE RIGHT / LEFT	E-11
OIL TEMP RIGHT / LEFT	E-11
OPT SIGHT NAV SYST	-
OVERHEAT RIGHT / LEFT	E-10, 12
RADAR	-
RADAR NOT READY	-
RECORD	-
RIGHT AIR INTK	E-13
RIGHT ENG STBY SYS	E-12
RIGHT OVER SPEED	E-12
START TURB CRIT CONDITNS	-
STBY DIR VERT GYRO	E-27
SKIN OVERHEAT 1)	-
TWO DIR VERT GYRO	E-28
TWO GENER WATCH TIME	E-15
UPPER INLET	E-1
USE OXY	-
VIBR RIGHT / LEFT	E-9
WEAPON CONT SYS (WCS)	-

1) Reduce airspeed if feasible

Figure 3-6

Interntionally left blank

SECTION 4

CREW DUTIES

TABLE OF CONTENTS

	Page
GENERAL	
General Aircrew Responsibilities	4-3
Aircraft Commander	4-3
Pilot in Control of the Aircraft	4-3
Pilot not in Control of the Aircraft	4-3
SIMULATION PANELS	
AFCS Failure Simulation Panel	4-3
Navigation Failure Simulation Panel	4-6
Radar Simulation Panel	4-7
Radar Simulation Modes	4-9
R/C Navigation System Control Panel	4-11
R/C Telelight Panel	4-12
Periscope System	4-12
Damper Pushbutton	4-13
Panel Priority Changeover	4-13

GENERAL

This section covers the requirements for crew duties which are characteristic for the MIG-29GT trainer version. It includes the general aircrew responsibilities and the simulation equipment for training purpose.

GENERAL AIRCREW RESPONSIBILITIES

Both crewmembers are responsible for safe aircraft operation. Each crewmember should have a thorough knowledge of aircraft systems, normal and emergency procedures, operating limitations, and aircraft flight characteristics.

AIRCRAFT COMMANDER

The primary responsibility of the aircraft commander is to ensure mission accomplishment within safe limits. Specific responsibilities of the aircraft commander are:

- Conduct adequate integral aircrew briefings to ensure definite division of responsibility during flight.
- Accomplish normal and emergency procedures as outlined in this flight manual and flight crew checklist.

PILOT IN CONTROL OF THE AIRCRAFT

The pilot actually in control of the aircraft is responsible for flying the aircraft and operating auxiliary equipment under his control in accordance with this flight manual.

PILOT NOT IN CONTROL OF THE AIRCRAFT

The pilot not in control of the aircraft shares overall responsibility for the safe accomplishment of the mission. In addition, he is responsible for operating auxiliary equipment under his control in accordance with this flight manual. Specifically, his responsibilities are:

- Assist other crewmember in monitoring flight progress.
- Assist other crewmember in monitoring the aircraft systems and detecting system malfunctions.
- Initiate required inflight checklist items when not called for by crewmember in control of the aircraft.
- Monitor instruments during all climbs and descents and advise the other crewmember of any deviations from established flight parameters.
- Clear the flight area whenever possible.

SIMULATION PANELS

AFCS FAILURE SIMULATION PANEL

NOTE

The AFCS failure simulation panel has been disabled and therefore presently not in use.

The AFCS failure simulation panel (AFCS FSP) allows to insert system malfunctions for training purposes. Failures of the DAMPER system and the ATT HOLD mode can be simulated.
This AFCS FSP is located at the upper LH corner of the R/C instrument panel.

WARNING

- Failure simulation is prohibited when flying in IMC and during night flying.
- The IP is responsible to prevent the development of a dangerous situation when simulated failures are introduced.
- If necessary, that IP has to take over control of the aircraft and deactivate the simulated failures.

OPERATING MODES

Damper Failure

When this failure is introduced, the aircraft starts to oscillate around the axis with steady or increasing amplitudes. To introduce this failure, the aircraft must be flown in the AFCS mode DAMPER or ATT HOLD.

The damper failure simulation is selected with the failure selector rotary knob in the FEEDBACK FAIL sector. After recognition of the failure, the pilot is expected to refer to the appropriate emergency procedure in the flight crew checklist.

Runaway Trim

To introduce a runaway trim condition, the aircraft must be flown in the AFCS mode DAMPER or ATT HOLD.

Failure of the desired trim motor is selected with the failure selector rotary knob in the RUN AWAY TRIM sector.

The trim runaway direction is selected with the LEFT/RIGHT-DESC/TOSS switch.

After recognition of the failure, the pilot is expected to refer to the appropriate emergency procedure in the flight crew checklist.

Damper Actuator Failure

To introduce a damper actuator failure, the aircraft must be flown in the AFCS mode DAMPER or ATT HOLD. A damper actuator failure or an automatic pitch control system failure results in abrupt aircraft attitude changes.

NOTE

> If the aircraft is flown in the mode ATT HOLD, the trim mechanism tries to compensate the runaway condition. Failure recognition is therefore delayed.

The desired failure is selected with the failure selector rotary knob in the RUN AWAY BOOSTER sector. Failure direction is selected with the LEFT/RIGHT-DESC/TOSS switch.

After recognition of the failure, the pilot is expected to counteract aircraft movement and disengage the AFCS completely.

NOTE

> When a pitch failure is selected the AOA must be decreased below 13^{o} before the AFCS is switched off.

Gyro Signal Failure

To introduce an gyro signal failure, the aircraft must be flown in the AFCS mode ATT HOLD.

The desired failure is selected with the failure selector rotary knob in the SWITCH OFF SIGNAL sector. The type of the failed signal is selected with the switch labeled ACT/NOM.

After the failure is inserted, the aircraft attitude changes abruptly.

After recognition of the failure, the pilot is expected to switch off the ATT HOLD mode.

FAILURE TERMINATION

The simulated failures can be terminated by:

- Pressing the AFCS MODES button on the R/C control stick for less than 3 sec. The damper mode is automatically reengaged.
- Pressing the RESET button on the simulation panels. The AFCS modes that were active previously are automatically reengaged.
- Switching the failure selector rotary knob to any other position.
- Switching the LEF/RIGHT-DESC/TOSS sw to the opposite position.
- Cycling the switch labeled IS/SHALL to the opposite position.
- Switching the AFCS FSP operation sw to OFF.
- Deselecting the AFCS sw on the F/C system power panel.

CAUTION

When the simulated failure has not been terminated by the IP, the same malfunction will reappear when the AFCS modes DAMPER and ATT HOLD are selected in the F/C.

AFCS FSP

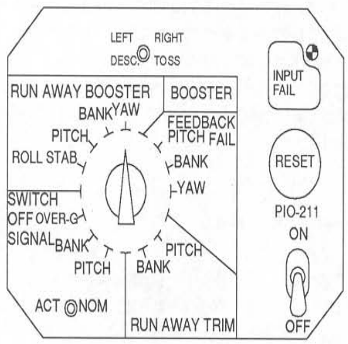


Figure 4-1

Failure Selector Rotary Knob

The failure selector rotary knob is used to select the type of failure.

LEFT/RIGHT - DESC/TOSS Switch

The switch is used to select a runaway trim direction or a damper actuator failure.

ACT/NOM Switch

The switch is used to select, which signal fails during a simulated gyro signal failure.

INPUT FAIL Button

The INPUT FAIL button is used to insert the selected failure to the appropriate system. When the button is selected, the INPUT FAIL button light illuminates.

RESET Button

The RESET button is used to terminate the failure.

AFCS FSP Switch

The AFCS FSP switch, marked PIO-211, has the positions ON and OFF.
In the ON position, power is applied to the system.

NAVIGATION FAILURE SIMULATION PANEL

NOTE

The navigation failure simulation panel has been disabled and therefore presently not in use.

The navigation failure simulation panel (NAV FSP) is located at the upper center of the R/C instrument panel. It allows implementation of failures into the NAV system. The following errors can be implemented:

- Pressure Altimeter failure
- TAS indicator failure
- ADI failure in bank or pitch
- Failure of TACAN BRG or RNG
- Course/glide slope deviation indicator failure

OPERATING MODES

Pressure Altimeter Failure

Pressing the ALT pushbutton causes the pressure altimeter and the altitude indication in the HUD/HDD to freeze. The failure can be terminated by pressing the SWS RESET or MAIN RESET pushbutton.

CAUTION

To prevent damage to the pressure altimeter, altitude difference between introduction and termination of the failure must not exceed 22 000 ft.

TAS Indicator Failure

Pressing the SPEED pushbutton causes the TAS indicator to fail to a position between 160 KTAS and 190 KTAS. The failure can be terminated by pressing SWS RESET or MAIN RESET pushbutton.

CAUTION

To prevent damage to the TAS indicator, airspeed difference between introduction and termination of the failure must not exceed 215 KTAS.

ADI Failure

Pressing the PITCH or BANK pushbutton causes the appropriate ADI indication to freeze without illumination of the gyro fail light. Proper indication can be regained by switching from MAIN to STBY gyro on the NAV system control panel. The failure can be terminated with the MAIN RESET pushbutton.

Heading Failure

Pressing the AZIMUTH pushbutton causes the HDG to freeze. Indication can be regained by switching the CHANNELS switch on the NAV system control panel to MAN. The failure can be terminated with the MAIN RESET pushbutton.

TACAN Failure

The BRG or RNG failure can be selected by pressing the COURSE or DISTANCE pushbuttons. The selected indication freezes. RNG indication can be regained by selecting MAN with the CHANNELS switch. The failure can be terminated with the MAIN RESET pushbutton.

Course/Glide Slope Deviation Indicator Failure

A course or glide slope indicator failure can be selected with the GLIDEPATH READY or the COURSE READY pushbutton. The appropriate OFF-flag appears on the ADI. The failure can be terminated with the MAIN RESET pushbutton.

NAV FSP

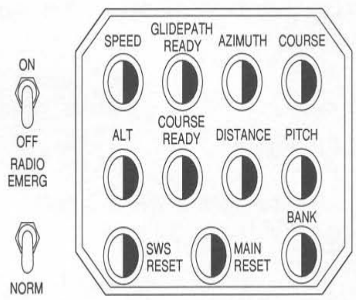


Figure 4-2

NAV FSP Power Switch

The NAV FSP power switch has the positions ON and OFF. In the ON position, power is applied to the system.

Pushbutton Indicator Lights

When a failure is implemented, the appropriate pushbutton light illuminates.

EMERGENCY RADIO Switch

It is a two position toggle switch with the positions EMERG and NORM. When the position EMERG is selected, all radio transmissions are made on XT-2000 guard frequency overriding any other radio selection.

RADAR SIMULATION PANEL

The radar simulation panel (RDR SP) is located at the upper center of the R/C instrument panel.

The RH side of the panel shows captions which monitor the actual radar operation and control sequences performed in the front cockpit, while the LH side provides several means to insert the required radar simulation modes and HUD/HDD failures.

The following Radar modes can be simulated:

- HEAD-ON
- PURSUIT
- AUTO
- CLOSE CMBT

Refer to figures 4-4 and 4-5.

The simulation includes the search and lock-on capability, aiming and attacking a target during air to air intercept with the deployment of missiles, without the presence of a real target.

Before initiating a target simulation, the IP advises the pilot about the program to be flown and announces target airspeed, altitude, range, aspect angle and the basic heading. When the pilot has selected the appropriate radar mode, the IP inserts the failure by pressing the INPUT pushbutton. When the pilot has achieved single target track, the IP can break lock-on by pressing the BCWM pushbutton. The HUD/HDD is switched to the NAV mode until BCWM is deselected.

CONTROLS AND INDICATORS

RDR SP

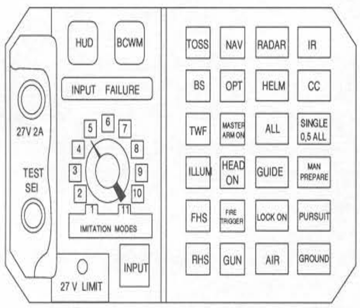


Figure 4-3

IMITATION MODES Selector

The rotary knob is used to select the desired simulation program. Depending on the RDR mode selected in the F/C, the program according to figure 4-4 is initiated in HEAD-ON and AUTO or according to figure 4-5 in PURSUIT and CLOSE CMBT.

INPUT Pushbutton

The INPUT pushbutton is used to activate and deactivate a radar simulation program.

HUD Pushbutton

The HUD pushbutton is used to implement a complete HUD failure.

BCWM Pushbutton

The BCWM pushbutton is used to interrupt the engagement.

Indicator Lights

The indicator lights illuminate in accordance with the switch positions and modes selected in the F/C.

RADAR SIMULATION MODES
HEAD-ON and AUTO

Imitation Modes	Target Altitude (ft)	Target Speed (Kts)	Aspect Angle	Detection Range (NM)	Interceptor Altitude (ft)	Interceptor speed (KTAS)	Δ H (Km)	ZONE - Switch Position	Target behaviour
1	65600	1350	0	43	39400	510	8	Neutral	
2	26200	650	0	32	26200	430	0	Neutral	Descending turn to 3300 ft
3	26200	650	0	32	26200	430	0	Neutral	Descending turn to 3300 ft
4	16400	650	- 30	32	32800	490	-5	Left	
5	16400	540	+30	32	32800	490	-5	Right	
6	13100	700	0	32	26200	430	-4	Neutral	turning
7	13100	430	+20	32	26200	430	-4	Right	turning
8	16400	0	0	11	16400	430	0	Neutral	
9	160	135	0	14	6600	380	-2	Neutral	
10	160	650	+20	22	6600	380	-2	Right	
11	160	760	0	22	6600	380	-2	Neutral	

NOTE

Below 3000 ft AGL, radar altimeter altitude should be used instead of HUD/HDD altitude.

Figure 4-4

RADAR SIMULATION MODES
PURSUIT and CLOSE CMBT

Imitation Modes	Target Altitude (ft)	Target Speed (Kts)	Aspect Angle	Detection Range (NM)	Interceptor Altitude (ft)	Interceptor speed (KTAS)	Δ H (Km)	ZONE - Switch Position	Target behaviour
1	59000	490	20	17	39360	970	6	Right	
2	59000	540	-10	17	39360	970	6	Left	
3	16400	430	0	17	32800	920	-5	Neutral	S - Turns
4	16400	195	20	15	32800	540	-5	Right	S - Turns
5	16400	270	0	14	16400	860	0	Neutral	Descending turn to 3300 ft
6	16400	290	0	11	16400	590	0	Neutral	Descending turn to 3300 ft
7	3300	230	0	10	9800	540	-2	Neutral	
8	16400	290	0	10	16400	590	0	Neutral	
9	160	135	0	10	6600	430	-2	Neutral	
10	160	230	-20	10	6600	540	-2	Left	
11	160	195	0	10	6600	590	-2	Neutral	

NOTE

Below 3000 ft AGL, radar altimeter altitude should be used instead of HUD/HDD altitude.

Figure 4-5

R/C NAVIGATION SYSTEM CONTROL PANEL

L/H VERTICAL CONSOLE R/C

The L/H vertical console in the R/C contains the PERISCOPE switch, the gear handle, the RUD TRIM switch, the EMERG RELEASE buttons and the control switches for the LG SYSTEM, FEEL UNIT, SPEED BRAKE, TRIM and EGT.

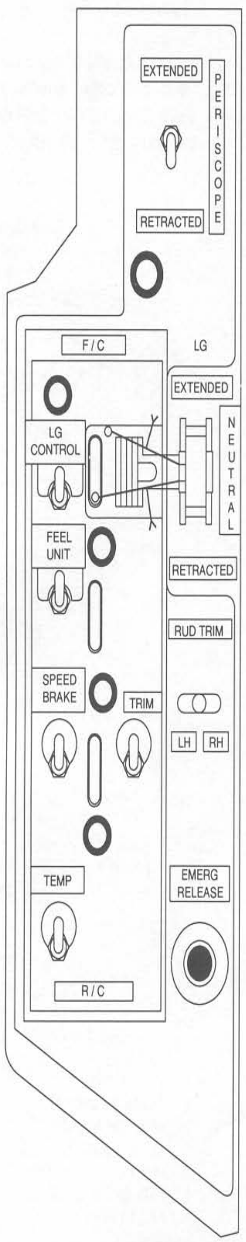


Figure 4-6

Gear Handle

The landing handle has three positions: RETRACTED, NEUTRAL and EXTENDED. The neutral position is a safety feature to prevent inadvertant gear operation in case of a control switch malfunction. Additionally, the handle is safety wired to the neutral position.

RUD TRIM Switch

See section 1, this manual.

EMERG RELEASE Button

The EMERG RELEASE button is pressed for emergency firing of the missiles.

Control Switches

Five control switches are located on the left side of the vertical panel, with a label F/C on top and a label R/C at the bottom of the panel.

In the upward, the normal position, labeled with the system name, the F/C is in control of all system functions. In the unlabeled downward position, the R/C controls the associated system.

R/C TELELIGHT PANEL

The R/C TLP provides the same warnings and informations as the F/C TLP. Six additional captions display informations about the AFCS modes selected in the F/C.

RED	GREEN

GBX FIRE	
LH ENG FIRE	RH ENG FIRE
REDUCE RPM LH ENG	REDUCE RPM RH ENG
OIL PRESS LEFT	OIL PRESS RIGHT
OIL GBX	550kg REMAIN

	DOUBLE HYD SYS
COC FAIL	DAMPER OFF
LH ENG START	RH ENG START
LH ENG AB	RH ENG AB
RUD TRIM NEUTRAL	STAB TRIM NEUTRAL

AIL TRIM NEUTRAL	FEEL UNIT TO / LD	
ATT HOLD	AUTO RECOVER	EMERG HYD PUMP ON
ALT HOLD	APPROACH	MARKER BEACON
SET COURSE MAN.	MISSED APPROACH	

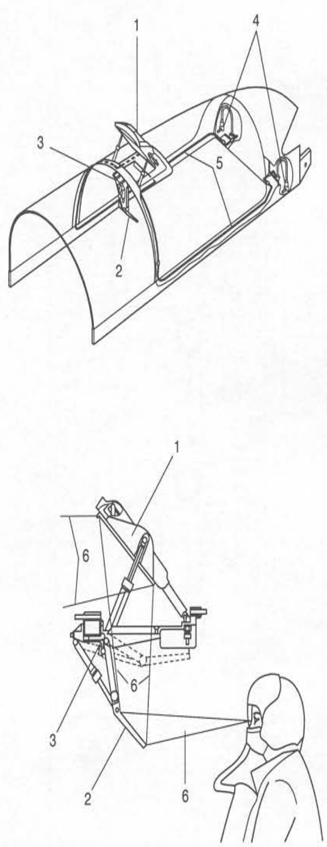
Figure 4-7

PERISCOPE SYSTEM

A periscope system is installed in the R/C to provide forward view to the IP during ground operations, takeoff and landing. The mirror system is electrically controlled and pneumatically operated. It is controlled by the PERISCOPE switch on the left vertical console, provided the landing gear is down.

CAUTION

To prevent overheating of the electropneumatic periscope extension control valve, maximum operating time for the periscope is 30 min.



1. EXTERIOR MIRROR
2. INTERIOR MIRROR
3. ACTUATORS
4. PNEUMATIC VALVES
5. PNEUMATIC LINES
6. PILOTS VIEW

Figure 4-8

DAMPER PUSHBUTTON

A rectangular pushbutton labeled DAMPER is installed beneath the radio on the instrument panel. The button is illuminated whenever the dampers are engaged. It can be used to engage or disengage the dampers from the R/C.

PANEL PRIORITY CHANGEOVER

Four pushbuttons to changeover the below mentioned functions in relationship to priority of the crewmembers are labeled

- ADF SEL
- TACAN RSBN
- TACAN SEL and
- RADIO SEL.

The pushbuttons are located in the F/C and R/C. Pushing the required pushbutton activates the appropriate function in the relevant cockpit.

Figure 4-9

SECTION 5

OPERATING LIMITATIONS

TABLE OF CONTENTS

	Page
Introduction	5-3
Crew Requirements	5-3
Engine Limitations	5-3
CG Limitations	5-6
Prohibited Maneuvers	5-6
Rudder Maneuvering	5-6
Gross Weight Limitations	5-6
System Operating limitations	5-7
Safe Ejection Envelope	5-8
Airspeed Limitations	5-8
AOA Limitations	5-9
Acceleration Limitations	5-9
Crosswind Limitations	5-9
T/O and Landing Limitations	5-9
Load Classification	5-10
Instrument Markings	5-10
External Store Limitations	5-12
Minimum Equipment List	5-14

INTRODUCTION

This section covers the aircraft operating limitations, which must be observed during normal operation.

Refer to other sections of the flight manual for operating limitations that are characteristic of a particular phase of operation; i.e. emergency procedures, engine starting procedures, etc.

Limitations are discussed for the normal power mode (NPM) and the limited power mode (LPM) where applicable.

Where applicable, different data for the MIG-29G single seat version are marked G, for the MIG-29GT trainer version GT.

NOTE

- The aircrew will make all necessary entries in Form 781 to indicate any limitations that has been exceeded.
- Refer to other sections of the flight manual for operating limitations that are characteristic of a particular phase of operation; i.e., emergency procedures, flight characteristics etc.

CREW REQUIREMENTS

GT: The crew requirement for normal flight is two. The rear seat may be occupied by a passenger.

ENGINE LIMITATIONS

APU

Continuous APU operation is limited to 40 min.

At least 5 relight attempts with oxygen are possible.

ENGINE START/SHUT-DOWN

Time interval between cold cranking and engine start or two consecutive engine starts is 3 min minimum.

RELIGHT ENVELOPE

Relight envelope for all relight types

ALT	KIAS	RPM
below 40 000 ft	220 - 540	≥ 12 %
40 000 - 56 000 ft	300 - M 1.8	≥ 50 %

Figure 5-1

NOTE

- At 40 000 ft or above, engine rotation above windmilling RPM may be required to achieve a reliable relight.
- If engine is not controllable through the entire RPM range, repeat engine relight at higher speed.

AFTERBURNER OPERATION

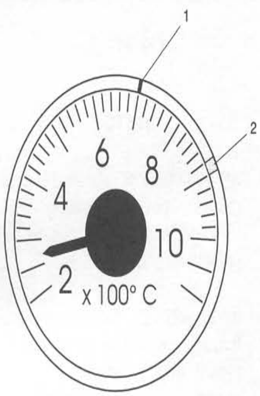
Use of AB is prohibited at fuel stages of 550 kg remaining or less due to lack of fuel transfer to the engines.

ENGINE EXHAUST TEMPERATURE LIMITATIONS

CONDITION	EGT - LIMIT	REASON	REMARKS
Engine start	Up to the yellow marker maximum	Continuous cooling of engine turbine blades	Refer to figure 5-3/5-4
IDLE / ground operation	450° C	Thermal limit of engine turbine blades	
Continuous operation, Inflight IDLE	Not in, or above red sector		Refer to figure 5-3/5-4
Acceleration to MIL or AB, AB ignition / shut-down	3 sec max within red sector		
Engine relight	600° C with windmilling RPM		
Preventive relight	750° C at 50 % RPM or more		During weapon employment

Figure 5-2

EGT INDICATOR



1. YELLOW MARKER
2. RED SECTOR

Figure 5-3

RPM LIMITATIONS

POWER SETTING	LIMIT	REASON
Steady IDLE, ground	15 minutes maximum	Cooling of engine turbine blades
Steady MIL / AB, ground	10 minutes maximum	
Steady state between IDLE and MIL, ground	Unlimited time	
Steady state, inflight	Unlimited time	Design limit of engine turbine blades
MIL / AB, ground, inflight	103 % RPM maximum	Engine design limit
MIL / AB, steady operation	4 % RPM maximum difference between engines	

Figure 5-4

RPM FLUCTUATION LIMITATIONS

POWER SETTING	FLUCTUATION LIMIT	REASON
Constant IDLE	± 1.5 % RPM	
Constant cruise between IDLE / MIL	± 1.2 % RPM	
Constant MIL and AB	± 0.6 % RPM	
Acceleration and deceleration, AB ignition and shut-down	± 3 % RPM up to 3 seconds	Stability of engine performance
All power settings, multiple g	Maximum 7 %, not to exceed 103 % RPM	

Figure 5-5

ENGINE G-LIMITATIONS

Due to limited oil distribution to the engines and the GBX during negative-g and near-zero-g flight, operation is limited to:

POWER SETTING	LOAD FACTOR	LIMIT
MIL	Near-zero g (0 ± 0.2)	10 seconds
	Negative g	15 seconds
AB	Near-zero g (0 ± 0.2)	5 seconds
	Negative g	5 seconds
All power settings	Zero g	2 seconds max during transition between positive and negative g.
	Multiple negative and near-zero g (0 ± 0.2)	Movement into negative and / or near-zero load multiples is allowed not more than 5 times during a flight, with an interval of at least 30 seconds.

Figure 5-6

CG LIMITATIONS

CG is primarily influenced by aircraft configuration and fuel consumption. Since the CG remains well within permissible range in any configuration and fuel load, it has virtually no effect on aircraft stability. See Section 6 in this manual.

Configuration	G	GT
Max fwd CG	23.7 % MAC	23.3 % MAC
Max aft CG	30.5 % MAC	30.0 % MAC

Figure 5-7

PROHIBITED MANEUVERS

Intentional spins.

RUDDER MANEUVERING

It is strongly recommended not to override the artificial stop.

CAUTION

To prevent overstress of the vertical stabilizers it is prohibited to override the rudder artificial stop at airspeeds
G: >485 KIAS,
GT: >432 KIAS.

GROSS WEIGHT LIMITATIONS

Gross weight	G	GT
Max T/O	18 480 kg	18 210 kg
Max LDG	15 760 kg	15 760 kg

Figure 5-8

NOTE

- Maximum gross weight for a touch-and-go landing is 14 200 kg.
- After each landing at weights above 14 200 kg an entry into DD FORM 781A is mandatory.
- The number of landings at weights between 14 200 kg and 15 760 kg must not exceed 3 % of total number of landings.

SYSTEM OPERATING LIMITATIONS

CONDITION	MAXIMUM AIRSPEED	REMARKS	LIMITING FACTOR
Landing gear operation	G: 370 KIAS GT: 320 KIAS	Maximum allowable sideslip is 2 ballwidths at airspeeds above 270 KIAS	Structural limit of the nose gear hydraulic actuator Design limit of landing gear, gear doors
LEF extended	G: M 0.95 GT: M 0.85		Structural limit of LEF
Drag chute deployment	167 KIAS		Strength of attaching mechanism
Wheel brake operation	120 KIAS	If necessary, the brakes may be engaged at any speed, provided all gear are on the ground	Energy absorbing limit of wheels
Engine air intake louvers open	M 0.8		Stability of engine performance
Canopy taxi position, gnd operation	16 kts	Taxiing with the canopy open is prohibited	Mechanical strength of canopy hinges
Canopy jettison, inflight	G: between 215 and 375 KIAS GT: between 215 and 270 KIAS	At or below 16 400 ft MSL	Safe separation of canopy above vertical fins
Flight with canopy jettisoned	G: 647 KIAS GT: 270 KIAS	Helmet visor(s) down GT: Landing from the rear seat not recommended	Impact of airstream on the pilot
AFCS, Automatic landing approach control	Minimum altitude 150 ft		Ability to land, considering possible pitch oscillations.
AFCS, Altitude hold	Minimum altitude 300 ft		Accuracy of altitude stabilization
AFCS, levelling mode		Prohibited with external tanks full or partly full	Exceeding of acceleration limits possible
AFCS, auto recover mode	Minimum altitude 600 ft	Prohibited with external tanks full or partly full	Exceeding of acceleration limits possible
Tire speed limit main landing gear	200 kts		Design limit

Figure 5-9

SAFE EJECTION ENVELOPE

Although the ejection seat system has a zero altitude capability, compensation for system inherent time delays and various enviromental factors require adherence to the following parameters.

GT:

NOTE

At airspeeds above 270 KIAS the rear seat should be lowered to the utmost position to minimize the impact of windblast to the rear seat occupant during canopy separation.

CONDITION	AIRSPEED	MINIMUM HEIGHT	REMARKS
Ejection, gnd	G: minimum 40 KIAS GT: minimum 80 KIAS	Not applicable	
Horizontal flight	≤ 510 KIAS	Any height	
Horizontal flight	510 to 645 KIAS	135 ft	
Horizontal flight	645 to 700 KIAS	265 ft	
Bank angles ≤ 90°		330 ft	No sinkrate permissible
Inverted flight		660 ft	No sinkrate permissible
Descent		G: sinkrate/min divided by 15 GT: sinkrate/min divided by 12	Without considering time required for decision and preparation

Figure 5-10

AIRSPEED LIMITATIONS

MIG 29G	ALTITUDE	MAXIMUM AIRSPEED		
	Range	KIAS	KTAS	MACH
Basic A / C including A / A missiles	≤ 41 000 ft	810		
	> 41 000 ft		1 295	2.35
LEF out				0.95
CL tank (full / part. Full)		485		1.5
CL tank (empty)		595		1.5
Wing drop tank		485		≤ 0.9
Travel pod		450		0.9

MIG 29GT	ALTITUDE	MAXIMUM AIRSPEED		
	Range	KIAS	KTAS	MACH
Basic A / C including A / A missiles	≤ 41 000 ft	810		
	> 41 000 ft		1 270	2.1
LEF out				0.85
CL tank (full / part. Full)		485		1.5
CL tank (empty)		595		1.5
Travel pod		450		0.9

Figure 5-11

AOA LIMITATIONS

MAX AOA

CAUTION

Exceeding 13° AOA during T/O or landing may cause the nozzles to contact the RWY.

NOTE

Overriding the pitch kicker is not permissible.

Configuration	G	GT
LEF out	26°	24°
LEF in	15°	14°
T/O, ldg config	15°	15°
Single engine	19°	19°
Damper / AFCS off	13°	13°
Wing drop tanks	20°	NA
Travel pod	15°	15°
Single asymmetric load ALAMO	19°	NA
Single asymmetric load ARCHER	Basic A/C	Basic A/C
Multiple asymmetric load ARCHER	20°	19°
Asymmetric load ALAMO plus two ARCHER	13°	NA

Figure 5-12

CROSSWIND LIMITATIONS

Due to limited rudder effectiveness for sideslip compensation and landing gear structural design limit, T/O and landing are restricted to a

- maximum crosswind component for takeoff and landing on a dry runway of 30 kts;
- maximum crosswind component for landing with an asymmetric load equivalent to one full wing drop tank of 10 kts with the wind from the unfavorable side;
- maximum tailwind component for takeoff and landing of 12 kts.

T/O AND LANDING LIMITATIONS

AIRSPEED

MAX T/O speed: 200 KIAS

MAX ldg speed: 178 KIAS

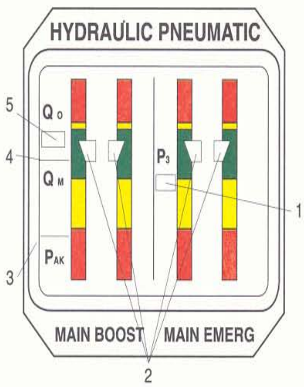
TOUCH-AND-GO LANDINGS

NOTE

A maximum of four touch-and-go landings per sortie is permissible.

INSTRUMENT MARKINGS

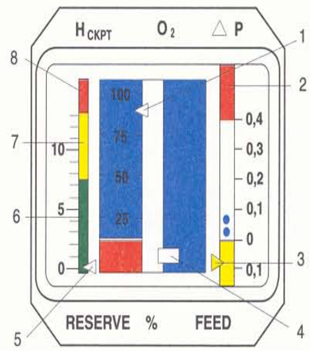
COMBINED PRESSURE INDICATOR



1. PRECHARGE PRESSURE
2. ACTUAL PRESSURE
3. PRECHARGE PRESSURE
4. MAX. DELIVERY
5. ZERO DELIVERY

Figure 5-15

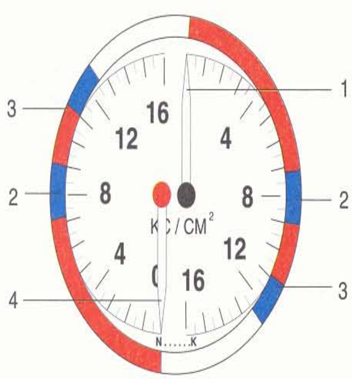
COMBINED OXYGEN INDICATOR



1. OXYGEN QUANTITY IN %
2. CABIN PRESSURIZATION FAILURE
3. CABIN PRESSURE DIFFERENTIAL INDEX
4. OXYGEN FLOW INDICATOR
5. CABIN ALTITUDE INDEX x 1 000 m
6. CABIN ALT 0 to 7 000 m
7. CABIN ALT 7 000 to 13 000 m
8. CABIN ALT ABOVE 13 000 m

Figure 5-17

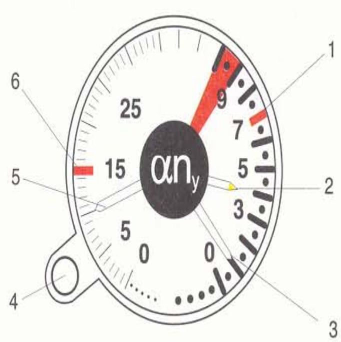
BRAKE PRESSURE INDICATOR



1. RH MAIN WHEEL BRAKE PRESSURE
2. MAX NORMAL BRAKE PRESSURE 8±0,5 kp/cm²
3. MAX RUN-UP BRAKE PRESSURE 11±1,0 kp/cm²
4. LH MAIN WHEEL BRAKE PRESSURE

Figure 5-16

COMBINED AOA AND G-METER



G-METER

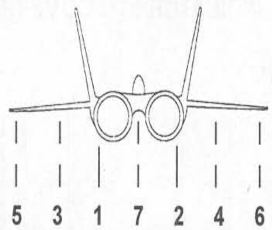
1. 7 G-MARKER
2. MAX G-INDEXER
3. G-POINTER
4. RESET BUTTON FOR MAX G-INDEX TAB

AOA

5. AOA POINTER
6 15° MARKER

Figure 5-18

EXTERNAL STORES LIMITATION



STORE	SUSPEN-SION	STATION LOADING							CARRIAGE		
									AIRSPEED		ACCEL
		5	3	1	7	2	4	6	KIAS	MACH	
CL TANK	NA				⬭				EMPTY		
									595	1.5	✈
									FULL / PARTLY FULL		
									485	1.5	+ 4.0 to - 1.5
WDT				(⊙)	⬭	(⊙)			EMPTY		
									485	0.9	+ 6.0 to - 1.0
									FULL / PARTLY FULL		
									485	0.9	+ 4.0 to - 1.0
AIS POD						⬡			✈	✈	✈
TRAVEL POD			⊕	⊕		⊕	⊕		485	0.9	+ 4,0 to - 1.5
FPR POD						⊖			✈	✈	✈
ALAMO	APU 470			X◎		X◎			✈	✈	+ 8.0 to - 1.5
ARCHER	P-72-1D	X⊙	X⊙	X⊙		X⊙	X⊙	X⊙	NE	NE	+ 9.0 to - 1.5
APHID	P-62-1DB1	X◯	X◯	X◯		X◯	X◯	X◯	✈	✈	NE
TRAINING EQUIP											
ARCHER DUMMY	P-72-1D	⊙	⊙	⊙		⊙	⊙	⊙	NE	NE	+ 8.0 to - 1.5
APHID DUMMY	P-62-1D	◯	◯	◯		◯	◯	◯	NE	NE	✈

HOT MSL

- X◎ AA 10 ALAMO (R-27R1)
- X◯ AA 8 APHID (R-60MK MOD)
- X⊙ AA 11 ARCHER (R-73Ä)

TRAINING MSL

- ⊙ TRAINING MISSILE AA 11 ARCHER
- ◯ TRAINING MISSILE AA 8 APHID
- ⊖ FLUGPROFILRECORDER POD

Figure 5-19 (Sheet 1 of 2)

EXTERNAL STORES LIMITATIONS

EMERGENCY JETTISON / RELEASE						EMPLOYMENT		REMARKS
AIRSPEED			ACCEL	SIDE SLIP	MIN ALT	MACH	ACCEL	
MIN	MAX	MACH						
EMPTY			EMPTY			EMPTY		CL tank jettisoning results in a shift of CG which increases with airspeed. Jettisoning the CL tank at or above 490 KIAS may result in a g-reduction up to 1.5 g, with altitude loss up to 500 ft.
240	510	0.85	NE	ZERO	300 FT	NA	NA	
PARTLY FULL			PARTLY FULL			PARTLY FULL		During jettisoning the CL tank will be released from the aft suspension when the tank tip is 90° low. For this reason, do not release below 20 ft AGL.
240	510	0.85	1.5 TO 2.0	ZERO	300 FT	NA	NA	
FULL			FULL			FULL		In AUTO RECOVER, the loading limitations for a full / partly full CL tank can be exceeded.
240	510	0.85	NE	ZERO	300 FT	NA	NA	
300	485	0.9	NE	NE	NE	NA	NA	Side slip must not exceed two ball widths. Wing drop tank jettisoning has to be performed in straight and level flight.
NA	NA	NA	NA	NA	NA	NA	NA	
NA	NA	NA	NA	NA	NA	NA	NA	Max AOA 15°. If MSL on stations 1 and 2, the travel pods can be carried on stations 3 and 4 (symmetr.).
NA	NA	NA	NA	NA	NA	NA	NA	As an exception, the pod can be carried on station 1.
NE	NE	NE	1.0	1/2 BALL WIDTH	NE	0.6 to 2.25	+3.5 to 0	
NE	NE	NE	2.0	1/2 BALL WIDTH	NE	0 to 2.25	+8.0 to -1.5	
NE	NE	NE	2.0	1/2 BALL WIDTH	NE	0 to 2.25	+7.0 to -1.5	
NE	NE	NE	NE	NE	NE	NA	NA	
NE	NE	NE	NE	NE	NE	NA	NA	

CL TANK — AIS POD — BASIC AIRCRAFT

WING DROP TANK — TRAVEL POD — NA NOT APPLICABLE

NE NOT ESTABLISHED

Figure 5-19 (Sheet 2 of 2)

MINIMUM EQUIPMENT LIST

To ensure safe operation and mission completion, this list details the minimum equipment which must be servicable for VFR or IFR operation or ferry flights. Ferry flights are defined as sorties which are flown to home base or a maintenance facility during daytime and in VMC only. Depending upon the failed items, these flights may have to be restricted to non-tactical maneuvering and / or to defined limitations.

MINIMUM EQUIPMENT LIST	VFR	IFR	Ferry
Navigation equipment:			
Main gyro system	X	X	1
Stby gyro system	X	X	1
ADC	X	X	X
Navigation computer	X	X	2
TCN with adapter assembly	X	X	X
Rad Alt	3	X	–
GPS	4	4	–
Flight instruments and systems:			
ADI	X	X	X
HSI	X	X	X
HUD/HDD	X	X	–
Stby mag compass	X	X	5
Main pitot static system	X	X	X
Emerg pitot static system	X	X	1
IAS	X	X	X
MACH-meter	X	X	–
Pressure Altimeter	X	X	X
VVI	X	X	X
Turn and slip indicator	X	X	–
Communication equipment:			
VHF / UHF Radio	X	X	X
XT-2000	X	X	X
Intercom System	8	8	8
HF-Radio	–	9	–
Additional systems:			
Engine anti-icing system	–	6	–
COC system	X	X	–
Emergency warning equipment	X	X	X
Cockpit pressurization	7	7	7
Stopwatch or pilot's wrist watch	X	X	X
IFF/SIF	X	X	5
Lighting equipment:			
Anti-collision lights	X	X	X
Navigation lights	X	X	–
Interior lights	X	X	–
Emergency interior lighting	X	X	–
Landing / taxi lights	X	X	–
Hand-held torch	X	X	–

NOTES

1 Either system operating
2 TACAN and main or stby gyro system
3 For low level flights from takeoff to landing
4 ICAO-II aircraft only
5 Not required in formation flight if the other aircraft is equipped with the respective system operating
6 The aircraft may be flown IFR provided the flight is conducted in VMC only
7 If flying above 25 000 ft MSL
8 GT only
9 When leaving UHF / VHF coverage

Figure 5-20

SECTION 6

FLIGHT CHARACTERISTICS

TABLE OF CONTENTS

	Page
General	6-3
Stability and Control	6-3
Longitudinal Stability	6-4
Static Longitudinal Stability	6-4
Maneuver Stability	6-6
Dynamic Longitudinal Stability	6-7
Lateral and Directional Stability and Roll	6-7
Roll Coupling	6-9
CG Travel	6-10
Handling	6-11
Normal Flight	6-11
Takeoff	6-11
Landing	6-11
Maneuvering Flight	6-11
Transonic Region	6-12
Supersonic Flight	6-12
High Altitude	6-12
Flight with Asymmetric Load	6-12
Flight with Wing Drop Tanks	6-12
Effect of Thrust	6-13
Speedbrakes	6-13
Departure from Controlled Flight	6-13
Deep Stall	6-14
Spin	6-14
Steep Spin	6-14
Moderate Flat Spin	6-14
Flat Spin	6-14
Inverted Spin	6-15

GENERAL

Handling qualities of an aircraft are measured by the ease and precision at which the pilot can carry out the maneuvers required by the role and mission of the aircraft. They essentially consist of two elements:

- The inherent stability characteristics which the airplane displays without pilot interaction (open loop)
- The closed loop control characteristics; e.g., control harmony, control power

Fighter aircraft like the MiG-29 which are designed to cover a very large flight envelope with regard to speeds, Mach numbers, altitudes, load factors, AOA, require sophisticated augmented flight controls to guarantee at least adequate handling qualities throughout their performance spectrum. The controls need to be hydraulically boosted due to the very high aerodynamic forces resulting from high q (dynamic pressure). Some degree of augmentation is required to compensate for adverse effects like shifts in center of pressure or weakly damped oscillations. The design goal is to provide maximum agility while simultaneously giving the pilot the feel of a stable and predictable aircraft.

In the MiG-29, hydromechanical devices are used to achieve this goal.

The following section provides an insight into the flight mechanical problems encountered and the solutions found for the MiG-29.

STABILITY AND CONTROL

Stability describes the tendency of a system to return to its original state after a disturbance. Three options are possible:

- Positive stability; the system will be driven back to its original state after a disturbance.
- Neutral stability; the system will remain in the new state after a disturbance.
- Negative stability; the system will be driven even further away once a disturbance occurs.

STATIC STABILITY

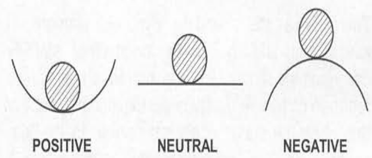


Figure 6-1

Static stability describes the inherent tendency to return to the trimmed state. Dynamic stability describes the way (oscillatory or dead beat) in which the actual return takes place.

DYNAMIC STABILITY

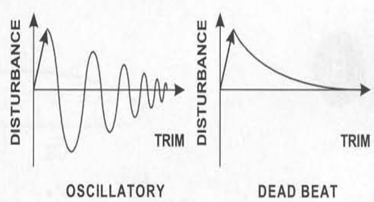


Figure 6-2

Dynamic stability always requires static stability as a prerequisite.

The man in the loop, the pilot, can usually cope with marginally stable or even weakly unstable systems. However, the more the stability is degraded, the more compensation and attention is required to maintain control.

Aircraft can translate and rotate about three axes, i.e., they have six degrees of freedom. The pilot exercises control mainly by rotational inputs around lateral, longitudinal and vertical axis. The appropriate stabilities are:

- Longitudinal stability in pitch
- Lateral stability (= dihedral effect) in roll
- Directional stability in yaw

LONGITUDINAL STABILITY

There is a static and a dynamic element in longitudinal stability. Static longitudinal stability describes the tendency of the aircraft to maintain or return to its trim AOA. Dynamic longitudinal stability describes the way the aircraft returns to the trim condition and / or responds to pitch control inputs.

STATIC LONGITUDINAL STABILITY

The MiG-29 displays positive longitudinal stability throughout the flight envelope. To improve agility, a rather small stability margin was chosen by the designers. The stability margin is defined as the longitudinal distance between the aircraft center of gravity (CG) and the neutral point (NP).

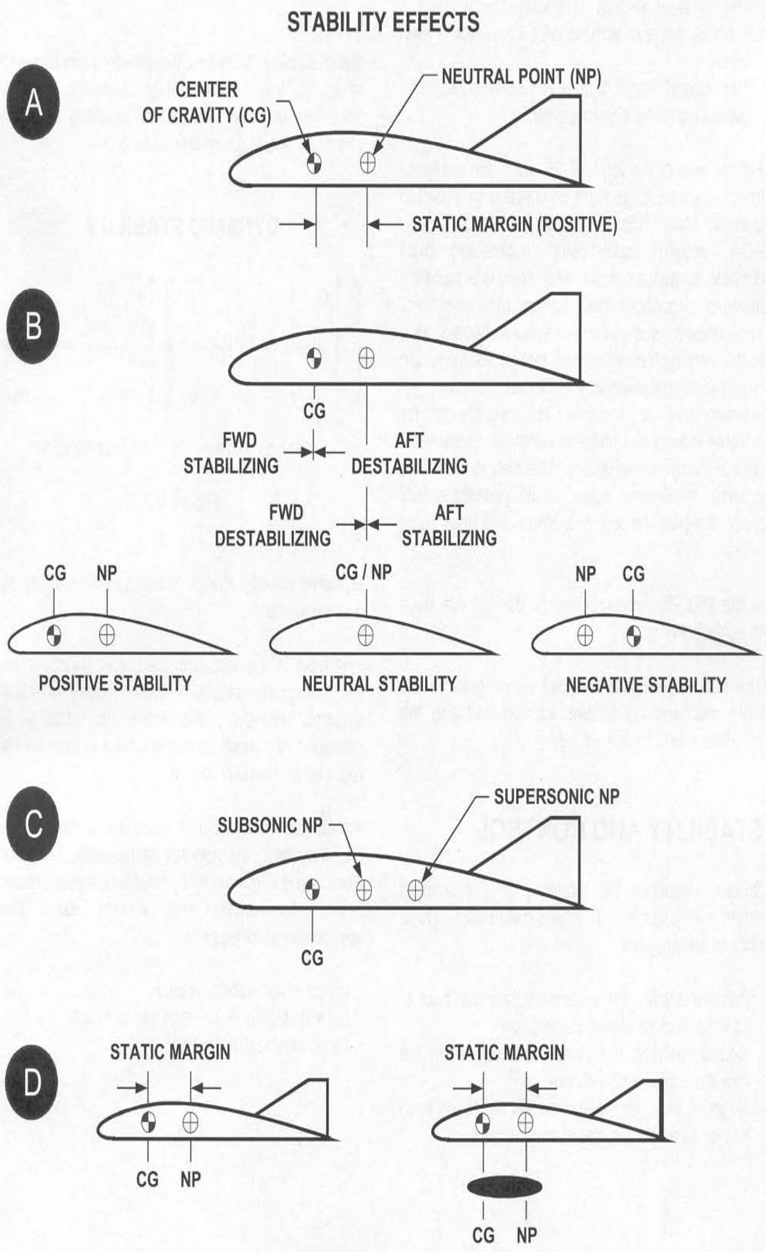


Figure 6-3

To create a reference measure, this distance is usually referred to the average length of the airfoil, the Mean Aerodynamic Chord (MAC), e.g., as 27 % MAC.

As either the CG wanders with fuel consumed, stores dropped etc., or the NP shifts due to aerodynamic effects, the static margin and along with it longitudinal static stability changes during flight.

While flight tests showed that all changes in CG remain adequately controllable for the pilot, NP shifts can be very dynamic and pronounced; therefore special augmentation devices had to be implemented in the flight control system.

Extension and retraction of the trailing edge flaps leads to a pitching moment. Generally, flap extension causes an aerodynamic pitch-down moment. However, in the MiG-29 there is a strong interaction (down wash) between flaps and taileron which pulls the taileron down and overrides the weaker pitch-down from the flaps alone. The result is a pitch-up which becomes more pronounced as speed increases.

Extension of the LEF causes a considerable pitching moment. As LEF scheduling is automatic in relation to AOA and occurs frequently during maneuvering, it was decided to introduce a device (automatic pitch control) which counteracts the LEF pitching moment by simultaneous opposite deflection of the horizontal tail. Refer to figure 6-4.

AUTOMATIC PITCH CONTROL

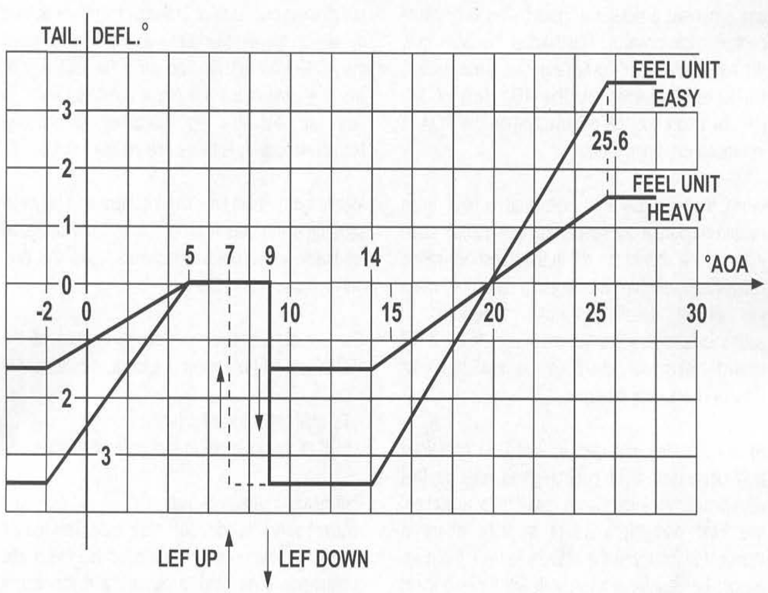


Figure 6-4

In this way, more predictable AOA control through the LEF actuation range was achieved.

As the AOA is increased through the medium range, a phenomenon named tip stall occurs. The airflow starts getting disrupted at the trailing edges of the outer wings, and this disrupted airflow wanders forward as AOA is further increased. Thus, the wing center of pressure moves forward and causes a strong pitch-up of the aircraft.

Again, the automatic pitch control is used to schedule the taileron via the fast acting trim actuators in opposition to this undesirable aircraft movement. However, a moderate degree of pitch-up tendency still remains and is felt by the pilot as stick force lightening. Precise acquisition of AOA and g requires good piloting technique. To avoid overshooting the allowable AOA of 26° (GT: 24°), a pitch kicker was added to the flight control system. Depending on the rate at which the limit AOA is approached, a hydraulic piston extends and generates a kick-down input on the longitudinal control (stick forward). The quicker the AOA rise, the earlier the pitch kicker responds. Thus, unless the kicker is overridden, the AOA limit of 26° (GT: 24°) can only be achieved when the AOA is increased extremely slow.

While the changes in longitudinal control force remain moderate as speed changes (small static margin), the shift of the NP in the transonic range causes large pitching moments. In particular, when the aircraft decelerates from supersonic to subsonic speeds, a sudden dig-in occurs which will lead to structural overstress unless the pilot releases back stick pressure.

At low altitudes, changes in flow field combined with decreased flight control gains (due to feel control unit stick-to-taileron gear ratio alteration, see next paragraph) cause a state where a transient tendency of the MiG-29 to raise the nose cannot be countered even with full forward stick; the resultant climb cannot be stopped until higher Mach numbers are reached and the neutral point wanders further aft.

Due to the low thrust line of the MiG-29, an increase in engine thrust may cause a rather pronounced pitch-up and vice versa.

The speedbrakes, which cannot be used when a centerline tank is installed, also have an effect on the pitch characteristics; extension leads to pitch-up in the subsonic range and pitch-down at supersonic Mach numbers. Under certain flight conditions, a considerable change in g may result unless the pilot adapts back stick pressure.

As airspeed increases above the threshold value during takeoff, the lower engine air intakes are opened while the upper louvers are closed. This induces a noticeable pitch-down moment due to transitory changes in the flow field around fuselage and wings.

Jettisoning the centerline tank will cause a noticeable forward CG shift which causes a pitch-down moment that intensifies with increasing airspeed.

MANEUVER STABILITY

Maneuver stability is inherently similar to static longitudinal stability. The difference is that during pull maneuvers (turns or pull-ups) there is a degree of rotation around the lateral axis which increases the AOA of the taileron and shifts the neutral point which is now called maneuver point aft. There is now an increase in (longitudinal) stability. Maneuver stability is measured in stick force per g.

Ideally there would be a linear relationship between stick force and load factor g. This would mean good feedback and optimum predictability for the pilot during maneuvering flight.

The actual stick-force-to-g characteristics of the MiG-29 are far from linear due to these factors:

- Tip stall / stick force lightening
- FCS related changes in stick-taileron gearing

Particularly in areas of high AOA, an increase in g requires very little additional stick force. This means for the pilot that in this region good technique and crosscheck is required to capture and maintain a desired load factor, because very little tactile feedback is available from the control column.

CAUTION

Above corner speed and particularly in the M 0.9 region, great care must be taken not to exceed the structural limits of the aircraft.

DYNAMIC LONGITUDINAL STABILITY

The dynamic longitudinal stability characteristics of any aircraft are defined by two characteristic motions:

- The Short Pitch Period Oscillation (SPPO)
- The Phugoid

The SPPO basically determines the response of the aircraft in pitch. The crisper and better it is dampened, the more precise the pilot perceives the pitch control to be. Due to the relatively small static margin of the MiG-29, the SPPO frequency is rather low. Thus the aircraft follows stick inputs in pitch somewhat sluggishly. However, the long and heavy control column balances this adverse characteristic somewhat and randers it tolerable to the pilot. Nevertheless, a certain sluggishness in pitch becomes obvious in high gain tasks like close formation flying. Large, quick pitch inputs should be avoided and a degree of anticipation is required to prevent PIO.

Natural SPPO damping is relatively low, but the pitch damper increases it to the comfortable range near dead-beat. However, careful pitch control is required when the MiG-29 is flown with a failed or disabled pitch damper. Any sudden changes in pitch may then easily cause PIO. In such a case, the pilot should attempt to freeze the stick in a position slightly aft of neutral until oscillations cease.

Other than the SPPO, the Phugoid is a very slow oscillation which only comes to bear in trimmed, straight and level flight (a perfectly trimmed aircraft suddenly deviates from its cruising altitude). It is a nuisance mode which can be particularly annoying when it interferes with a poorly calibrated autopilot and causes prolonged, slowly porpoising flight paths in cruise. In such a case it is advisable to disengage the ALT HOLD mode and trim the aircraft manually.

LATERAL AND DIRECTIONAL STABILITY AND ROLL

The main difference between lateral / directional and longitudinal stability is, that the characteristic motions of an aircraft around roll and yaw axis are usually coupled and cannot be analyzed in isolation. This means that when the pilot pulls on the stick, a pure pitch motion will result. However, an input with the rudder will induce both yaw and roll.

Lateral stability is defined as the tendency of an aircraft to roll into a sideslip (right rudder leads to right roll).

Directional stability (= weathercock effect) is the tendency of an aircraft to turn its nose into the wind; i.e. reduce a sideslip when one is present.

The MiG-29 displays positive lateral stability. For this reason it can be rolled predictably around the longitudinal axis with the rudder. The higher the AOA, the more pronounced this lateral stability is; for this reason it is a good technique to use the rudder for roll at slow speeds.

When sideslip is changed rapidly, a dynamic, tumbling motion is initiated which consists of roll and yaw coupled. This motion is called 'Dutch Roll'. The MiG-29 yaw damper system dampens the Dutch Roll well.

However, should the aircraft be flown with dampers inoperative, careful use of the rudder is recommended. Furthermore, a sudden yawing motion as induced by the asymmetric thrust of an engine failure at a high thrust setting will set off a severe Dutch Roll with rapid and unexpected rolling. At high AOA, the pronounced adverse yaw of the MiG-29 is also prone to initiate the Dutch Roll; this is most noticeable to the pilot at higher altitudes where e.g. the rollrate becomes oscillatory due to the low dampening authority in thin air.

The directional stability reserves of the MiG-29 are good throughout the cleared envelope. Even throughout most of the critical regimes (high AOA, trans- / supersonic flight, asymmetric engine failure), the twin tails provide a strong weathercock effect. In the MiG-29GT aircraft, due to its increased fuselage area ahead of the CG, the directional stability reserves are somewhat reduced but also adequate. Due to the fact that the departure AOA of an aircraft will decrease (i.e. earlier departure) as sideslip increases, good directional stability is a key feature at high AOA.

Here again, the pronounced adverse yaw of the MiG-29 becomes important; as the ailerons deflect at high AOA, they generate a sideslip due to high differences in induced drag between upgoing and downgoing side. Despite the powerful vertical stabilizers, there is a point where the adverse yaw effect overrides the roll power of the ailerons, and the lateral control becomes ineffective, or worse, reverses. This is why the AOA limiter of the MiG-29 has been set to 26° (GT: 24°). At these AOAs, the aircraft barely retains aileron effectiveness when a centerline tank (which slightly degrades directional stability) is carried. As mentioned earlier, roll control under such circumstances is much improved when rudder is used. It is also advisable to use less than full aileron at high AOA. For example, at 20° AOA, half lateral stick will provide about twice the roll rate as full lateral stick.

The available roll rates of the MiG-29 vary considerably with speed. Refer to figure 6-5.

At lower AOAs, the tailerons are deflected differentially in order to generate an extra rolling moment. However, the adverse yaw of the differential tailerons is even stronger than that of the ailerons. Therefore, at the same AOA where the LEF extend, movement of the differential taileron is suspended.

At very high dynamic pressure, the hydraulic actuation force of the ailerons no longer is sufficient to reach full deflection. As a consequence, the roll rate at high numbers becomes quite modest.

The response of the MiG-29 to a quick lateral control input is characterized by some delay followed by a noticeable acceleration in roll rate. This renders the aircraft roll answer somewhat unpredictable when aggressive inputs are made, but there is, however, little tendency to overshoot once the lateral stick input ceases. The higher the altitude, the less pleasant the roll control characteristics of the aircraft become.

ROLL RATE VERSUS MACH NUMBER

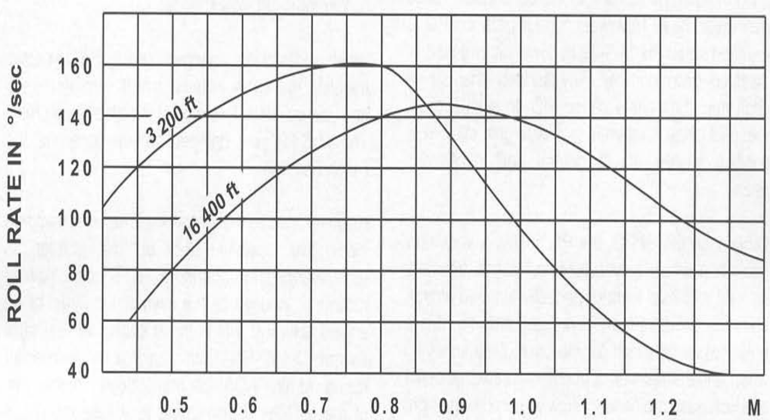


Figure 6-5

ROLL COUPLING

Roll coupling is an interaction of aerodynamic and inertial forces which is encountered when aerodynamic stabilities are low and high roll rates are present.

A perfectly stable aircraft, when rolled, would maintain its AOA due to longitudinal static stability and keep any sideslip near zero due to directional stability. Refer to figure 6-6.

PERFECTLY STABLE AIRCRAFT

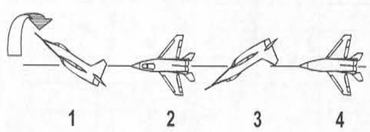


Figure 6-6

A perfectly inert aircraft, in contrast, would maintain its position in space. Consequently, any AOA would become sideslip and vice versa during roll. Refer to figure 6-7.

PERFECTLY INERT AIRCRAFT

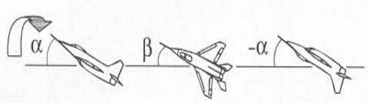


Figure 6-7

In the real world, stability tends to override inertia. However, under certain circumstances, dangerous changes can take place. For the MiG-29, the transonic Mach range is critical. In this range, both directional and longitudinal stability are somewhat degraded. At the same time, lift builds up quickly even at moderate AOAs. If the pilot pulls on the control stick aggressively while simultaneously rolling the aircraft, a strong adverse yaw is present which cannot be countered by the vertical tails. The resulting large sideslip angle then changes into an AOA due to roll, and a massive build-up in g results. Besides, a roll autorotation may be started.

In order to stop the hazardous coupling, the pilot must immediately reduce the AOA and centralize controls. Due to its lower directional stability, the MiG-29GT is more prone to roll couplings and departures.

CG TRAVEL

CG is primarily influenced by aircraft configuration and fuel consumption. Figure 6-8 depicts CG travel due to fuel consumption and dispensing of external loads in a typical configuration. Since the CG always remains well within permissible range, it has rather little influence on the stability of the MiG-29.

EXAMPLE FOR CG TRAVEL

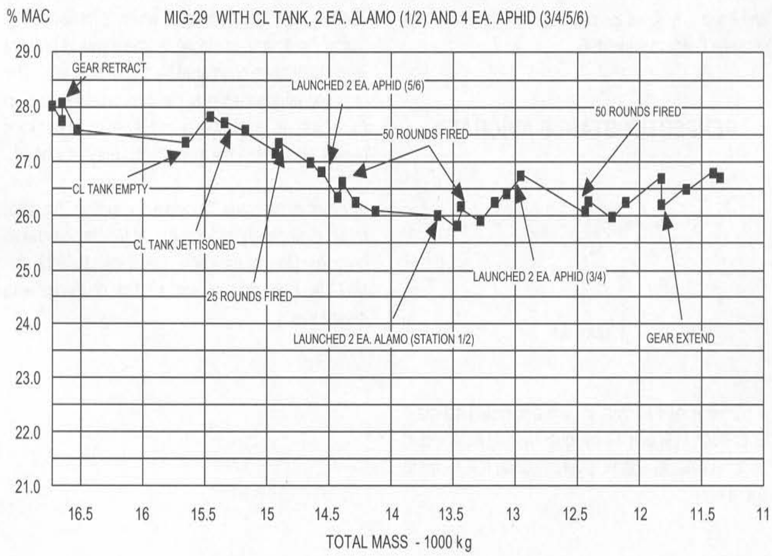


Figure 6-8

HANDLING

Large variations in handling characteristics and qualities exist throughout the flight envelope. Consideration must be given to AOA, Mach number, indicated airspeed, external store loading and CG position.

NORMAL FLIGHT

TAKEOFF

During takeoff roll, with the control stick in neutral, the aircraft nose rises slightly when approaching nose wheel liftoff speed. During lower intake duct opening, a noticeable thrust increase and a nose lowering tendency are experienced. Rotating the stick aft to attain a takeoff attitude of approximately 10° allows the aircraft to fly off the runway; however, an overly aggressive rotation may lead to premature liftoff, especially during maximum afterburner takeoff.

When the gear and the LEF / flaps are raised, the nose drops slightly due to momentary loss of lift. Further acceleration requires few trim changes to relieve forward stick pressure.

Response to control inputs with gear and flaps down is nearly identical to that of the clean aircraft; however, if the AOA is increased above 15°, longitudinal stability becomes marginal.

LANDING

During final approach, a noticeable nose lowering tendency caused by reduced taileron effectiveness during airspeed decrease is experienced. Nearly full aft stick is required during flare.

CAUTION

Premature power reduction on final leads to a sudden loss of lift due to the missing vertical thrust component combined with a simultaneous pitch-down tendency. Tail scratches may result if the pilot compensates with rapid aft stick.

Power reduction in the flare should be delayed until a smooth touch-down is assured. Excessive sink rates have to be countered primarily with power and careful aft stick; yet, consideration has to be given to engine spool-up time.

MANEUVERING FLIGHT

Below 9° AOA, stick force and control input are not linear, resulting in small control transients which impede e.g. accurate altitude control slightly. From 9° to 15° AOA, stick forces required increase continuously; however, LEF extension causes an uncommanded pitch-up to approximately 11° AOA within half a second.

Beyond 15° AOA, the required stick force and control input decrease rapidly to a degree where the aircraft has an inherent tendency towards uncommanded pitch-up at an AOA of approximately 18°. This may lead to inadvertent overshoot of the load factor limit due to stick force lightening. Roll capability deteriorates with increasing AOA, and lateral control stick inputs must be kept at or below half the available stick travel to avoid excessive yaw which is accompanied by even lower roll rates.

Above 20°, stick forces and the required control deflections increase rapidly and remain heavy. Available roll rates deteriorate further.

WARNING

If exceeding the operational AOA limit even momentarily, aileron inputs must be avoided because the risk of departure increases rapidly.

With the LEF retracted, the usable AOA range is reduced considerably; however, buffet onset at 12° to 13° gives a good warning of the LEF not being extended. Stick force lightening will occur already at 13° to 14° AOA, wing drop can be expected in the region of 17° to 18° AOA. However, the pitch kicker threshold is lowered to 15° AOA (GT: 14°) with the LEF retracted.

TRANSONIC REGION

While accelerating in the high subsonic region, the aircraft is subject to an uncommon nose-up moment, especially at low altitude. Depending on store loading, even full forward stick may not be sufficient to maintain level flight beyond M 0.95. The resultant climb cannot be stopped until higher Mach numbers (above M 1.05) are reached.

CAUTION

With the dampers operating, SPPO may occur between M 0.95 and M 1.3 at altitudes below 13 000 ft. Oscillations are more intense at low altitude where the amplitude may reach up to 1 g below 3 000 ft. The oscillation frequency of 1.0 to 1.5 Hz in combination with other transient inputs, e.g., large thrust changes or speedbrake extension / retraction, contains an inherent risk of PIO.

Intensity of the oscillation amplitude and also severity of the nose-up tendency diminish with increasing altitude and are barely noticeable above 30 000 ft.

SUPERSONIC FLIGHT

As Mach number increases to the supersonic region, taileron effectiveness decreases. Maneuvering stick forces are high. Maneuvering capability is limited by taileron effectiveness at higher Mach numbers and altitudes; for example, full aft stick at M 2.0 at 50 000 ft will produce about 5.3 g while full aft stick at M 1.5 at 40 000 ft will produce about 6 g. Roll rate, although decreasing with Mach number, remains adequate up to the limiting Mach numbers.

HIGH ALTITUDE

As altitude increases, damper effectiveness decreases in all three axes, stabilization is slowed and less effective than at lower altitudes. Aircraft response to control inputs is slow, roll rates develop hesitantly, but once a rate is established, it takes longer to stop it.

FLIGHT WITH ASYMMETRIC LOAD

On flights with one ALAMO and two APHIDs under the same wing and the other wing clean, aileron trim required to maintain wings level flight is equivalent to 1/3 stick travel at 12° AOA.

As AOA increases, trim required to maintain wings level increases, too; e.g., at 14° AOA, trim equivalent to 1/3 stick travel is only sufficient to balance one ALAMO missile or two APHID missiles.

At 15° AOA, roll rate development is slow with a delay of about 3 to 4 seconds.

CAUTION

At 20° to 22° AOA, the available roll rate decreases to 10 to 15 °/sec, roll rates become jerky and reversals have to be expected. Above 22° AOA, lateral control is lost.

FLIGHT WITH WING DROP TANKS

As long as there are no asymmetries and the AOA remains low, there is very little apparent influence of the WDTs on the handling qualities. However, measurements have given evidence of a detrimental effect of the tanks, both on longitudinal and lateral / directional stability characteristics.

In the region of 18° AOA, the aircraft has an inherent tendency to pitch-up uncommanded. If WDTs are carried, this may lead to inadvertent overshooting of the 20° operational AOA limit of the tanks. In such a case, aileron inputs must be minimized to avoid the risk of a departure. A similar effect applies to the load factor limit; due to stick force lightening there may be a tendency of the aircraft to increase g without the pilot increasing backstick pressure. This becomes particularly relevant when maneuvering near the operational limit of the WDTs (4 g feeding / 6 g empty) while airspeed is decreasing.

With the WDTs partially full (approximately 3 600 to 4 800 kg total fuel load), there is the possibility of the fuel sloshing massively within the tanks. In conjunction with rapid pitch inputs, e.g., during formation flying or gun aiming, this causes sudden CG changes which add up to the pilot's inputs and therefore provoke PIOs. In this condition, flight with damper failure requires particularly smooth control inputs.

The WDTs have a strong influence on buffet levels. While buffet onset appears roughly at the same parameters as with the basic aircraft, buffet intensity is much increased. Buffeting gives good warning of approaching AOA limits or g limits throughout most of the envelope.

CAUTION

If an AOA of 18° is approached slowly, the aircraft displays a peculiar lateral divergence which causes a sudden rolling motion to the right. This effect becomes significant in the landing pattern and particularly so with a fuel asymmetry (one WDT full, the other empty).

EFFECT OF THRUST

Increasing thrust leads to a nose-up pitch moment (e.g., acceleration from IDLE to MIL power requires a forward stick movement of approximately 15 mm at 325 KIAS and of up to 40 mm at 160 to 190 KIAS).

SPEEDBRAKES

Speedbrake extension causes a pitch-up moment at subsonic airspeeds and a pitch-down moment at supersonic airspeeds. The load factor change may reach up to 1 g.

DEPARTURE FROM CONTROLLED FLIGHT

Departure is the loss of aircraft control that is characterized primarily by uncommanded aircraft motions or failure of the aircraft to react to control inputs.

Departures are caused by an adverse combination of AOA and sideslip and can be prevented only by proper control of AOA. The loss of stability usually causes a sudden wing drop (post stall gyration) in either direction. Development of a departure varies with configuration, airspeed and attitude. The slower the airspeed, the slower the departure.

Even with small angles of sideslip, e.g., induced by aileron deflection, the AOA at which a departure occurs is reduced considerably. Aileron deflection causes a wing drop in the direction opposite to the control input. The MiG-29 is generally very benign and highly departure resistant. Serious losses of control result from extended application of pro-departure control inputs.

WARNING

With the LEF not extended, a departure may occur at AOAs as low as 18°.

The best method to break a stall is to neutralize controls. Moving the control stick to a position forward of neutral hampers recovery since taileron effectiveness is reduced at high AOA and the rudders are partially blanked out by the taileron if the stick is moved forward of neutral.

WARNING

The normal tendency to counteract the wing drop by applying opposite aileron will aggravate the situation and make the development of a spin probable.

DEEP STALL

A deep stall is characterized by irregular pitch and bank oscillations with the yaw rate cycling back and forth, best described as 'like a falling leaf', and development of a high sink rate.

Recovery only requires neutralizing the controls.

NOTE

Moving the control stick to a position forward of neutral hampers recovery since taileron effectiveness is reduced at high AOA and the rudders are partially blanked out by the taileron if the stick is moved forward of neutral.

Recovery is generally characterized by the nose pitching down, airspeed increasing, and AOA and sideslip returning to the normal range. The airspeed should be allowed to increase to 190 KIAS, if altitude permits, prior to dive recovery to prevent possible secondary departure.

SPIN

A spin is a stall with practically all forward motion stopped and a sustained yaw rate in one direction. Spins can be entered from level flight stalls and tactical maneuvers including accelerated turns, reversals, and vertical climbs and dives. Spins have been entered through a wide airspeed range, but are most likely to occur between 190 kts and 350 kts. However, development of a spin usually results from applying pro-spin controls during departure. Investigations have shown that altitude has virtually no effect on spin characteristics. Above 40 000 ft, protracted development simplifies recovery, however, engine instabilities and possible flameout are more likely than at lower altitudes.

STEEP SPIN

A steep spin is characterized by an AOA of 35° to 50°. The oscillation in yaw rate can vary between 30 and 40 °/sec. Pitch and roll oscillations are rather moderate. A sinkrate of 21 000 to 24 000 ft/min, approximately 3 100 to 4 800 ft per rotation, will develop within 10 to 12 seconds.

WARNING

Engaging the Auto Recover Mode (green button) will provide pro-spin controls.

NOTE

Usually, recovery is initiated by neutralizing the controls during development, however, application of full rudder in the direction of the spin during recovery procedure should effectively initiate recovery.

MODERATE FLAT SPIN

A moderate flat spin is characterized by an AOA of 50° to 60°. The oscillation in yaw rate can vary between 40 and 65 °/sec. Pitch and roll oscillations are rather violent. Severity and magnitude of the oscillations depend on entry conditions and aircraft loading. Recovery can be effectively initiated by application of the recovery procedure.

FLAT SPIN

A flat spin is characterized by an AOA of 60° to 70°. Oscillation in pitch and roll are very small and the yaw rate stabilizes between 85 and 115 °/sec. The flat spin is very smooth and there will be no hesitations in yaw during each turn as the nose wanders nearly along the horizon. However, the rotation rate causes a forward acceleration to the pilot which hampers control inputs. A sinkrate of 17 000 to 20 000 ft/min, approximately 900 to 1 400 ft per rotation will develop within 10 to 12 seconds.

Usually the flat spin results either from extreme lateral control inputs during departure, or develops from a steep spin during recovery attempt.

Recovery technique is initially identical to the steep spin, however, it requires full aileron deflection in the direction of the spin.

As soon as the yaw rate decreases or the nose drops, the stick is moved forward to the neutral position. When the yaw rate has ceased, ailerons and rudders are neutralized, too.

INVERTED SPIN

An inverted spin usually results from misapplying the recovery technique used for recovery from a flat spin. Tip over to the inverted position is accompanied by considerable negative load factors. In this case, all controls must be neutralized immediately.

CAUTION

A double engine flame out is highly probable, because the engine air intakes are not designed for high negative g loads with high yaw rates.

SECTION 7

ALL WEATHER OPERATION

TABLE OF CONTENTS

	Page
Introduction	7-3
Instrument Flight	7-3
Takeoff	7-3
Climb	7-3
Cruise	7-3
Holding	7-3
Descent	7-3
INSTRUMENT APPROACHES	
TACAN Approach	7-4
TACAN Approach - Single Engine	7-4
Circling Approach	7-4
GCA (PAR) Approach	7-6
Single Engine GCA	7-6
Missed Approach	7-6
NIGHT FLYING	
Preflight	7-8
Flight	7-8
COLD WEATHER PROCEDURES	
Ground Operation	7-8
Taxiing	7-8
Takeoff	7-8
Flight, Penetration and Landing	7-8
HOT WEATHER/DESERT PROCEDURES	
Turbulence and Thunderstorms	7-9
Approaching the Thunderstorm	7-9
In the Thunderstorm	7-9
Lightning	7-9

INDRODUCTION

This section provides information about the aircraft operation under various conditions such as IMC, turbulent air, extreme temperature and about penetration and approach procedures. These are procedures that differ from, or are in addition to those contained in the normal operating procedures covered in section 2 of this manual.

INSTRUMENT FLIGHT

The MIG-29G/GT generally has the capability to comply with all ICAO regulations, some modifications of the standard instrument procedures may be required.

TAKE OFF

The instrument takeoff is accomplished by using a combination of visual outside references and instruments. The HUD/HDD should only be used as secondary instrument. After brake release use visual references to maintain runway alignment. As the takeoff progresses the pilot should alter his attention to the instruments readings, mainly airspeed, AOA and pitch attitude. Apply takeoff procedures and technique, as described for takeoff in Section 2 of this manual.

CLIMB

After liftoff, approximately maintain 10° climb attitude until gear and flaps/LEF are retracted. As airspeed and altitude increases, cross check all flight and engine instruments. When approaching 300 KIAS, adjust pitch as necessary to maintain airspeed until reaching M 0.8 or cruise Mach/TAS.

To prevent overshooting the assigned altitude, use approximately 10% of the VVI reading as a lead point to initiate level off.

CRUISE

For maximum range or endurance data, refer to Appendix A, Performance Data, of this manual.

HOLDING

Holding patterns are normally flown with 280 KIAS, using standard rate turns, 30° AOB.

DECENT

For a typical TACAN penetration refer to figure 7-1. If a descent through precipitation or clouds is required, recheck pitot heat switch ON and AIR lever to OPEN. The pressure altimeter should be cross checked to confirm terrain clearance at low altitude.

NOTE

During transition to landing, in heavy rain, forward visibility is serverely limited. In order to better determine sink rate and height above touchdown the visual crosscheck should include frequent glances through the left and right front quarter of the canopy.

INSTRUMENT APPROACHES

TACAN APPROACH

A typical TACAN penetration and approach is shown in figure 7-1.

Prior penetration, confirm HUD readings versus instruments. To establish a constant descent with 300 KIAS reduce throttles to 75 % RPM and extend speedbrakes as required.

Lower the landing gear, flaps/LEF and decelerate to reach final approach speed at least one mile prior to the final approach fix (FAF).

TACAN APPROACH - SINGLE ENGINE

The single engine TACAN approach is identical to the normal TACAN approach.

CIRCLING APPROACH

Circling to land is a visual flight maneuver used to align the aircraft with the landing runway when the instrument approach is completed. Situation permitting it should be flown at an altitude higher than the circling MDA, up to normal VFR pattern altitude. Recommended airspeed for circling is 190 KIAS minimum with gear and flaps/LEF extended until established on final.

TACAN APPROACH
TYPICAL

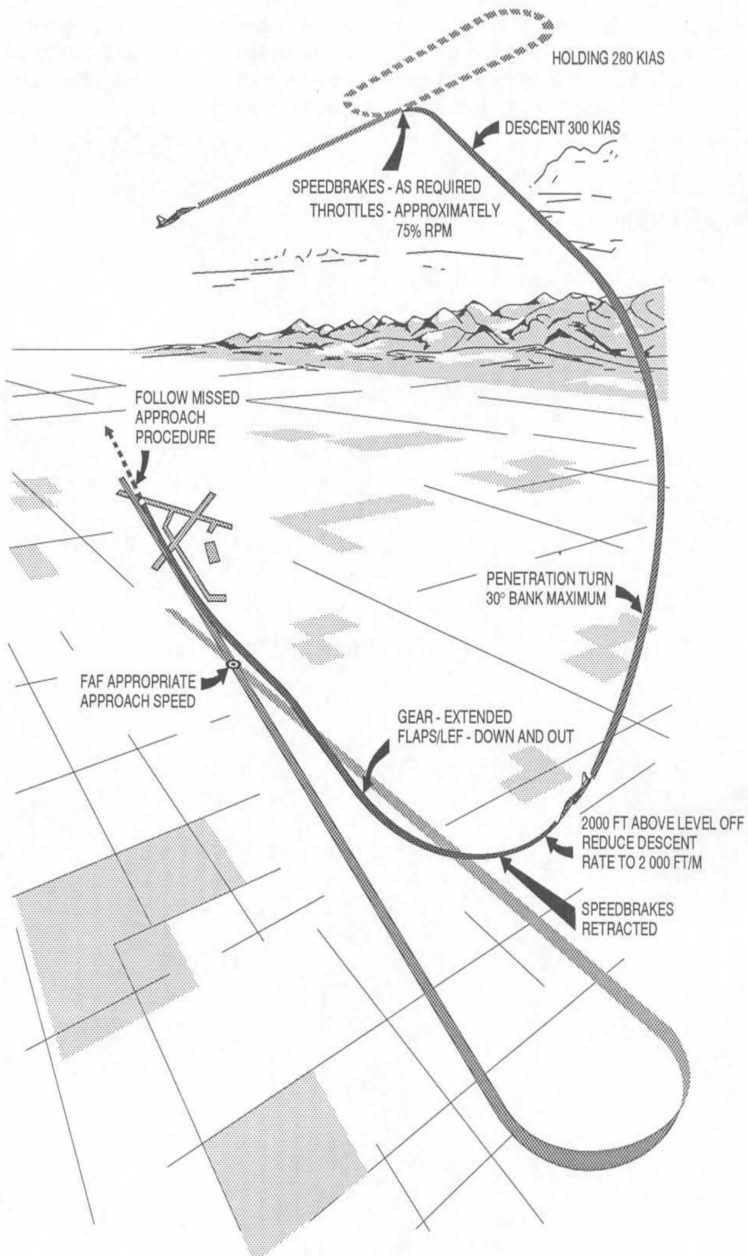


Figure 7-1

GCA (PAR) APPROACH

A typical GCA approach is shown in figure 7-2. Descend to GCA pattern altitude and maintain 230 to 250 KIAS. Establish landing configuration on base leg or at 10 to 12 NM on final approach. Maintain 190 KIAS until completion of turn on to final approach. Rolling out on final reduce approach speed to 175 KIAS.

SINGLE ENGINE GCA

The single engine GCA is flown basically as the normal GCA. Correct for yaw with rudder, as required.

MISSED APPROACH

At missed approach point, advance the throttles to MIL and rotate to climbing attitude. Retract the gear as soon as a positive climb rate is established. Maintain a climb rate of 1 500 to 2 500 ft/min. Retract flaps/LEF and follow missed approach procedure.

GCA (PAR) APPROACH
TYPICAL

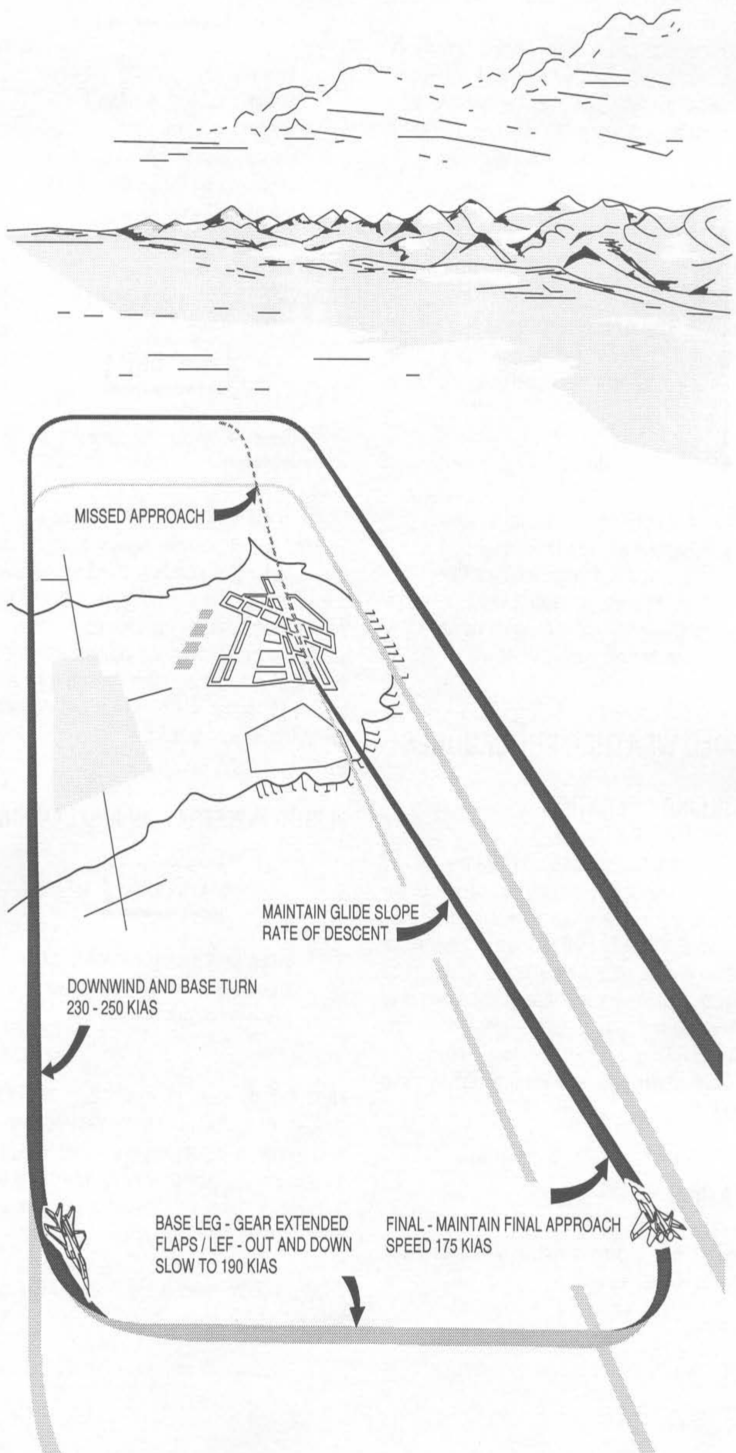


Figure 7-2

NIGHT FLYING

PREFLIGHT

The external and internal lighting should be checked carefully. The internal white lights, except those of the AEKRAN, may be adjusted to a comfortable level using the dimmers. To reduce the brightness of the AEKRAN lighting, a transparent foil may be used.

FLIGHT

The takeoff will normally be performed with the taxi light off. Techniques used for night flying do not differ essentially from those used under instrument conditions during daylight.

NOTE

Normally, the obstruction and navigation lights should be selected to steady and the anti-collision light on. However, to avoid a vertigo in IMC, the anti-collision light may be switched off.

COLD WEATHER PROCEDURES

GROUND OPERATION

The entire aircraft should be free of snow, ice and frost. Accretions may be removed by use of de-icing fluid or hot air. Inspect the aircraft carefully for possible fuel or hydraulic leaks. Ensure that water does not accumulate in engine intakes or on control surfaces where subsequent freezing may cause FOD or binding. Check flight controls and flaps/LEF for proper operation. Move controls fully through several cycles to warm up the hydraulic fluid.

TAXIING

Avoid taxiing in deep or rutted snow since frozen brakes will likely result.

CAUTION

Increase the spacing between taxiing aircraft to maintain a safe stopping distance and to avoid damage caused by pieces of ice thrown up by the jet blast of the preceeding aircraft.

TAKEOFF

WARNING

Takeoff in severe icing conditions is prohibited.

Taxi the aircraft onto the runway to an ice free area to perform the after line-up and engine run-up checks. Rain has little or no appreciable effect on the aircraft's flight performance. However, substantial ice build-ups will cause distortions in the shape of the airfoil surfaces, resulting in partial loss of lift, higher stalling speed and degraded overall handling characteristics.

FLIGHT, PENETRATION AND LANDING

WARNING

When severe icing conditions are encountered, an immediate diversion is necessary.

Flight through areas of known icing should be avoided. If required to climb or descend through icing conditions, penetration time should be kept to a minimum. Optimum penetration speed is above 380 KIAS or 430 to 490 KTAS. If icing is encountered, increase speed and descent rate if feasible.

If icing is encountered below 3 000 ft AGL, land from a straight-in.

HOT WEATHER/DESERT PROCEDURES

CAUTION

Do not attempt takeoff or engine operation in a sand storm or dust storm if avoidable. Park aircraft crosswind and shut down engine to prevent sand or dirt from damaging engine.

TURBULENCE AND THUNDERSTORMS

WARNING

The following factors, single or in combination, could cause a degration of engine performance:

- Penetration of cumulus clouds with associated high moisture content.
- Engine icing of either engine intake or inlet guide vanes.
- Turbulence associated with penetration is likely to result in extreme angles of attack which may cause marginal engine performance.

APPROACHING THE THUNDERSTORM

In view of the above, the pilot should avoid areas of turbulent air, hail storms, or thunderstorms, whenever possible. If a thunderstorm cannot be avoided pentration should be accomplished at an angle of 90° and an airspeed of 270 to 325 KIAS.

During day:
- Pitot heat switch .... Recheck ON
- AFCS modes .... OFF (press < 3 sec)
- Lower ejection seat

Additionally at night:
- Cockpit lighting .... Full bright

CAUTION

Do not try to top thunderstorms at subsonic speeds above 40 000 ft. The stall margin of both the airframe and engines is reduced in this region. Flying through a thunderstorm at the proper airspeed is much more advantageous than floundering into the storm at a dangerously slow airspeed while attempting to reach the top.

IN THE THUNDERSTORM

Maintain a normal instrument crosscheck with added emphasis on the ADI. Attempt to maintain attitude, and accept altitude and airspeed fluctuations.

LIGHTNING

When flying in or near a thunderstorm, the aircraft is susceptible to strikes by lightning. If lightning hits the aircraft, it is usually accompanied by a muffled bang and a flash of light. Sometimes the pilot will experience a light prickling sensation of the skin or a definite static in the headset can be heard. In any case, when a loud bang or a flash of light is experienced, it should be assumed that the aircraft has been hit by lightning.

Lightning usually hits the aircraft in the pitot boom or in some other protruding parts in the front and leaves the aircraft at the trailing edges of the wings, tailerons, vertical stabilizers or any other sharp edges. These parts can be severely damaged. Damage of the aircraft tail section cannot easily be determined by the pilot.

The built-in lightning protection is designed to reduce the damage of the aircraft.
The pilot is well protected, but the avionic equipments, especially the radios and the NAV computer may be affected. The operation of the magnetic compass may also be affected.

When a lightning strike is suspected:
- Check for correct instrument readings.
- Check aircraft handling.
- If possible, have aircraft checked by a chase aircraft.
- Abort the mission and land as soon as practical.
- An entry into the FORM 781 has to be made.

APPENDIX A

PERFORMANCE DATA

TABLE OF CONTENTS

Page

PART 1

INTRODUCTION
Scope A1-1
Aircraft Loading A1-1
Drag Index and Weights A1-1
Airspeed Conversion Data A1-2
Temperature Conversion A1-5
Standard Atmosphere Table A1-6
Wind Components Chart A1-7

PART 2

TAKEOFF
Introduction A2-1
Definition of Terms A2-1
Takeoff Speed Data A2-1
Takeoff Distance Data A2-3
Minimum Go Speed Data A2-7
Maximum Abort Speed Data A2-10

PART 3

CLIMB
Introduction A3-1
Time / Distance Required to Climb A3-1
Fuel Required to Climb A3-3
Maximum Ceiling after T/O MIL Thrust A3-5

PART 4

CRUISE
Introduction A4-1
Initial Optimum Cruise Altitude A4-1
Optimum Cruise Summary A4-3
Fuel Index Number A4-5
Constant Mach Cruise A4-7
Constant Altitude Cruise Fuel Flow A4-10

Page

PART 5

ACCELERATION
Acceleration Data A5-1
Low Altitude Acceleration A5-1
High Altitude Acceleration A5-4
Fuel Consumption Data A5-7

PART 6

DESCENT
Descent Data A6-1

PART 7

LANDING
Introduction A7-1
Landing Speed A7-1
Landing Roll Distance A7-3

PART 8

TACTICAL / COMBAT PERFORMANCE
Introduction A8-1
Zoom Climb A8-1
Sustained G Turn Capability A8-4
Calculated Sustained G A8-7
Calculated G Versus G Available A8-10
Turn Radius A8-12
Time of Turn 180° A8-14
Split S Recovery A8-16
Dive Recovery A8-18
Instantaneous G Available A8-20
Instantaneous Available AOA A8-22
Lift Coefficient A8-24

PART 1

INTRODUCTION

SCOPE

The appendix A is divided into 8 parts to present the performance data in proper sequence for mission planning. Each part contains descriptive text and sample problems for the applicable charts.

AIRCRAFT LOADING

The drag index (DI) and weights chart (refer to figure A1-1) contains the drag number and weight of each externally carried store and its associated suspension equipment.

USE

The drag index for a specific configuration may be found by multiplying the number of stores carried by its drag number and adding the drag number of the applicable suspension equipment. The total drag index may be used to enter other charts for flight planning.

SAMPLE PROBLEM

			DI
Basic aircraft		1 x	230
ALAMO R-27R1	(1, 2)	2 x	17
Launcher APU 470		2 x	7
ARCHER R-73Ä	(3, 4)	2 x	12
Launcher P-72-1D		2 x	3
		Total DI	308

DRAG INDEX AND WEIGHTS

	DRAG / STORE	WEIGHT / STORE (KG)	STATION NUMBER
Basic aircraft MIG-29G incl. 3 360 kg fuel	230	14 360	-
Basic aircraft MIG-29GT incl. 3 360 kg fuel	230	14 300	-
Launcher P-72-1D for ARCHER	3	59	1, 2, 3, 4, 5, 6
Launcher APU 470 for ALAMO	7	60	1, 2
Launcher P-62-1DB1 for APHID	3	45	1, 2, 3, 4, 5, 6
ARCHER R-73Ä	12	105	1, 2, 3, 4, 5, 6
ALAMO R-27R1	17	253	1, 2
APHID R-60 MK MOD	8	45	1, 2, 3, 4, 5, 6
ARCHER R-73 ÜB	12	77	1, 2, 3, 4, 5, 6
APHID R-60 ÜB	8	25	1, 2, 3, 4, 5, 6
CL TANK empty	22	116	7
CL TANK incl. 1 500 l fuel	22	1 316	7
TRAVEL POD	NE	53	1, 2
AIS POD	NE	57	2
PYLON FOR WDT	3	59	1, 2
WDT	37	83	1, 2
WDT incl. 920 kg FUEL	37	1 003	1, 2
FLIGHT DATA RECORDER	NE	86 ±2	2
NOSE GUN AMMO (150 ROUNDS)	NA	125	-

NE = Not Established

Figure A1-1

AIRSPEED CONVERSION DATA

Airspeed conversion charts are presented for low Mach in figure A1-2 and high Mach in figure A1-3. Calibrated airspeed, true airspeed and Mach numbers as a function of altitude and temperature can be obtained.

Indicated Airspeed (IAS)

Indicated airspeed is the uncorrected airspeed read directly from the indicator.

Calibrated Airspeed (CAS)

Calibrated airspeed is indicated airspeed corrected for static source error.

Equivalent Airspeed (EAS)

Equivalent airspeed is calibrated airspeed corrected for compressibility.

True Airspeed (TAS)

True airspeed is equivalent airspeed corrected for density altitude.

USE

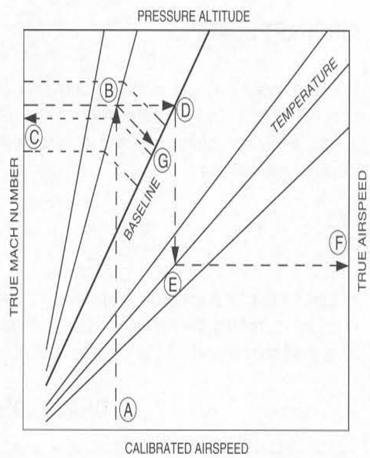
To find true Mach number or TAS, enter these charts at CAS (A), proceed vertically upwards to intersect altitude (B), continue horizontally to the left to read true Mach number (C). To determine TAS proceed to the right towards the sea level baseline (D), continue vertically down to intersect the temperature corresponding to flight level temperature (E), then horizontally to the right to read TAS (F).

The TAS for standard day may be obtained directly by paralleling the curved dashed lines from the intersection of CAS and altitude (B) to the sea level baseline (G).

SAMPLE PROBLEM

KIAS	= 300 kts
Pressure altitude	= 25 000 ft
Temperature	= -20 °C
True Mach	= M 0.72
TAS (Std Day)	= 445 kts

SAMPLE AIRSPEED CONVERSION



AIRSPEED CONVERSION

LOW MACH

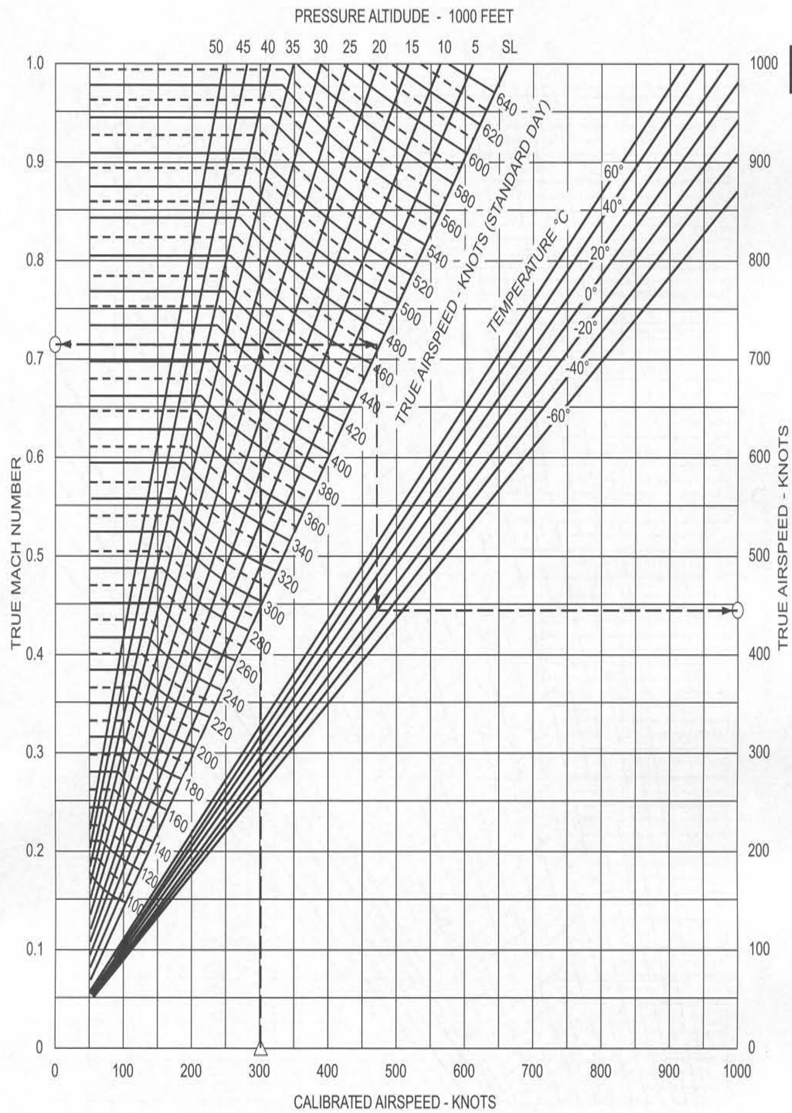


Figure A1-2

AIRSPEED CONVERSION

HIGH MACH

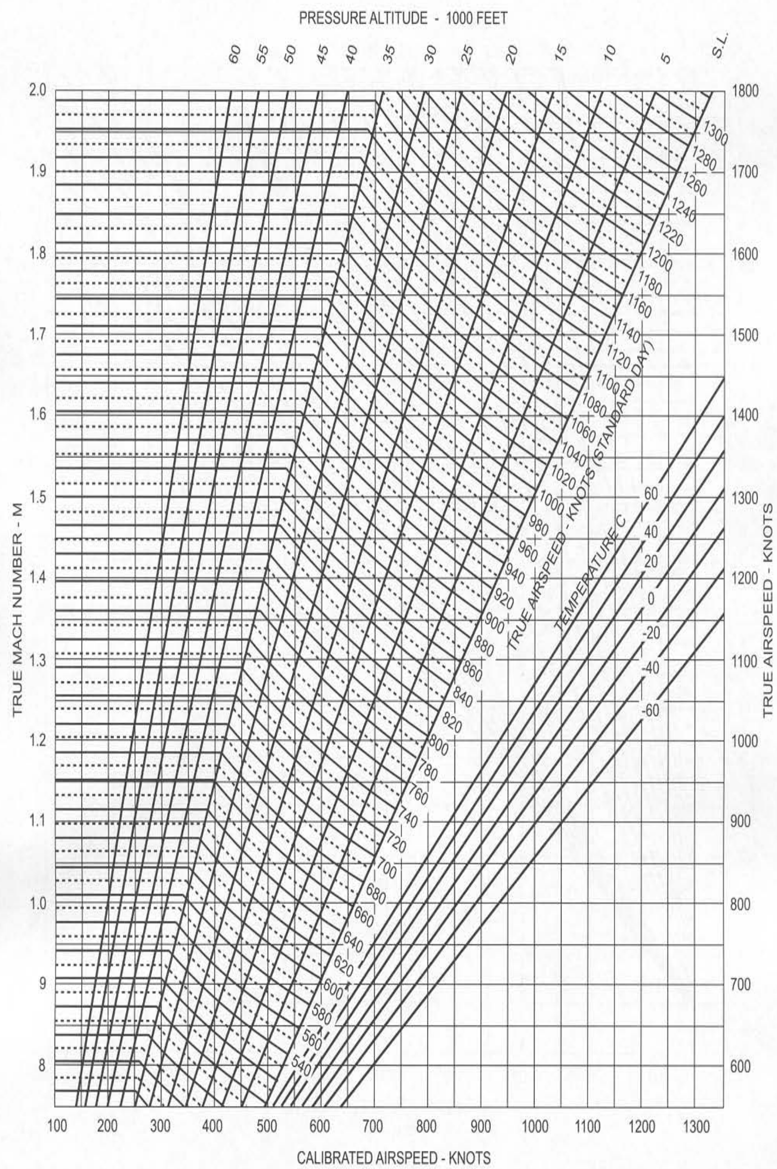


Figure A1-3

TEMPERATURE CONVERSION

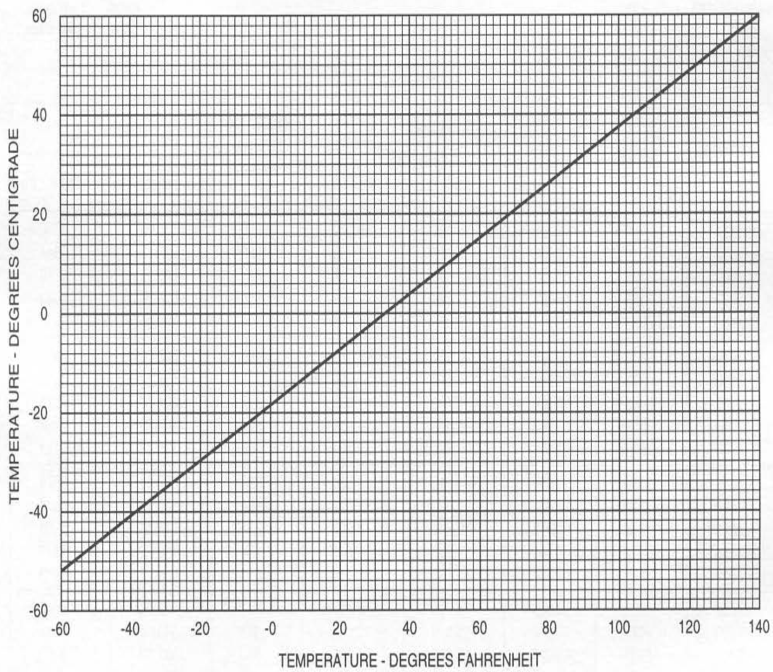


Figure A1-4

STANDARD ATMOSPHERE TABLE

STANDARD SEA LEVEL AIR:
T = 15° C
P = hPa

1 KNOT - 1,852 km/h
1 KNOT - 1,688 ft/sec

ALTITUDE FEET	DENSITY RATIO P / Po	$1/\sqrt{\sigma}$	TEMPERATURE		SPEED OF SOUND RATIO a, a_0	PRESSURE	
			DEG. C	DEG. F		hPA	RATIO P / Po
0	1.0000	1.0000	15.000	59.000	1.000	1013.25	1.0000
1000	.9710	1.0148	13.019	55.434	.997	977.18	.9644
2000	.9428	1.0299	11.038	51.868	.993	942.12	.9298
3000	.9151	1.0454	9.056	48.301	.990	908.07	.8962
4000	.8881	1.0611	7.075	44.735	.986	875.24	.8636
5000	.8616	1.0773	5.094	41.169	.983	843.02	.8320
6000	.8358	1.0938	3.113	37.603	.979	812.02	.8013
7000	.8106	1.1107	1.132	34.037	.976	781.87	.7716
8000	.7859	1.1280	-0.850	30.471	.972	752.63	.7427
9000	.7619	1.1456	-2.831	26.904	.968	724.27	.7147
10,000	.7384	1.1637	-4.812	23.338	.965	696.81	.6876
11,000	.7154	1.1822	-6.793	19.772	.962	669.16	.6614
12,000	.6931	1.2012	-8.774	16.206	.958	644.43	.6359
13,000	.6712	1.2206	-10.756	12.640	.954	619.40	.6112
14,000	.6499	1.2404	-12.737	9.074	.950	595.28	.5873
15,000	.6291	1.2608	-14.718	5.507	.947	571.78	.5642
16,000	.6088	1.2816	-16.699	1.941	.943	549.18	.5418
17,000	.5891	1.3029	-18.680	-1.625	.940	527.19	.5202
18,000	.5698	1.3247	-20.662	-5.191	.936	506.02	.4992
19,000	.5509	1.3473	-22.643	-8.757	.932	485.45	.4790
20,000	.5327	1.3701	-24.624	-12.323	.929	465.59	.4594
21,000	.5148	1.3937	-26.605	-15.890	.925	446.44	.4405
22,000	.4974	1.4179	-28.586	-19.456	.922	427.90	.4222
23,000	.4805	1.4426	-30.568	-23.022	.917	409.96	.4045
24,000	.4640	1.4681	-32.549	-26.588	.914	392.74	.3874
25,000	.4480	1.4940	-34.530	-30.154	.910	376.02	.3709
26,000	.4323	1.5209	-36.511	-33.720	.906	359.91	.3550
27,000	.4171	1.5484	-38.493	-37.287	.903	344.30	.3397
28,000	.4023	1.5768	-40.474	-40.853	.899	329.31	.3248
29,000	.3879	1.6056	-42.455	-44.419	.895	314.82	.3106
30,000	.3740	1.6352	-44.436	-47.985	.891	300.94	.2968
31,000	.3603	1.6659	-46.417	-51.551	.887	287.46	.2834
32,000	.3472	1.6971	-48.399	-55.117	.883	274.49	.2707
33,000	.3343	1.7295	-50.379	-58.684	.879	262.03	.2583
34,000	.3218	1.7628	-52.361	-62.250	.875	249.97	.2465
35,000	.3098	1.7966	-54.342	-65.816	.871	238.42	.2352
36,000	.2981	1.8315	-56.323	-69.382	.868	227.27	.2243
36,089	.2971	1.8347	-56.500	-69.700	.867	226.36	.2234
37,000	.2843	1.8753	-56.500	-69.700	.867	216.63	.2138
38,000	.2710	1.9209	-56.500	-69.700	.867	206.50	.2038
39,000	.2583	19677	-56.500	-69.700	.867	196.77	.1942
40,000	.2462	2.0155	-56.500	-69.700	.867	187.55	.1851
41,000	.2346	2.0645	-56.500	-69.700	.867	178.37	.1764
42,000	.2236	2.1148	-56.500	-69.700	.867	170.44	.1681
43,000	.2131	2.1662	-56.500	-69.700	.867	162.21	.1602
44,000	.2031	2.2189	-56.500	-69.700	.867	154.76	.1527
45,000	.1936	2.2728	-56.500	-69.700	.867	147.65	.1455
46,000	.1845	2.3281	-56.500	-69.700	.867	140.50	.1387
47,000	.1758	2.3848	-56.500	-69.700	.867	133.90	.1322
48,000	.1676	2.4428	-56.500	-69.700	.867	127.60	.1260
49,000	.1597	2.5022	-56.500	-69.700	.867	121.60	.1201
50,000	.1522	2.5630	-56.500	-69.700	.867	115.90	.1145

Figure A1-5

WIND COMPONENTS CHART

A standard wind components chart (figure A1-6) is included. It is used primarily for breaking a forecast wind down into crosswind and headwind components.

USE

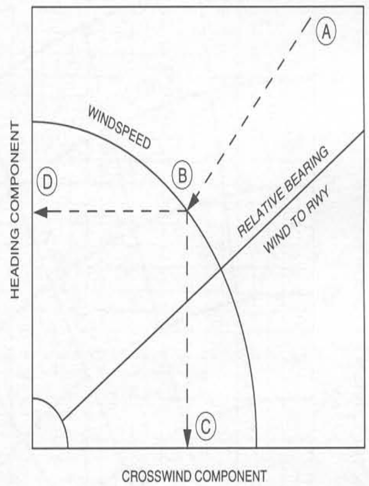
Determine the effective wind velocity by adding one half of the gust velocity (incremental wind factor) to the steady state velocity; e.g., reported wind 050/20G30, effective wind is 050/25. Reduce the reported wind direction to a relative bearing by determining the difference between the wind direction and runway heading. Enter the chart with the relative bearing (A). Move along the relative bearing to intercept the effective wind speed arc (B). From this point, descend vertically downward to read the crosswind component (C). From the intersection of bearing and wind speed, project horizontally to the left to read headwind component (D).

SAMPLE PROBLEM

Reported wind 050/35, runway heading 030

Relative bearing	= 40°
Intersect windspeed arc	= 35 kts
Crosswind component	= 22 kts
Headwind component	= 27 kts

SAMPLE WIND COMPONENTS



WIND COMPONENTS

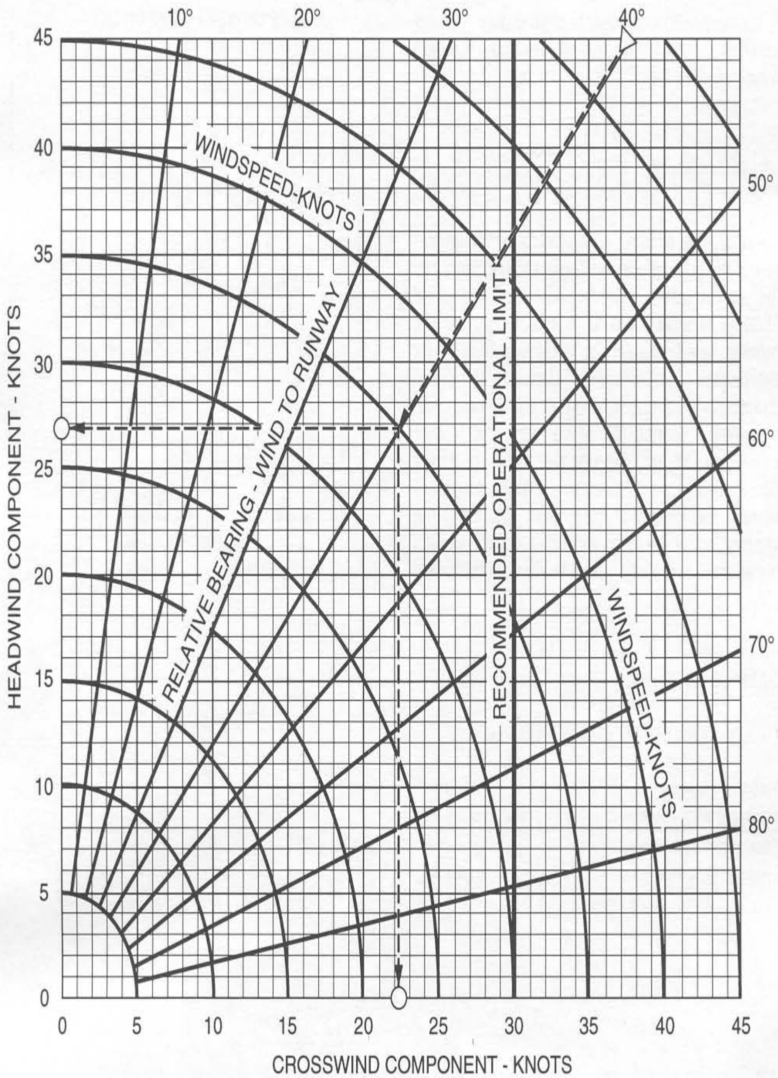


Figure A1-6

PART 2

TAKEOFF

INTRODUCTION

Planning data for takeoff under various conditions are presented in this part.

DEFINITION OF TERMS

TAKEOFF SPEED

The speed at which the main gear leaves the runway.

NORMAL TAKEOFF

This takeoff is carried out with throttles in MIL or AB.

MINIMUM GO SPEED

The minimum engine failure speed to continue the takeoff within the remaining runway length, with the failed engine windmilling and the operating engine at MIL. The takeoff must be aborted if an engine fails before minimum go speed is reached.

MAXIMUM ABORT SPEED

The maximum speed at which an abort may be started and the aircraft stopped within the remaining runway length.

TAKEOFF SPEED DATA

The chart in figure A2-1 provides takeoff speed for MIL and MAX AB takeoff. For various gross weights it is primarily to adjust takeoff distances resulting from adverse weather conditions.

USE

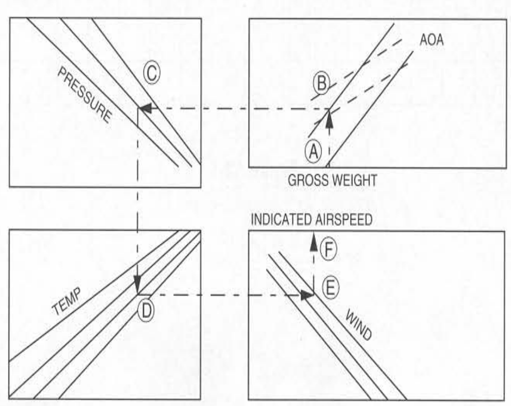
To determine takeoff speed, enter the chart with applicable gross weight (A), proceed vertically upwards to AOA with MIL or MAX thrust (B), project horizontally to pressure altitude (C), proceed vertically downwards to temperature (D), project horizontally to wind (E) and continue vertically upwards to read takeoff speed (F).

SAMPLE PROBLEM

Normal Takeoff

Gross weight	= 15 000 kg
AOA	= 12°, MIL thrust
Pressure altitude	= 0 ft
Temperature	= +34 °C
Wind	= 25 kts tailwind
Takeoff speed	= 154 kts

SAMPLE TAKEOFF SPEED



TAKEOFF SPEED

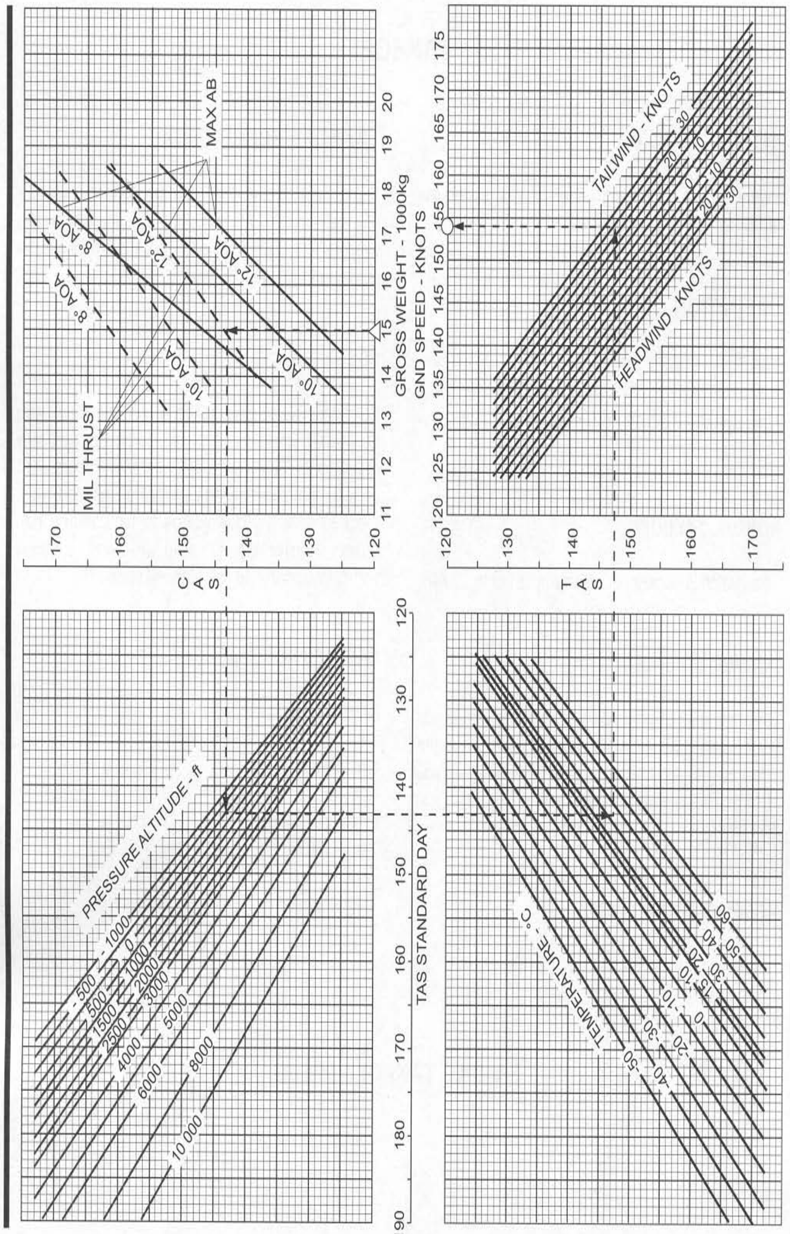


Figure A2-1

TAKEOFF DISTANCE DATA

These charts are used to determine the takeoff distance. Separate charts are provided for aircraft engines in NPM (figure A2-2), aircraft engines in LPM (figure A2-3) and for the GT (figure A2-4). A simplified method to calculate liftoff speed is included.

USE

Enter these charts with gross weight (A), proceed vertically upwards to intercept the lower MIL or MAX AB line (B), proceed horizontally to intercept the appropriate pressure altitude line (C). Proceed vertically downwards to temperature (D) and continue horizontally to relevant wind curves (E). Project vertically downwards to the required takeoff distance baseline (F). To obtain liftoff speed, proceed with the gross weight vertically upwards to the upper MIL or MAX AB line (G) continue left to read liftoff speed (H).

SAMPLE PROBLEM (NPM)

Normal Takeoff

Gross weight	= 15 750 kg
AOA	= 12°, MIL thrust
Liftoff speed	= 148 kts
Pressure altitude	= 4 500 ft
Temperature	= -20 °C
Wind	= 10 kts headwind
Takeoff distance	= 2 450 ft

SAMPLE PROBLEM (LPM)

Normal Takeoff

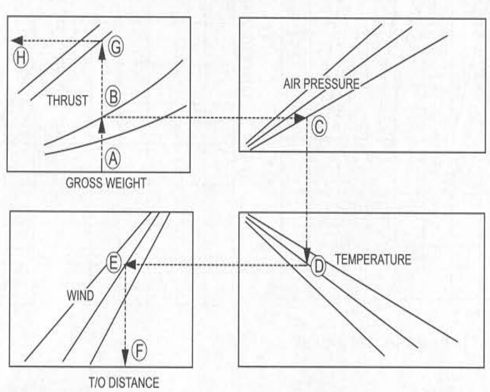
Gross weight	= 15 750 kg
AOA	= 12°, MIL thrust
Liftoff speed	= 148 kts
Pressure altitude	= 4 500 ft
Temperature	= -20 °C
Wind	= 10 kts headwind
Takeoff distance	= 2 700 ft

SAMPLE PROBLEM (GT)

Normal Takeoff

Gross weight	= 15 750 kg
AOA	= 12°, MIL thrust
Liftoff speed	= 148 kts
Pressure altitude	= 4 500 ft
Temperature	= -20 °C
Wind	= 10 kts headwind
Takeoff distance	= 2 500 ft

SAMPLE TAKEOFF DISTANCE



TAKEOFF DISTANCE (NPM)

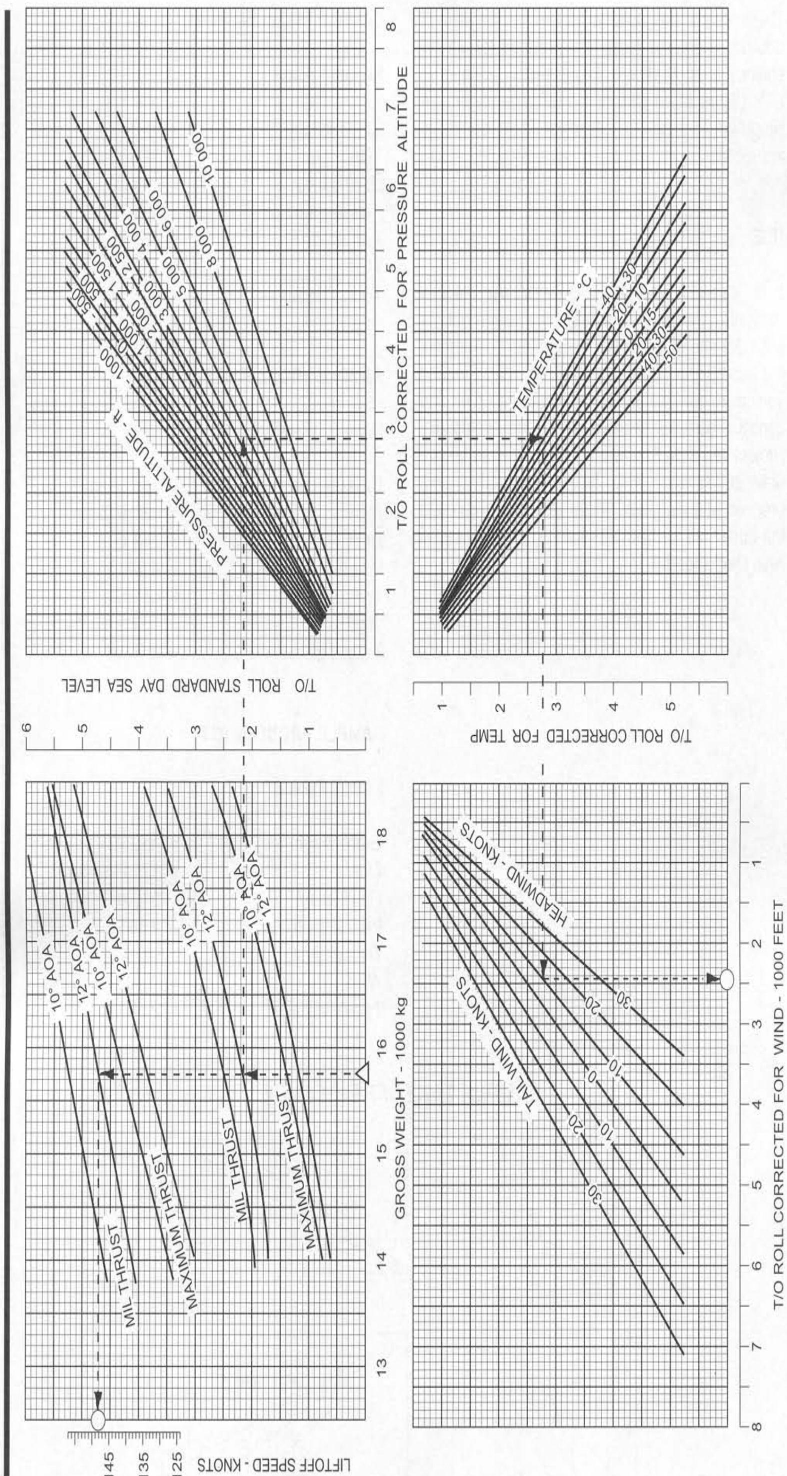


Figure A2-2

TAKEOFF DISTANCE (LPM)

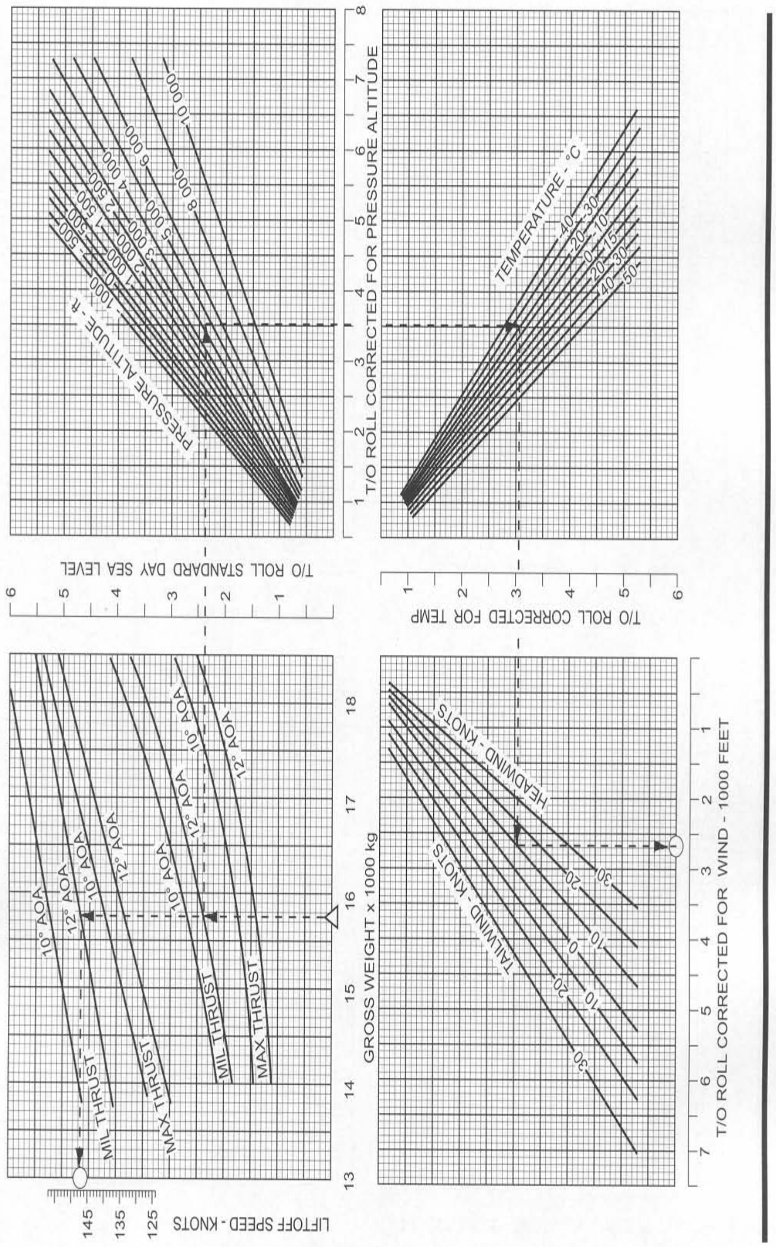


Figure A2-3

TAKEOFF DISTANCE (GT)

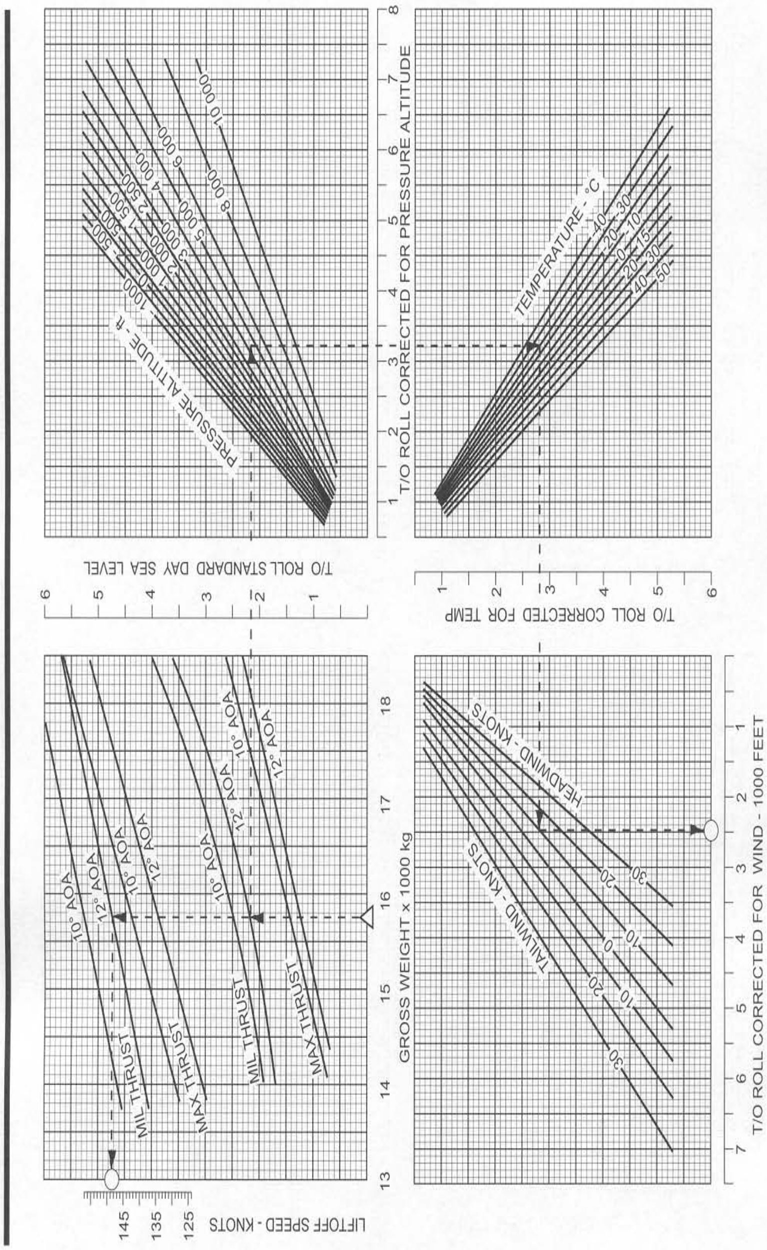


Figure A2-4

MINIMUM GO SPEED DATA

The charts presented are used to determine the minimum speed at which an engine failure can be experienced but safe takeoff is still assured. Separate charts are provided for aircraft engines in NPM (figure A2-5) and in LPM (figure A2-6).

USE

Enter these charts with the available RWY length (A), project horizontally to gross weight (B) and proceed vertically downwards to the baseline to read the minimum go speed (C).

SAMPLE PROBLEM (NPM)

Normal Takeoff

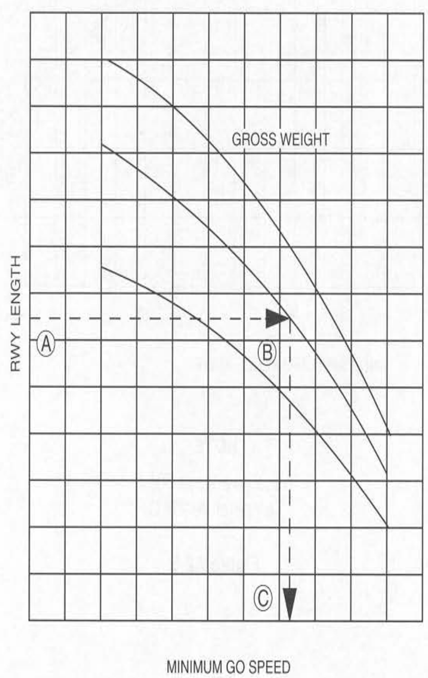
Avail. RWY length	= 4 350 ft
Gross weight	= 15 500 kg
Min go speed	= 113 kts

SAMPLE PROBLEM (LPM)

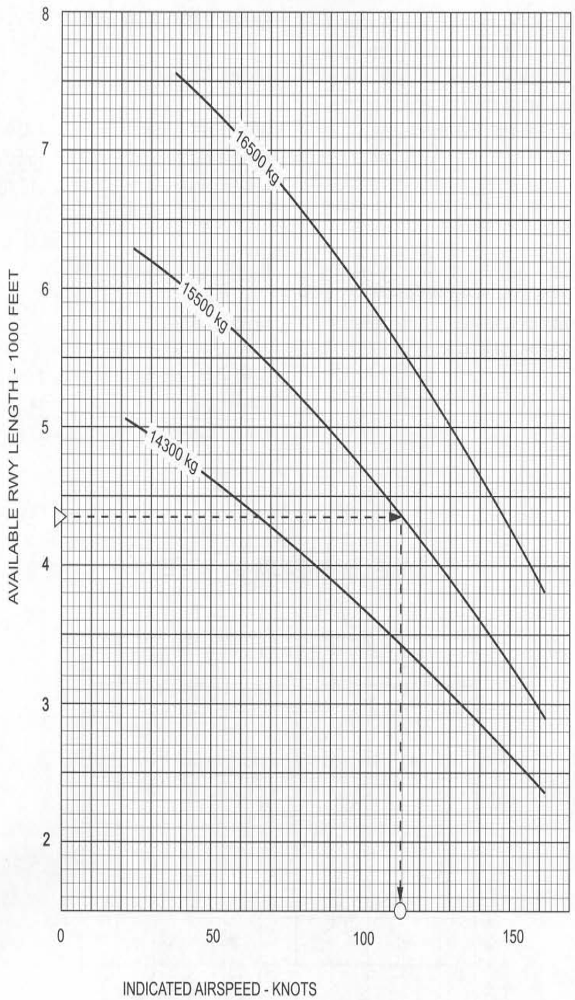
Normal Takeoff

Avail. RWY length	= 4 350 ft
Gross weight	= 14 300 kg
Min go speed	= 93 kts

SAMPLE MINIMUM GO SPEED



MINIMUM GO SPEED (NPM)

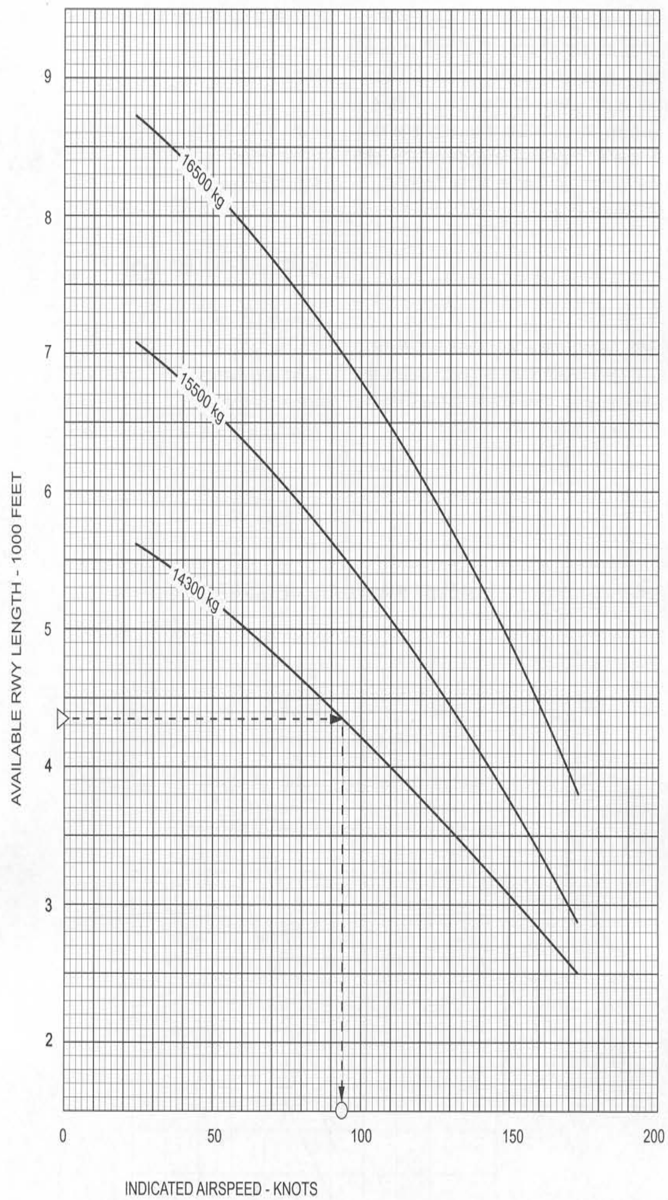


NOTE

Pressure altitude 530 ft
Temperature 27° C

Figure A2-5

MINIMUM GO SPEED (LPM)



NOTE

Pressure altitude 530 ft
Temperature 27° C

Figure A2-6

MAXIMUM ABORT SPEED DATA

These charts present the maximum speed at which an abort may be started and the aircraft stopped within then remaining runway length. Barrier engagement is not taken into consideration. Brakes can be applied at or below the recommended maximum braking speed. Separate charts are provided for aircraft engines in NPM (figure A2-7) and in LPM (figure A2-8).

USE

Enter these charts with the available runway length (A), project horizontally to gross weight (B) and proceed vertically downwards to the baseline to read the maximum abort speed (C).

SAMPLE PROBLEM (NPM)

Normal Takeoff

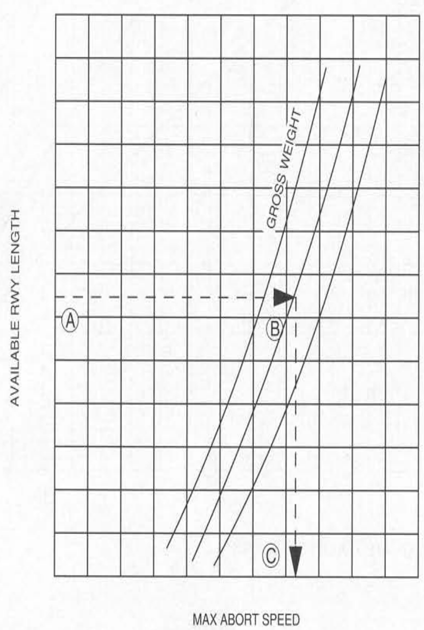
Avail. RWY length	= 4 350 ft
Gross weight	= 14 300 kg
Max abort speed	= 109 kts

SAMPLE PROBLEM (LPM)

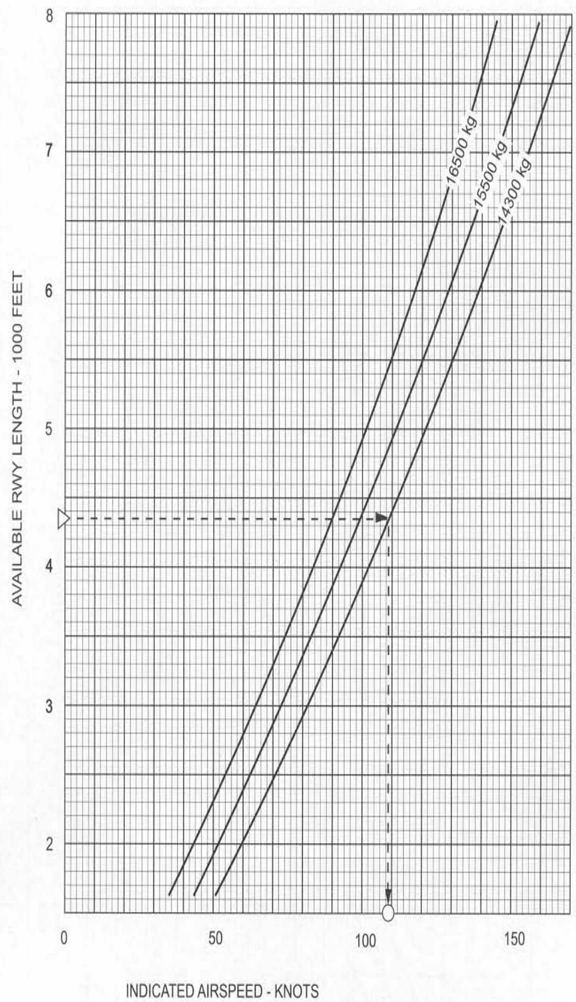
Normal Takeoff

Avail. RWY length	= 4 350 ft
Gross weight	= 14 300 kg
Max abort speed	= 106 kts

SAMPLE MAX ABORT SPEED



MAXIMUM ABORT SPEED (NPM)

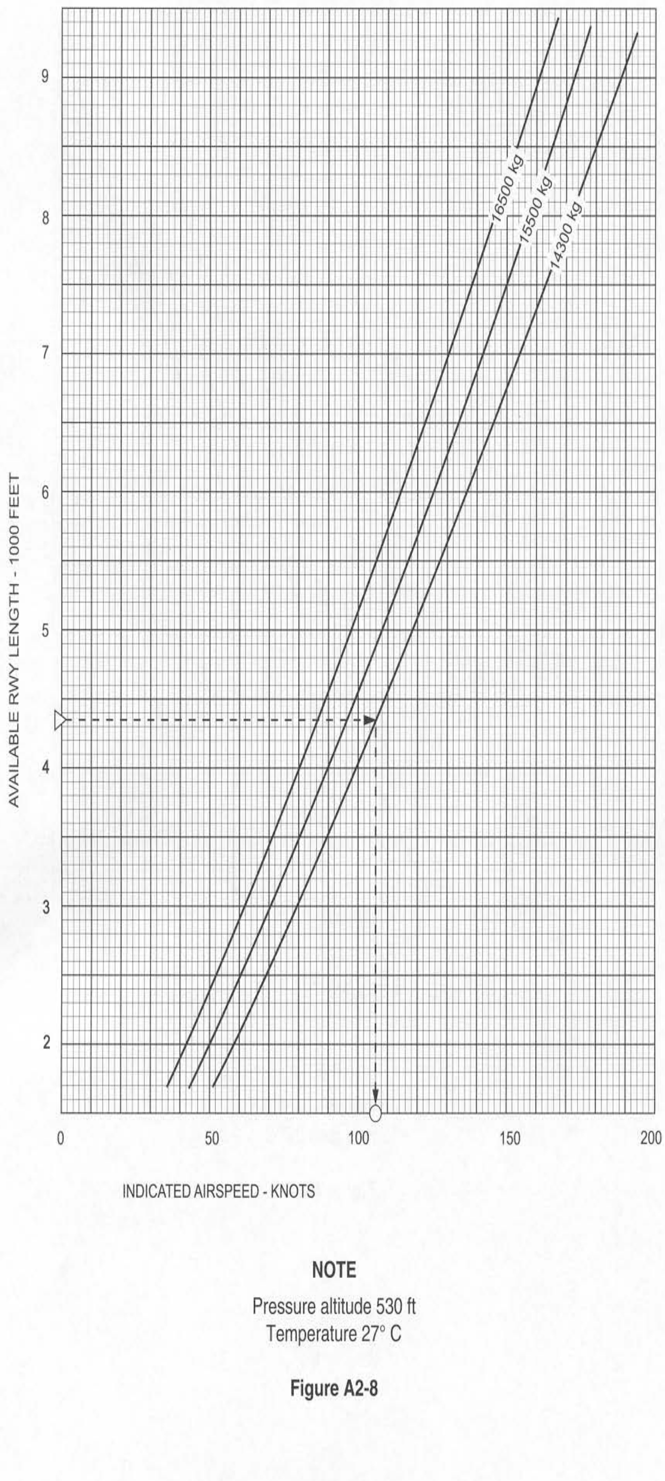


NOTE

Pressure altitude 530 ft
Temperature 27° C

Figure A2-7

MAXIMUM ABORT SPEED (LPM)



NOTE

Pressure altitude 530 ft
Temperature 27° C

Figure A2-8

PART 3

CLIMB

INTRODUCTION

The following charts contain information to determine time, distance covered and fuel consumption during military thrust climb and combat ceiling. Data are based on a constant climb speed of 460 KTAS.

TIME / DISTANCE REQUIRED TO CLIMB

The chart is used to determine time and distance required to climb, corrected for drag index and temperature deviation. Time required for takeoff and acceleration to climb speed is incorporated in the chart. Distance required to climb starts at a point of 650 ft AGL.

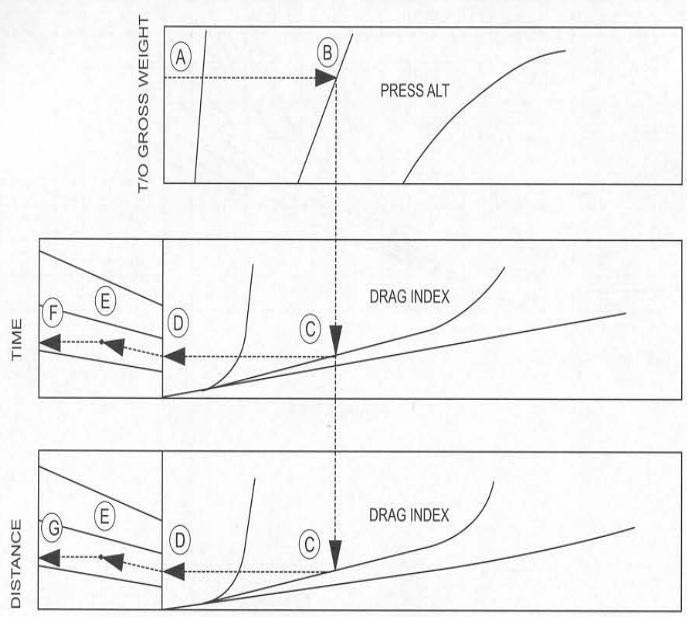
USE

Enter the chart with the initial gross weight (A). Project horizontally to the right to intersect the assigned cruise altitude (B). Proceed vertically downwards to intersect to applicable drag index lines (C), then project horizontally to the left to the temperature baseline (D) (corresponds to ICAO standard day °C). Parallel the guide line to intersect a vertical grid line corresponding to the degree of deviation between forecast flight temperature and standard ICAO day temperature (E). From this point, continue horizontally to the left to read time (F) and distance (G) to climb.

SAMPLE PROBLEM

Gross weight	= 15 800 kg
Pressure altitude	= 37 000 ft
DI	= 310
Temp deviation	= +10 °C
Time	= 11 min 40 sec
Distance	= 80 NM

SAMPLE TIME / DISTANCE REQUIRED TO CLIMB



TIME / DISTANCE REQUIRED TO CLIMB 460 KTAS MIL THRUST (NPM)

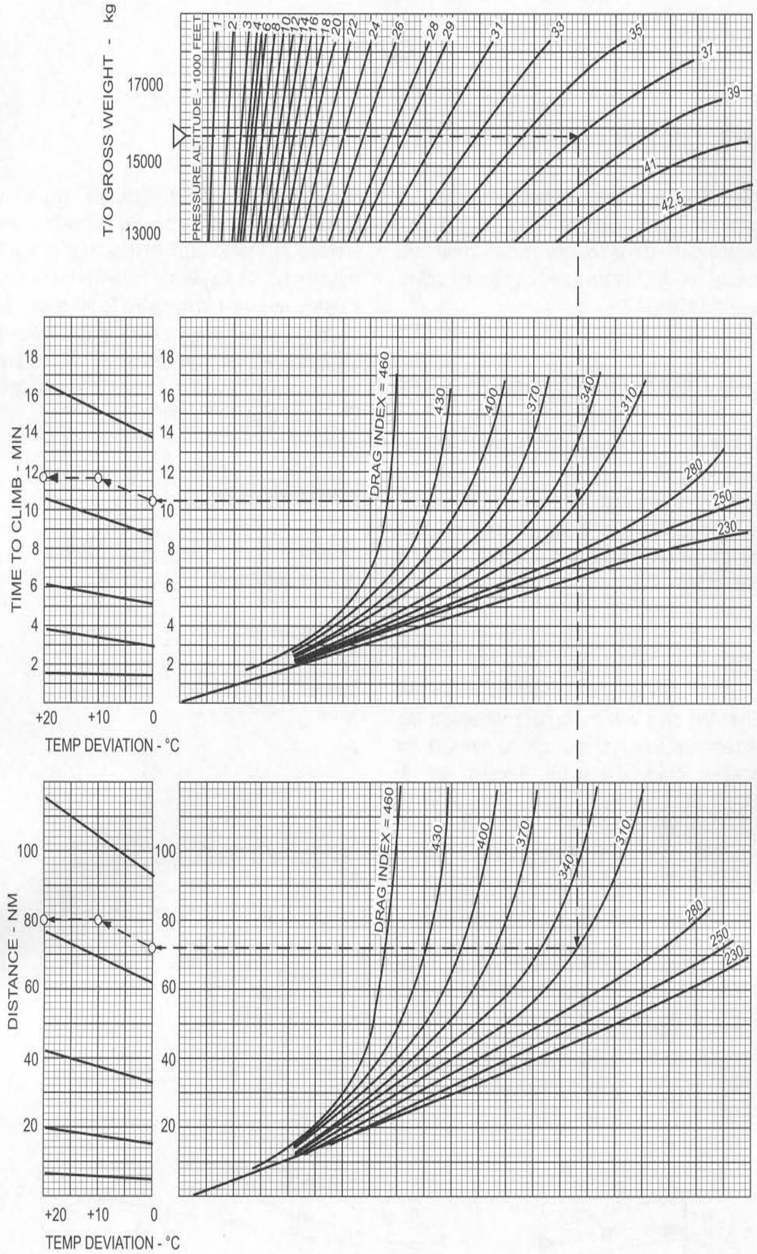


Figure A3-1

FUEL REQUIRED TO CLIMB

The chart is used to determine fuel required to climb, corrected for DI and temperature deviation. Fuel required for takeoff and acceleration to climb speed is incorporated in these chart.

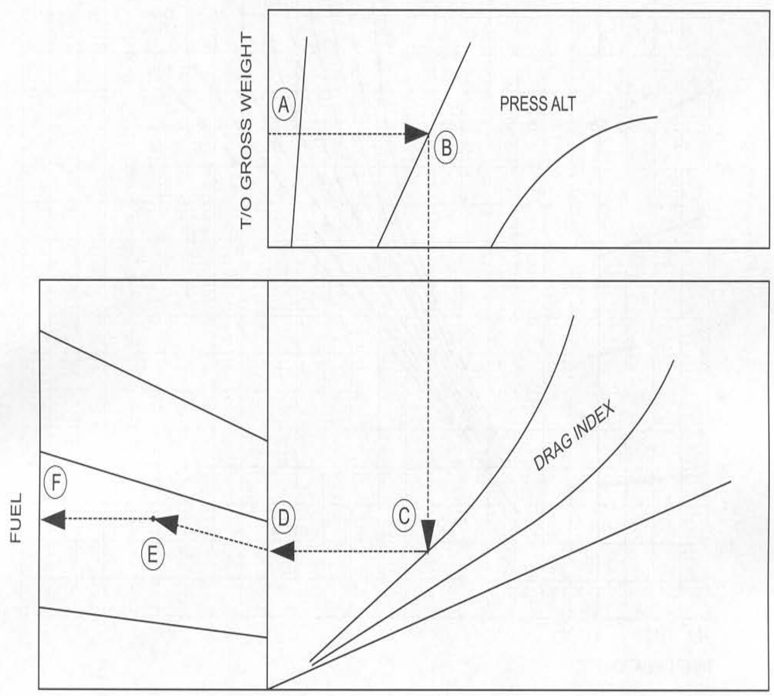
USE

Enter the chart with the initial gross weight (A). Project horizontally to the right to intersect the assigned cruise altitude (B). Proceed vertically downwards to intersect to applicable drag index line (C), then project horizontally to the left to the temperature baseline (D) (corresponds to ICAO standard day °C). Parallel the guide line to intersect a vertical grid line corresponding to the degree of deviation between forecast flight temperature and standard ICAO day temperature (E). From this point, continue horizontally to the left to read fuel required to climb (F).

SAMPLE PROBLEM

Gross weight	= 15 800 kg
Pressure altitude	= 37 000 ft
DI	= 310
Temp deviation	= +10 °C
Fuel	705 kg

SAMPLE FUEL REQUIRED TO CLIMB



FUEL REQUIRED TO CLIMB 460 KTAS MIL THRUST (NPM)

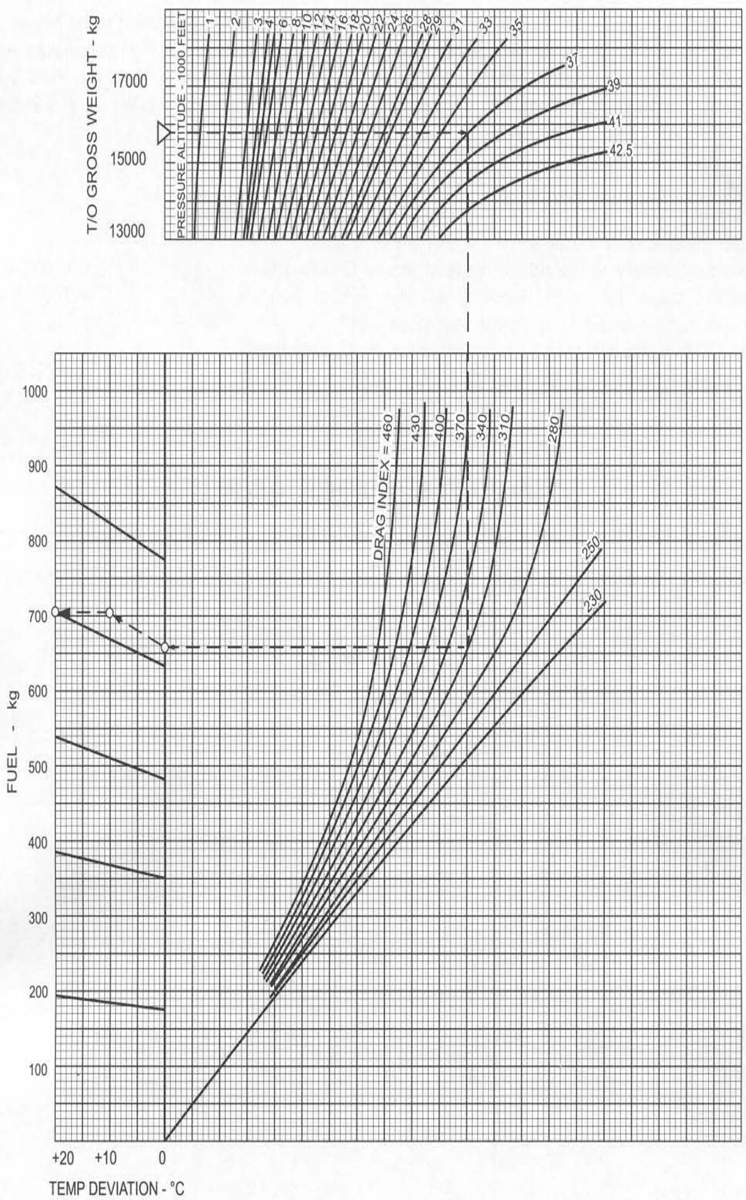


Figure A3-2

MAXIMUM CEILING AFTER T/O MIL THRUST

The chart presents the military thrust combat ceiling for two engines operating at various combinations of gross weight and drag index.

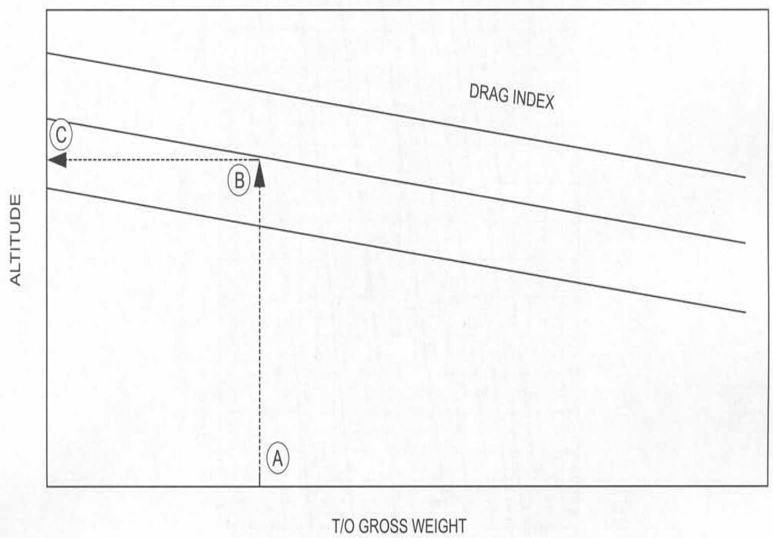
USE

Enter the chart with takeoff gross weight (A). Proceed vertically upwards to intercept the applicable drag index line (B), continue horizontally left to read combat ceiling (C).

SAMPLE CHART

Gross weight	= 14 550 kg
DI	= 370
Combat ceiling	= 37 800 ft

SAMPLE MAXIMUM CEILING



MAXIMUM CEILING AFTER T/O MIL THRUST (NPM)

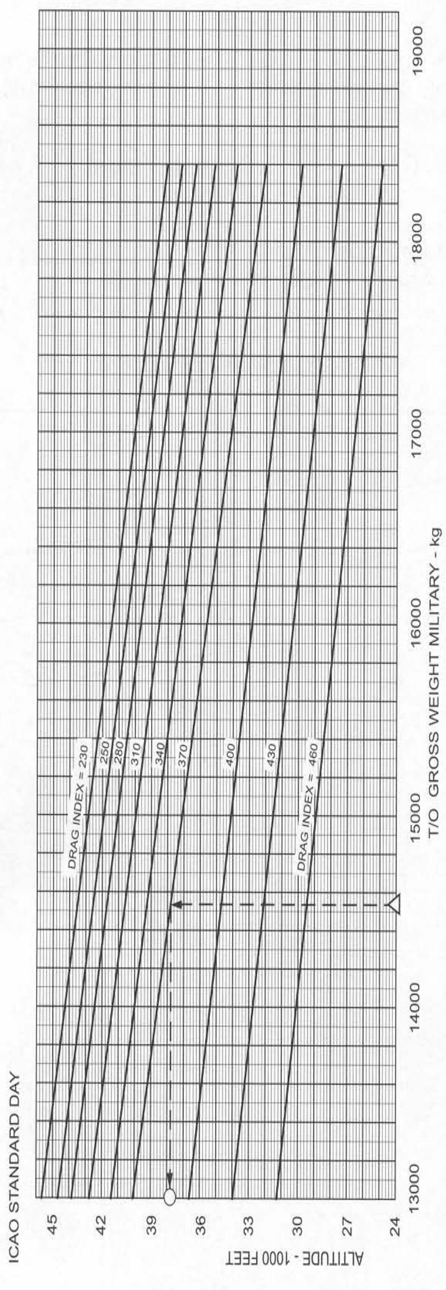


Figure A3-3

PART 4

CRUISE

INTRODUCTION

The following charts contain information to determine initial optimum cruise altitude, maximum range / maximum endurance data, constant Mach cruise data and constant altitude cruise fuel flow.

INITIAL OPTIMUM CRUISE ALTITUDE

The chart presents initial optimum cruise altitude. The chart depicts optimum cruise altitude immediately after climb for all gross weights and drag indexes.

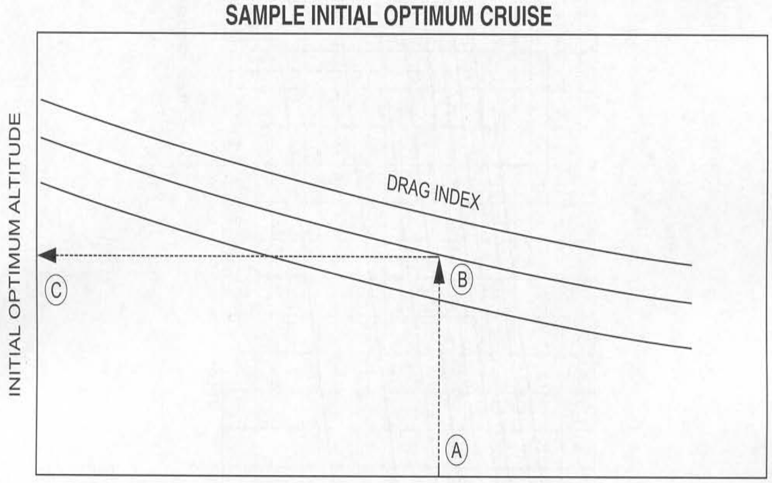
USE

Enter the chart with takeoff gross weight (A) and project vertically to intersect previously computed drag index (B). Continue horizontally to the left and obtain initial optimum cruise altitude (C).

SAMPLE PROBLEM

Gross weight	= 15 700 kg
DI	= 290
Initial optimum altitude	= 37 200 ft

SAMPLE INITIAL OPTIMUM CRUISE



INITIAL OPTIMUM CRUISE ALTITUDE (NPM)

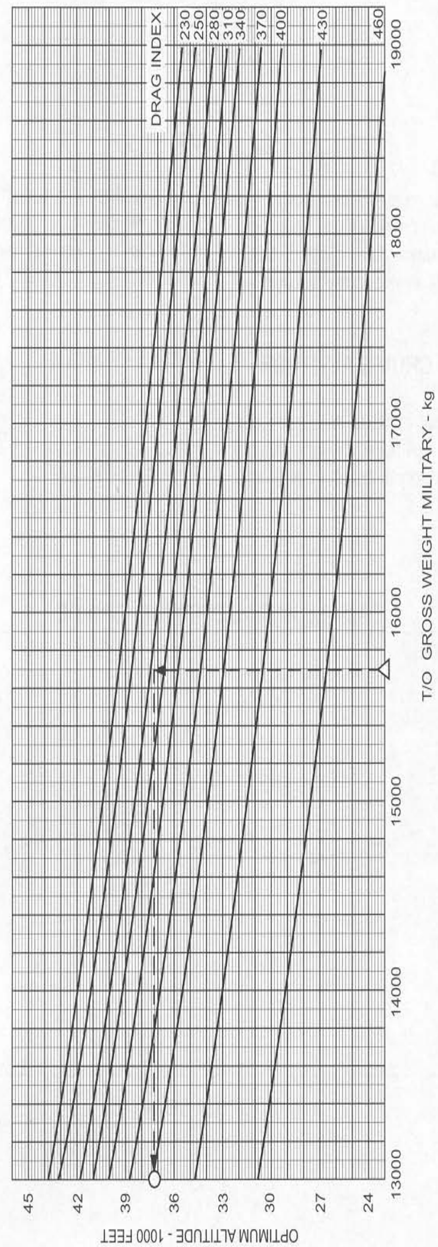


Figure A4-1

OPTIMUM CRUISE SUMMARY

The chart presents optimum cruise and maximum endurance data since both are nearly identical. The chart depicts Mach number and fuel consumption for all gross weights and drag indexes. Optimum cruise altitude can be obtained as well.

USE

Enter the chart with applicable gross weight (A) and proceed horizontally to the right to intersect the desired flight altitude (B). Continue vertically upwards to the applicable drag index line (C) and project horizontally right to the applicable gross weight (D). Proceed vertically downwards to obtain fuel required (E).

To obtain max range and / or max endurance Mach number, proceed vertically upwards from the altitude line (B) to the max range / max endurance line (F), continue horizontally left to obtain the Mach number (G).

To obtain the optimum cruise altitude, enter the chart with the applicable gross weight (A) and project horizontally to the right. Enter the chart with the applicable drag index at the optimum altitude line (G) and project vertically downwards. Read the optimum cruise altitude at the intersection of the two lines (H).

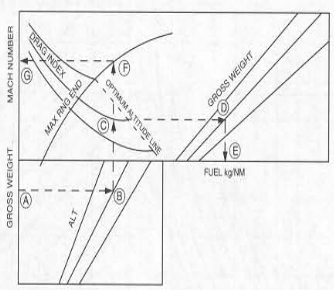
SAMPLE PROBLEM

Gross weight	= 15 500 kg
Cruise altitude	= 36 000 ft
DI	= 320
Mach number	= M 0.79
Fuel	= 4.8 kg/NM

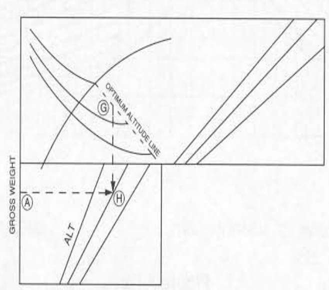
SAMPLE PROBLEM

Gross weight	= 15 500 kg
DI	= 320
Optimum cruise altitude	= 36 000 ft

SAMPLE OPTIMUM CRUISE SUMMARY
(FUEL / NM, MACH NUMBER)



SAMPLE OPTIMUM CRUISE SUMMARY
(OPTIMUM CRUISE ALTITUDE)



OPTIMUM CRUISE SUMMARY (NPM)

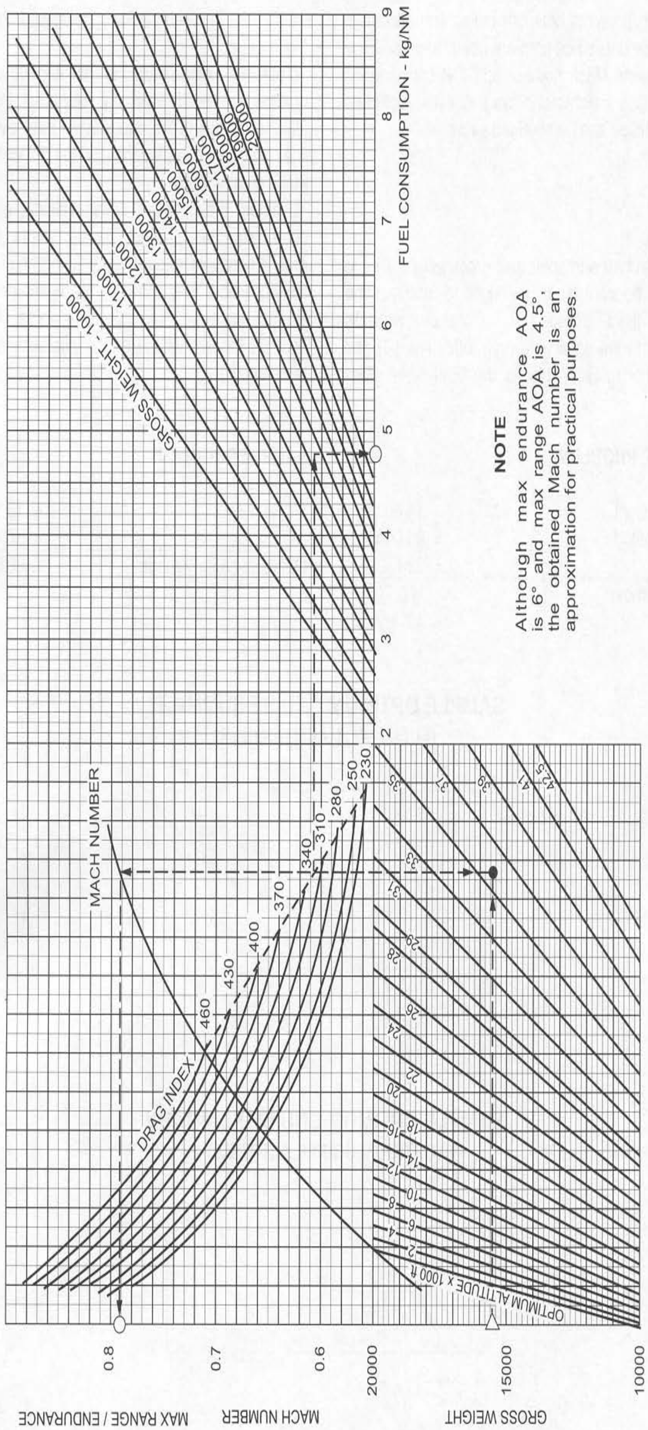


Figure A4-2

FUEL INDEX NUMBER

The chart presents fuel index numbers for all gross weights and drag indexes. The fuel index number is required to figure engine RPM and fuel consumption for cruising at a given altitude in a given configuration.

USE

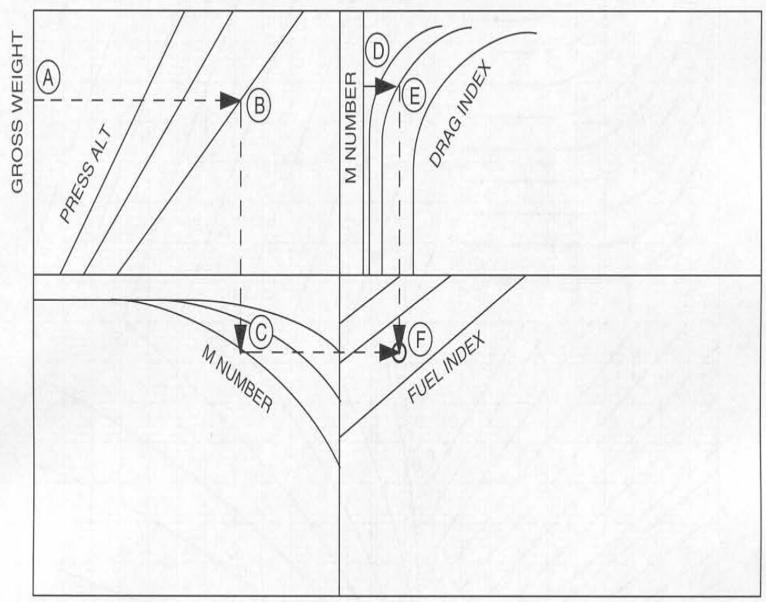
Enter the chart with the applicable gross weight (A). Proceed horizontally to the right to intersect the desired altitude (B), continue vertically downwards to the desired Mach number (C) and project horizontally right.

Enter the chart with the desired Mach number (D). Proceed horizontally to the right to intercept the applicable drag index (E), project vertically downwards. Receive the fuel index number (F) at the intersection of the two projected lines.

SAMPLE PROBLEM

Gross weight	= 15 400 kg
Pressure altitude	= 26 000 ft
Mach number	= M 0.66
DI	= 300
Fuel index number	= 36

SAMPLE FUEL INDEX NUMBER



FUEL INDEX NUMBER

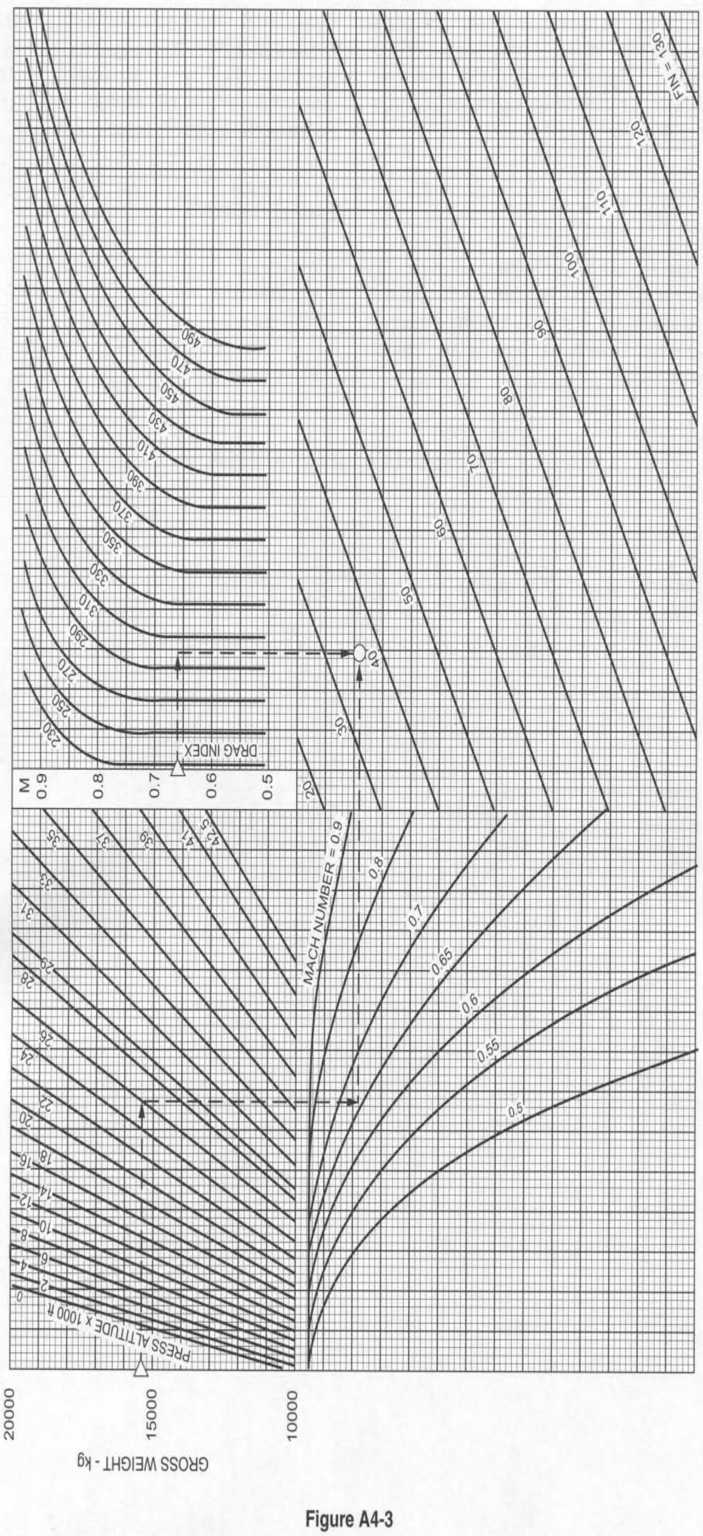


Figure A4-3

CONSTANT MACH CRUISE

The charts presented are used to determining fuel required per NM and RPM for constant Mach cruise.

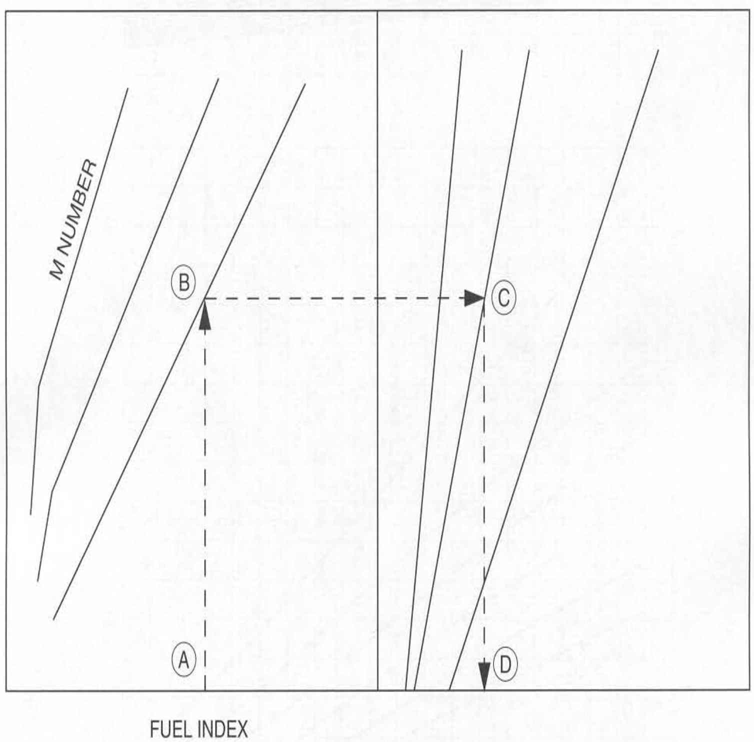
USE

Enter the charts with the previously computed fuel index number (A), proceed vertically upwards to the applicable Mach number (B), continue horizontally to the right to intersect the applicable altitude / temperature (C) and project vertically downwards to obtain fuel required per NM or RPM (D).

SAMPLE PROBLEM

Fuel index	= 52.5
Mach number	= M 0.5
Altitude	= 12 000 ft
Temperature	= -20 °C
Fuel required	= 9.7 kg/NM
RPM	84.5 %

SAMPLE CONSTANT MACH CRUISE



CONSTANT MACH CRUISE (FUEL CONSUMPTION)

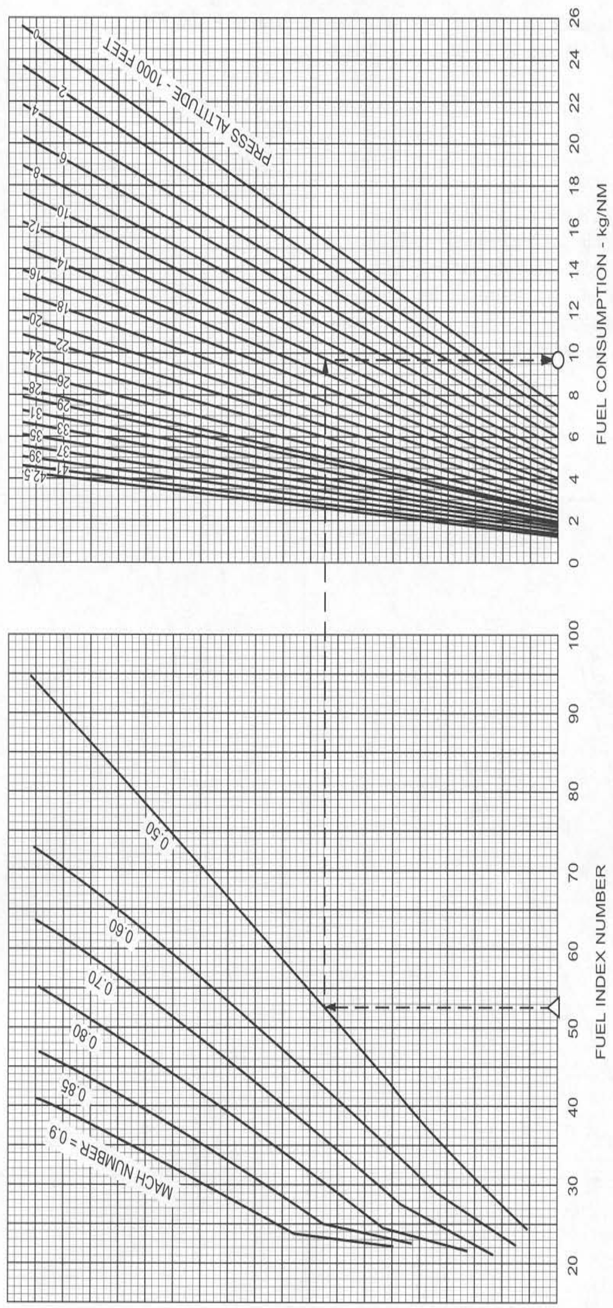


Figure A4-4

CONSTANT MACH CRUISE (ENGINE RPM)

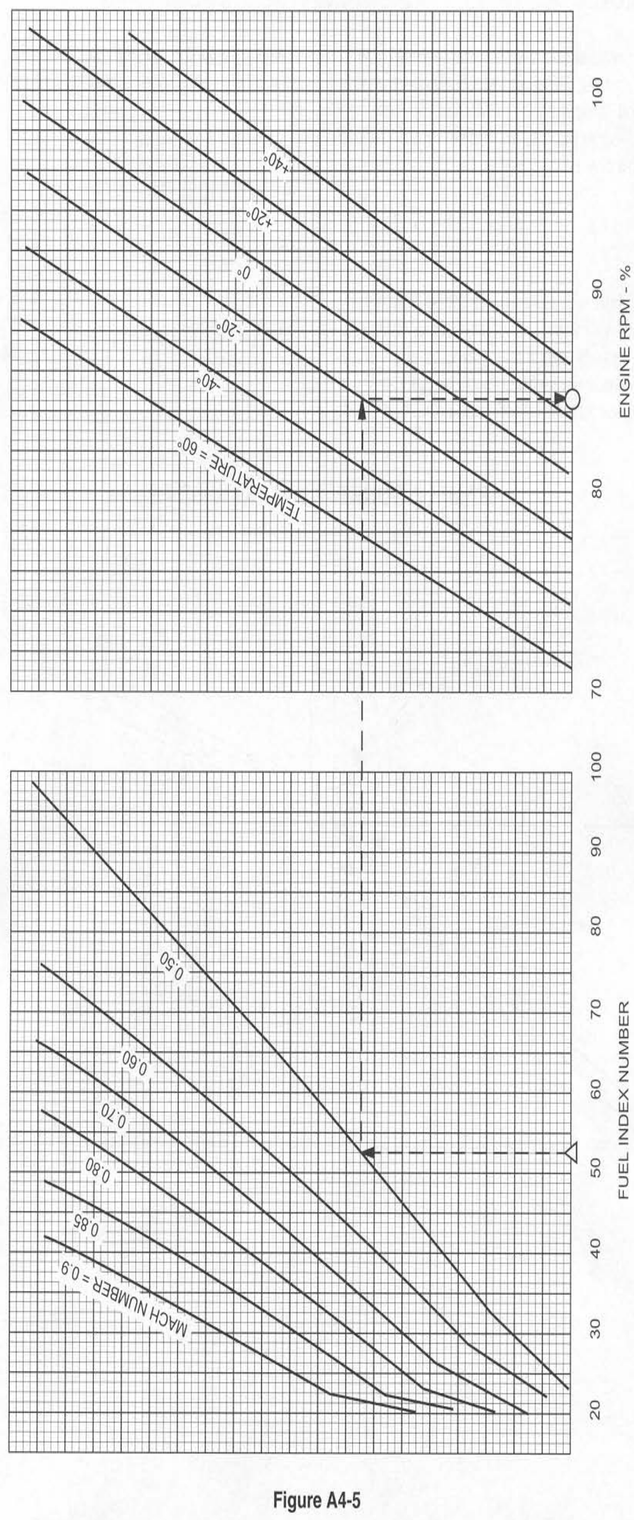


Figure A4-5

CONSTANT ALTITUDE CRUISE FUEL FLOW

The chart presented is used to calculate fuel flow in kg/min for various RPM and Mach numbers at any altitude and temperature. RPM must be obtained from the constant Mach cruise chart before entering this chart.

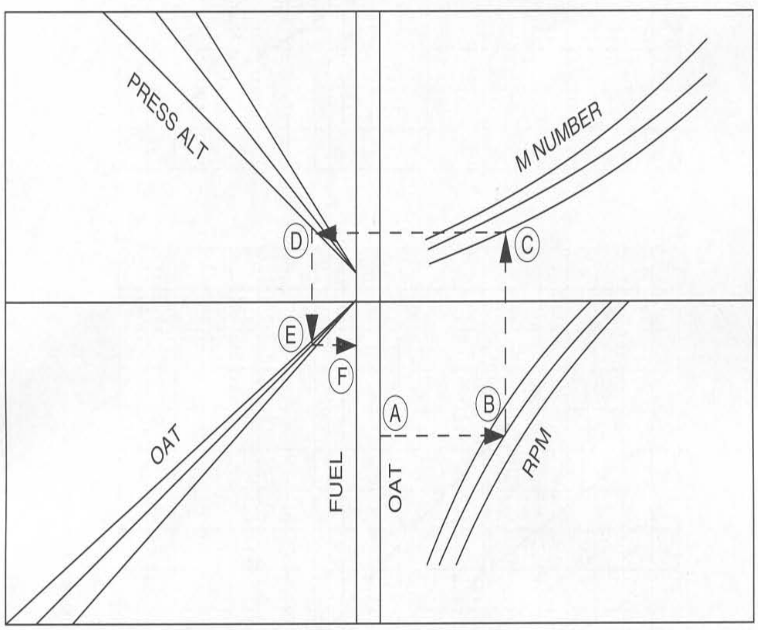
USE

Enter the chart with OAT (A), proceed horizontally to the right to intersect the previously computed RPM (B). Project vertically upwards to appropriate constant altitude cruise Mach number (C). Continue left to the desired press alt (D) and project vertically downwards to the appropriate OAT (E). Proceed horizontally to the right to obtain fuel required per min (F).

SAMPLE PROBLEM

OAT	= -7°
RPM	= 82 %
Mach number	= M 0.8
Pressure altitude	= 10 000 ft
Fuel required	= 44 kg/min

SAMPLE CONSTANT ALT CRUISE FF



CONSTANT ALTITUDE CRUISE FUEL FLOW (NPM)

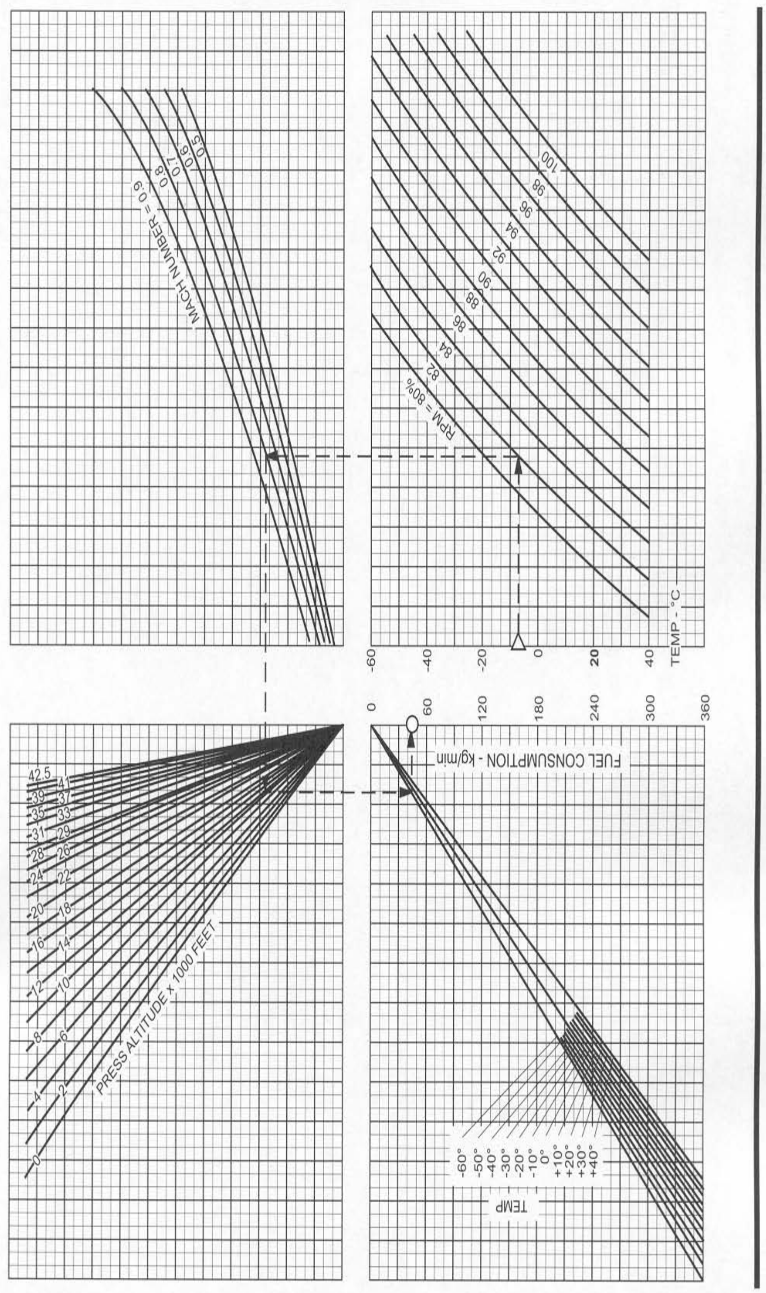


Figure A4-6

PART 5

ACCELERATION

ACCELERATION DATA

The following charts contain information about time, distance and fuel required to accelerate in level flight and for maximum thrust fuel flow. Separate charts are provided for low and for high altitude acceleration. All charts are valid for clean aircraft with two APHID missiles loaded and throttles in MAX AB.

LOW ALTITUDE ACCELERATION

These charts present data for low altitude acceleration at an entry speed of Mach 0.5. To obtain the time refer to figure A5-1, for distance and fuel refer to figure A5-2.

USE

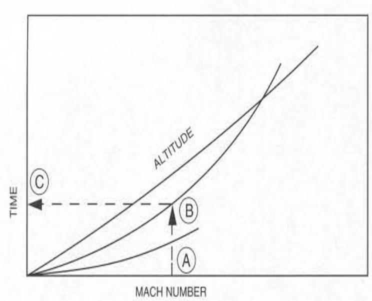
Enter the chart in figure A5-1 with final indicated airspeed (A), proceed vertically upwards to intersect the pressure altitude (B) and project horizontally left to the baseline to read time (C).

To obtain the required distance enter the chart in figure A5-2 with the final indicated airspeed (A), proceed vertically upwards to the pressure altitude (B) and project horizontally left to read the flight distance. To obtain the required fuel, continue from (B) vertically upwards to intersect the pressure altitude (D) and project horizontally left to the fuel baseline (E).

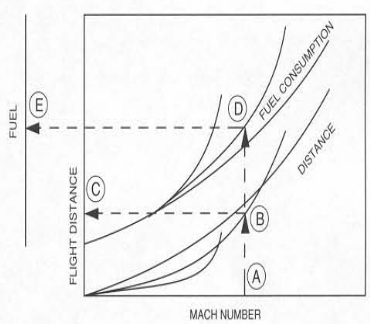
SAMPLE PROBLEM

Final Mach number	= M 1.3
Altitude	= 16 000 ft
Time	= 46 sec
Distance	= 8.7 NM
Fuel	= 440 kg

SAMPLE ACCELERATION TIME M 0.5 TO SUPERSONIC



SAMPLE FUEL / DISTANCE REQUIRED FOR ACCELERATION (MAX AB) M 0.5 TO SUPERSONIC



ACCELERATION TIME M 0.5 TO SUPERSONIC

AIRCRAFT CONFIGURATION:
CLEAN OR 2 APHID

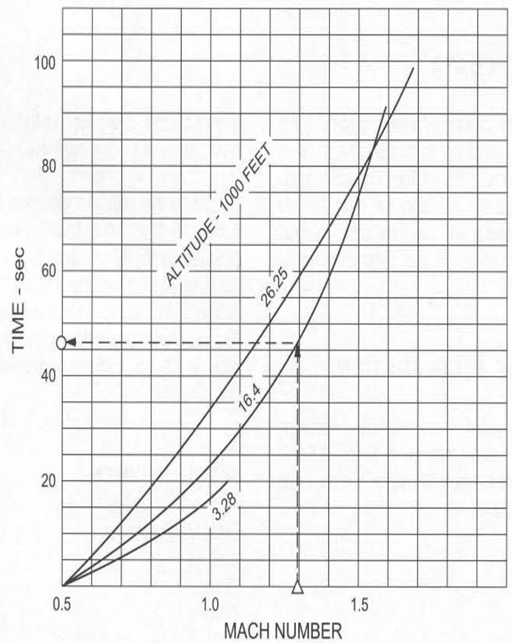


Figure A5-1

FUEL / DISTANCE REQUIRED FOR ACCELERATION (MAX AB) M 0.5 TO SUPERSONIC

AIRCRAFT CONFIGURATION:
CLEAN OR 2 APHID

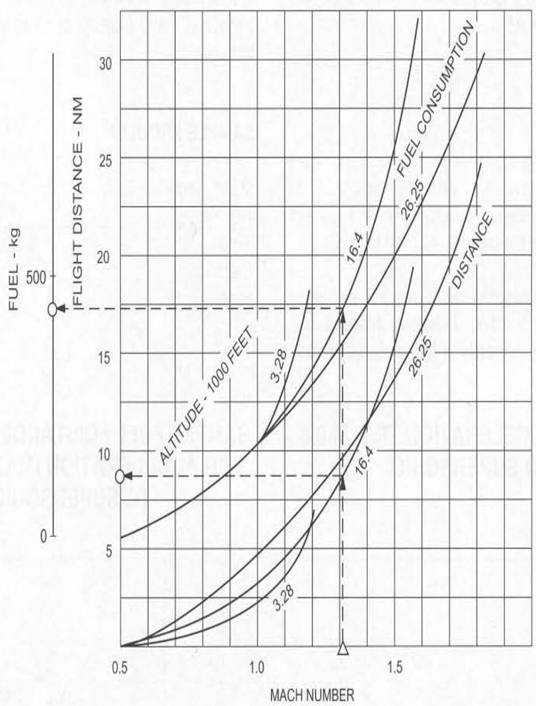


Figure A5-2

HIGH ALTITUDE ACCELERATION

These charts present data for high altitude acceleration at an entry speed of Mach 0.8. To obtain the time refer to figure A5-3, for distance and fuel refer to figure A5-4.

USE

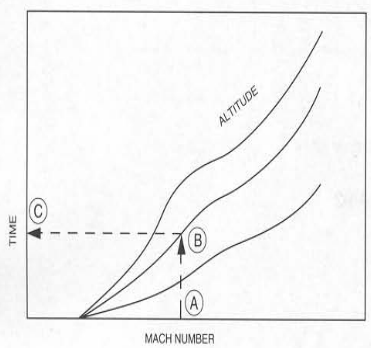
Enter the chart in figure A5-3 with final indicated airspeed (A), proceed vertically upwards to intersect the pressure altitude (B) and project horizontally left to the baseline to read time (C).

To obtain the required distance enter the chart in figure A5-4 with the final indicated airspeed (A), proceed vertically upwards to the pressure altitude (B) and project horizontally left to read the flight distance. To obtain the required fuel, continue from (B) vertically upwards to intersect the pressure altitude (D) and project horizontally left to the fuel baseline (E).

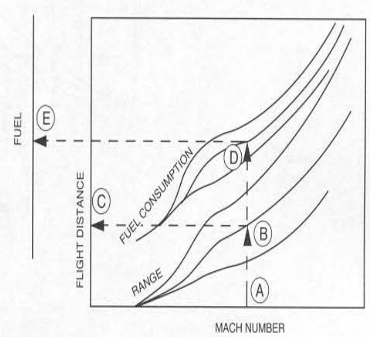
SAMPLE PROBLEM

Mach number	= M 1.8
Altitude	= 39 000 ft
Time	= 140 sec
Distance	= 28 NM
Fuel	= 650 kg

SAMPLE ACCELERATION TIME M 0.8 TO SUPERSONIC



SAMPLE FUEL / DISTANCE REQUIRED FOR ACCELERATION (MAX AB) M 0.8 TO SUPERSONIC



ACCELERATION TIME M 0.8 TO SUPERSONIC

AIRCRAFT CONFIGURATION:
CLEAN OR 2 APHID

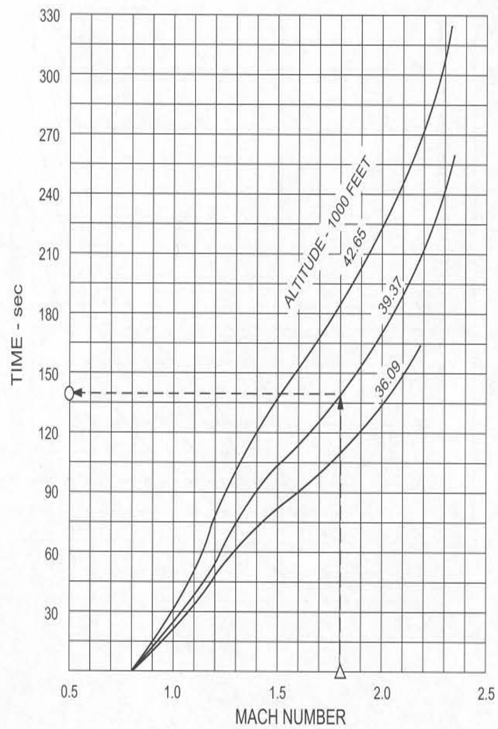


Figure A5-3

FUEL / DISTANCE REQUIRED FOR ACCELERATION TIME M 0.8 TO SUPERSONIC

AIRCRAFT CONFIGURATION:
CLEAN OR 2 APHID

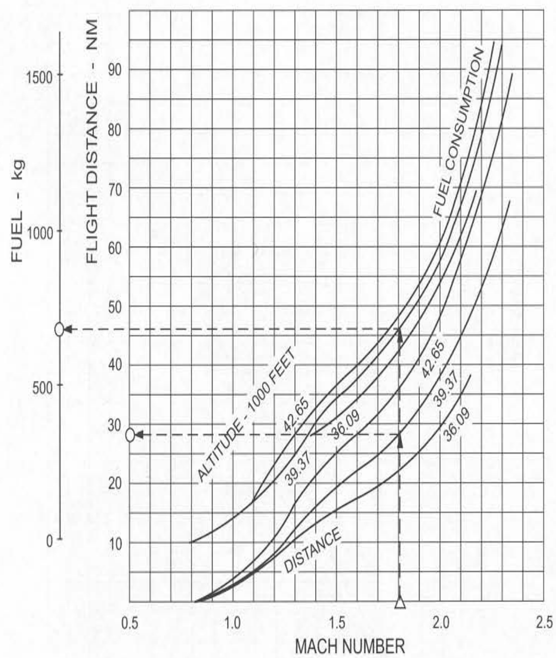


Figure A5-4

FUEL CONSUMPTION DATA

The following chart may be used to determine fuel consumption per second depending on mach number and altitude. The chart is valid for ICAO standard temperature (dashed lines for ICAO temperature +10 °C) and throttles in MAX AB.

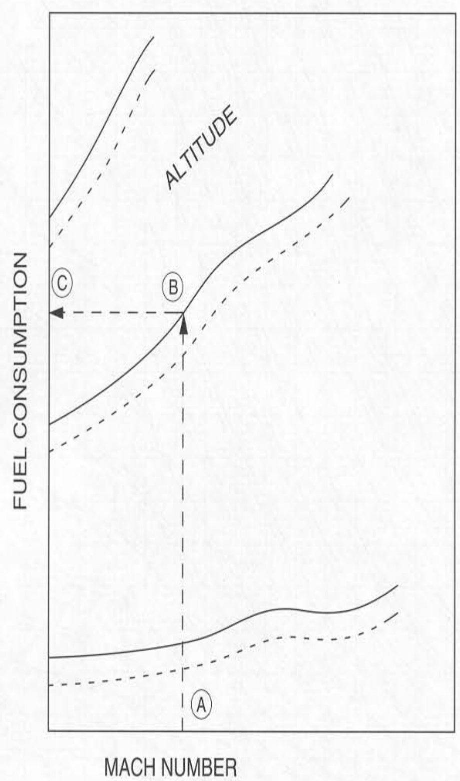
USE

Enter the chart with airspeed (A), proceed vertically upwards to intersect the applicable pressure altitude and temperature (B) and project horizontally left to the baseline to read the fuel required per second (C).

SAMPLE PROBLEM

Mach number	= M 0.77
Temperature	= 0 °C
Pressure altitude	= 10 000 ft
Fuel consumption	= 9.55 kg/sec

SAMPLE MAX THRUST FUEL FLOW



MAXIMUM THRUST FUEL FLOW

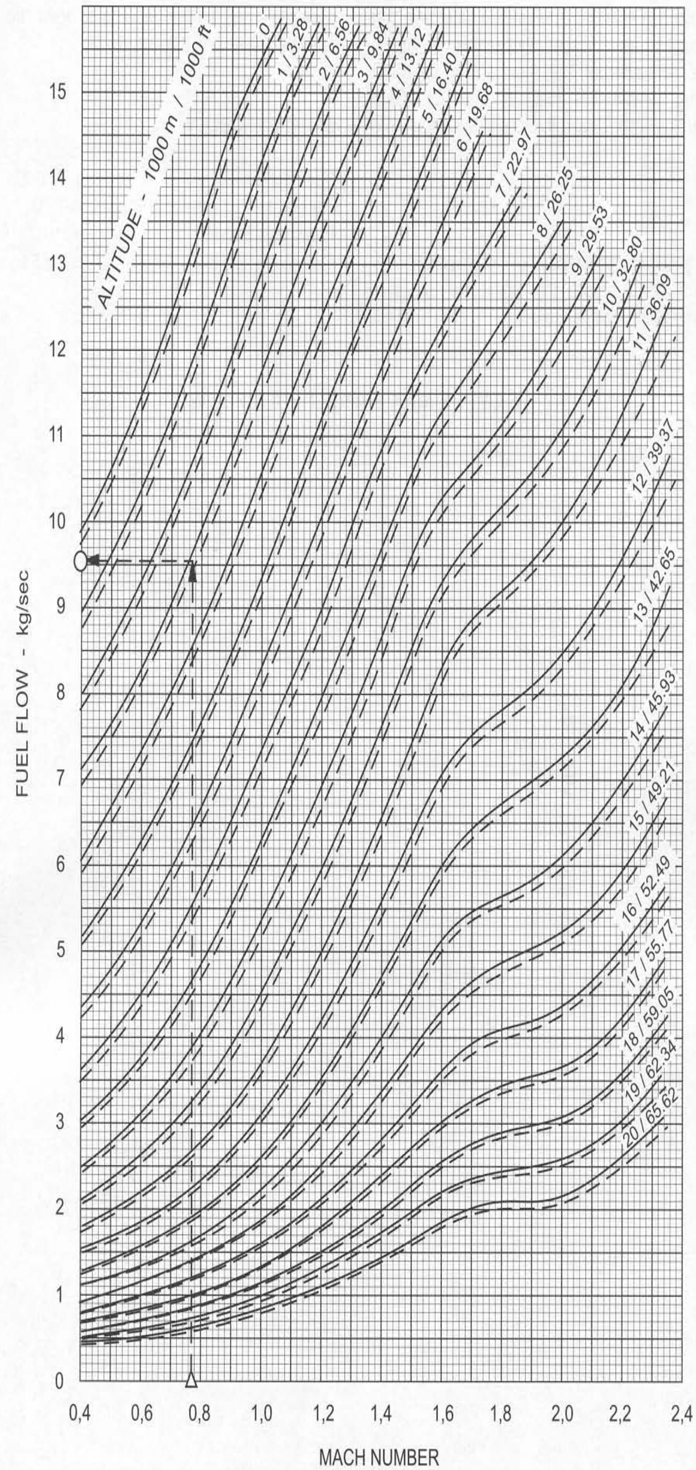


Figure A5-5

PART 6

DESCENT

DESCENT DATA

The chart presented is used to determine distance, fuel used and time required to descent. Throttles are in IDLE position. The chart is valid for all drag indexes and gross weights.

Incremental data may be obtained for distance, fuel and time by subtracting data corresponding to level-off altitude from the data for the original cruising altitude.

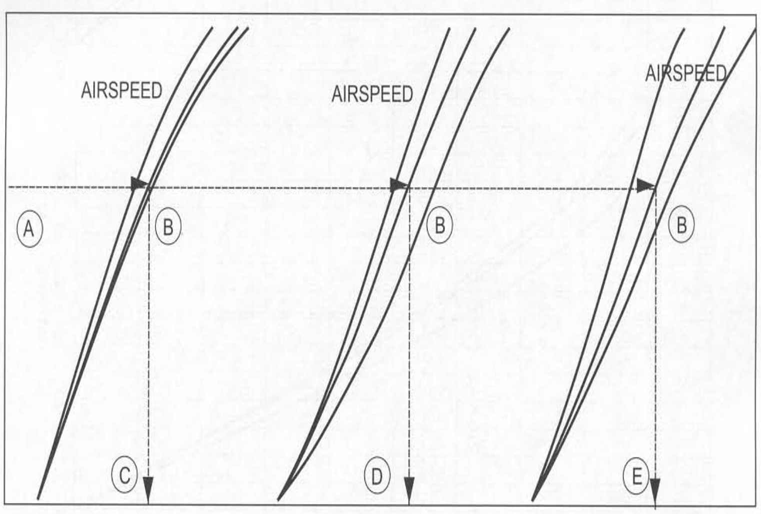
USE

Enter the chart at cruising flight level (A), project horizontally to the right to intersect the applicable IAS (B) for distance, fuel required and time. From the first intersection, project vertically downwards to intersect and read the distance required (C). From the second intersection, project vertically downwards to intersect and read the fuel used to descent (D). From the third intersection, project vertically downwards to intersect and read the time required for descent (E).

SAMPLE PROBLEM

Cruising altitude (A)	= 27 500 ft
Indicated airspeed (B)	= 243 kts
Distance (C)	= 36 NM
Fuel (D)	= 86 kg
Time (E)	= 6 min 50 sec

SAMPLE DESCENT



DESCENT CHART, IDLE THRUST, SPEED BRAKES RETRACTED

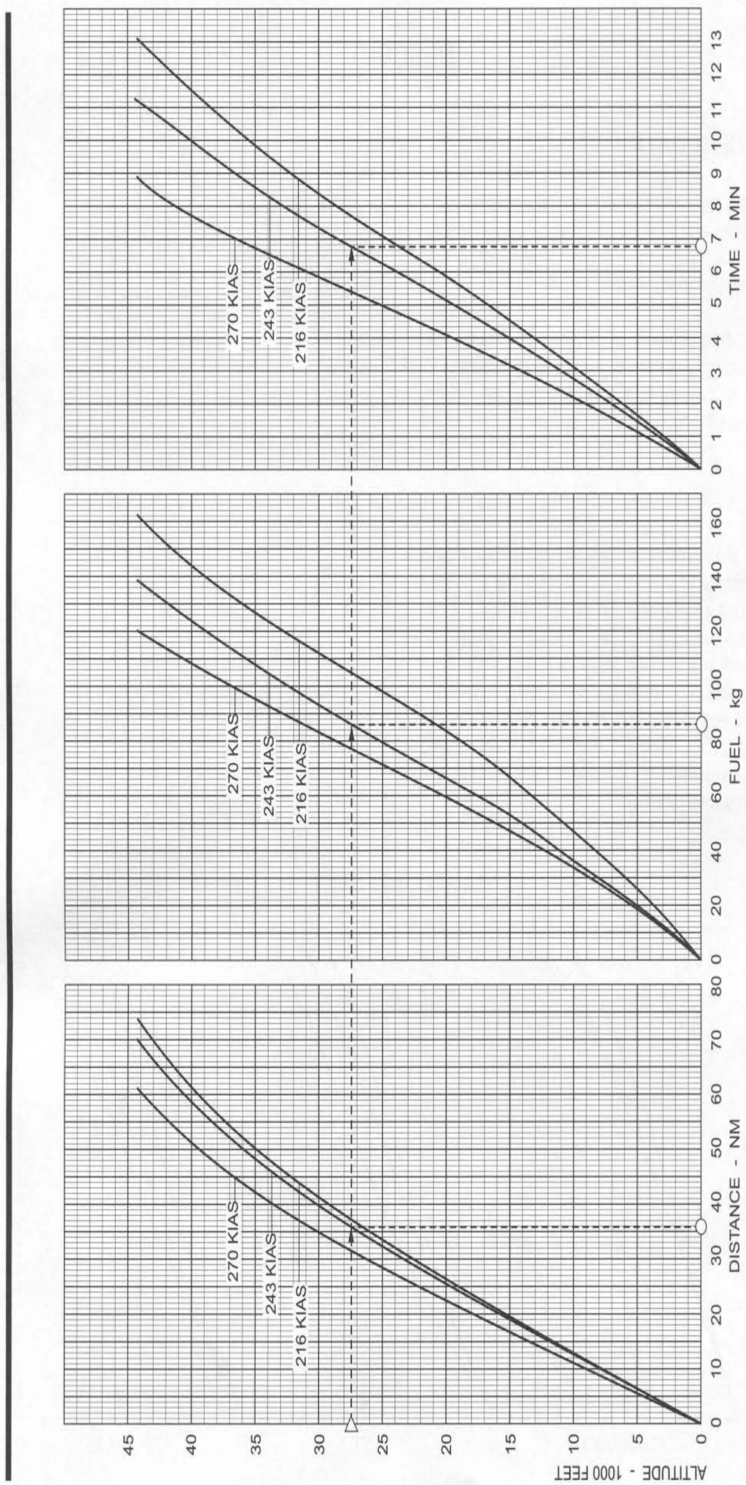


Figure A6-1

PART 7

LANDING

INTRODUCTION

Planning data for landing under various conditions are presented in this part.

LANDING SPEED

The chart contains information about landing speed depending on gross weight, AOA, pressure altitude, temperature and wind.

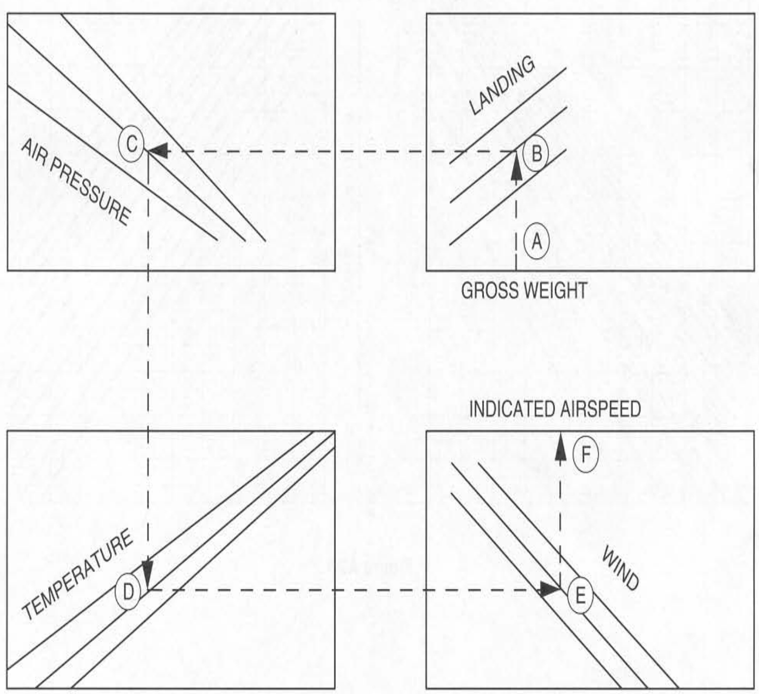
USE

Enter the chart with estimated gross weight (A). Proceed vertically upwards and intersect the AOA reflector line (B), project horizontally to the left to intersect the desired pressure altitude (C), proceed vertically downwards to actual temperature (D), project horizontally to the right to intersect the present wind (E) and proceed vertically upwards to read the landing speed (F).

SAMPLE PROBLEM

Gross weight	= 13 500 kg
AOA	= 12°
Pressure altitude	= 0 ft
Temperature	= +32 °C
Wind	= 25 kts headwind
Landing speed	= 141 kts

SAMPLE LANDING SPEED



LANDING SPEED

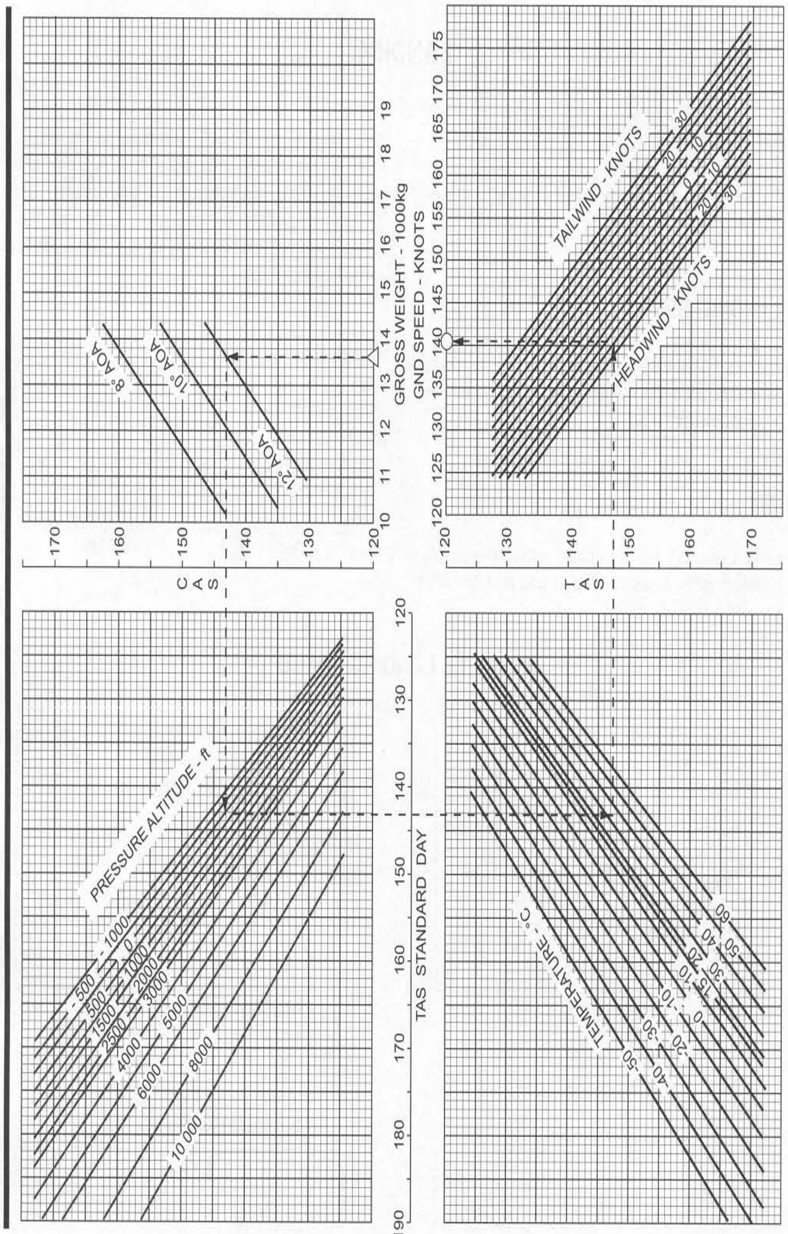


Figure A7-1

LANDING ROLL DISTANCE

These charts present information about landing roll distance depending on gross weight, AOA, pressure altitude, temperature and wind. Separate charts are provided for landing roll distance with drag chute (figure A7-2) and without drag chute (figure A7-3). A simplified method to calculate landing speed is included.

USE

Enter these charts with gross weight (A), proceed vertically upwards to intersect the lower touchdown AOA line (B) and project horizontally right to the applicable pressure altitude (C). From this point, proceed vertically downwards to intersect temperature (D), project horizontally left to the actual wind (E), proceed vertically downwards to the required landing roll distance (F).

To obtain touchdown speed, proceed with the gross weight (A) vertically upwards to the upper touchdown AOA line (G) and project horizontally left to read touchdown speed (H).

SAMPLE PROBLEM

Landing with drag chute

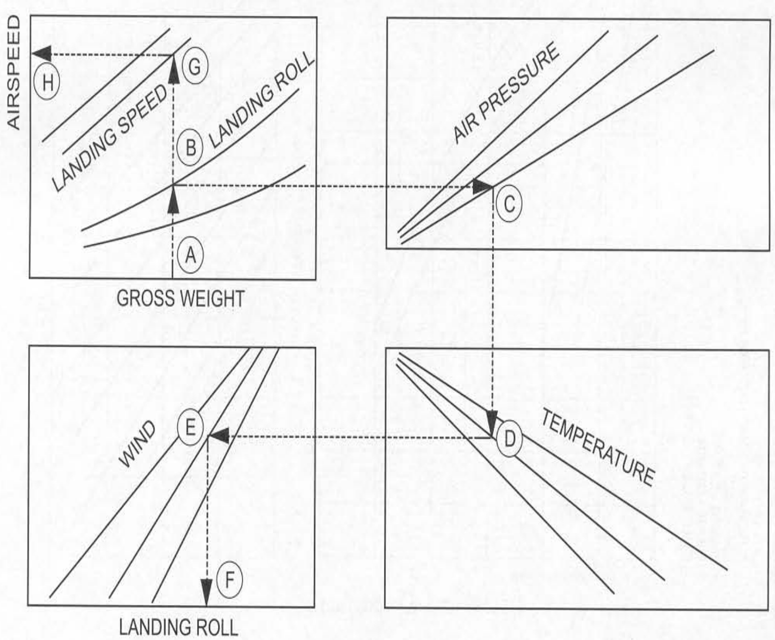
Gross weight	= 13 700 kg
AOA	= 10°
Touchdown speed	= 150 kts
Pressure altitude	= 2 500 ft
Temperature	= 0 °C
Wind	= 0 kts
Landing roll distance	= 2 980 ft

SAMPLE PROBLEM

Landing without drag chute

Gross weight	= 13 100 kg
AOA	= 12°
Touchdown speed	= 138 kts
Pressure altitude	= 2 500 ft
Temperature	= +32 °C
Wind	= 10 kts headwind
Landing roll distance	= 4 550 ft

SAMPLE LANDING ROLL DISTANCE



LANDING ROLL DISTANCE WITH DRAG CHUTE

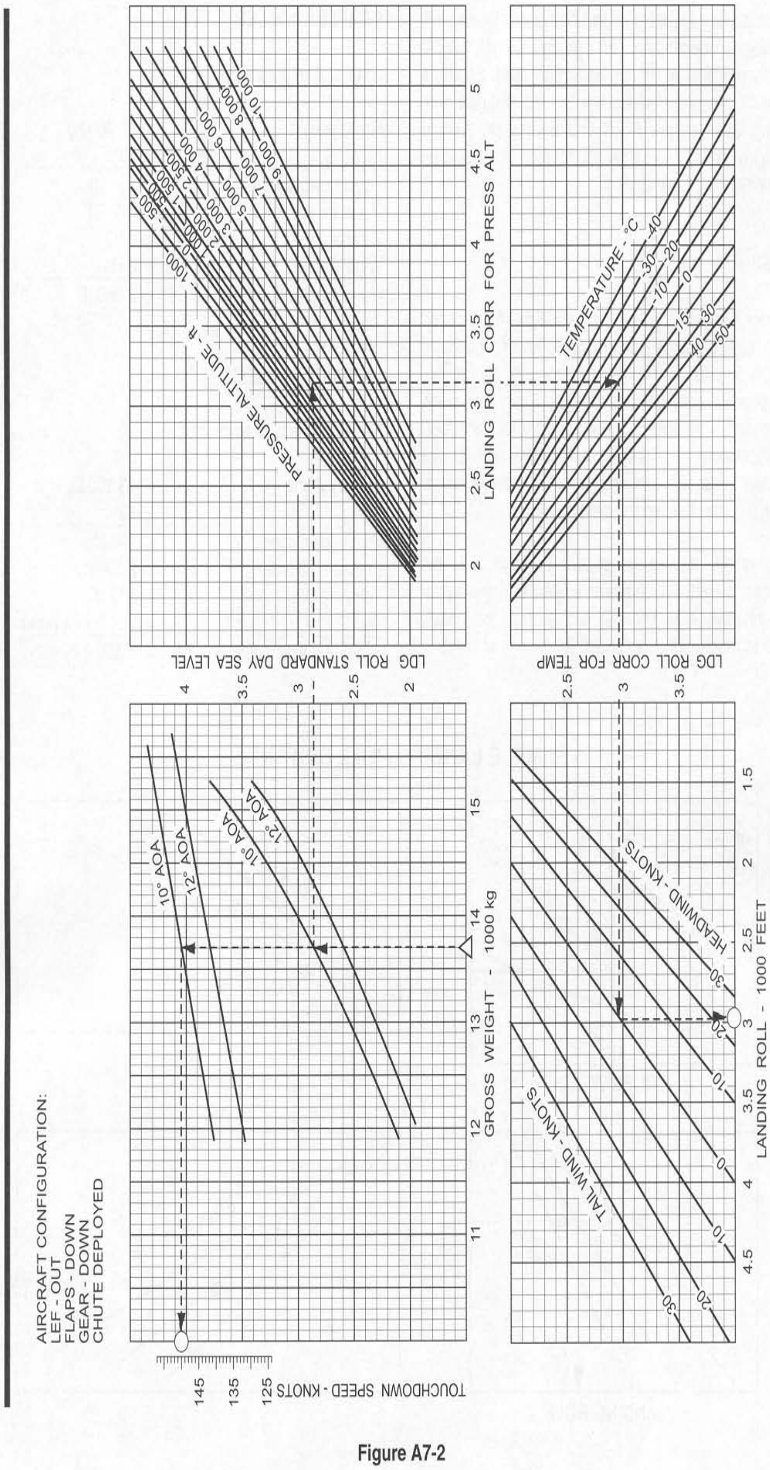


Figure A7-2

LANDING ROLL DISTANCE WITHOUT DRAG CHUTE

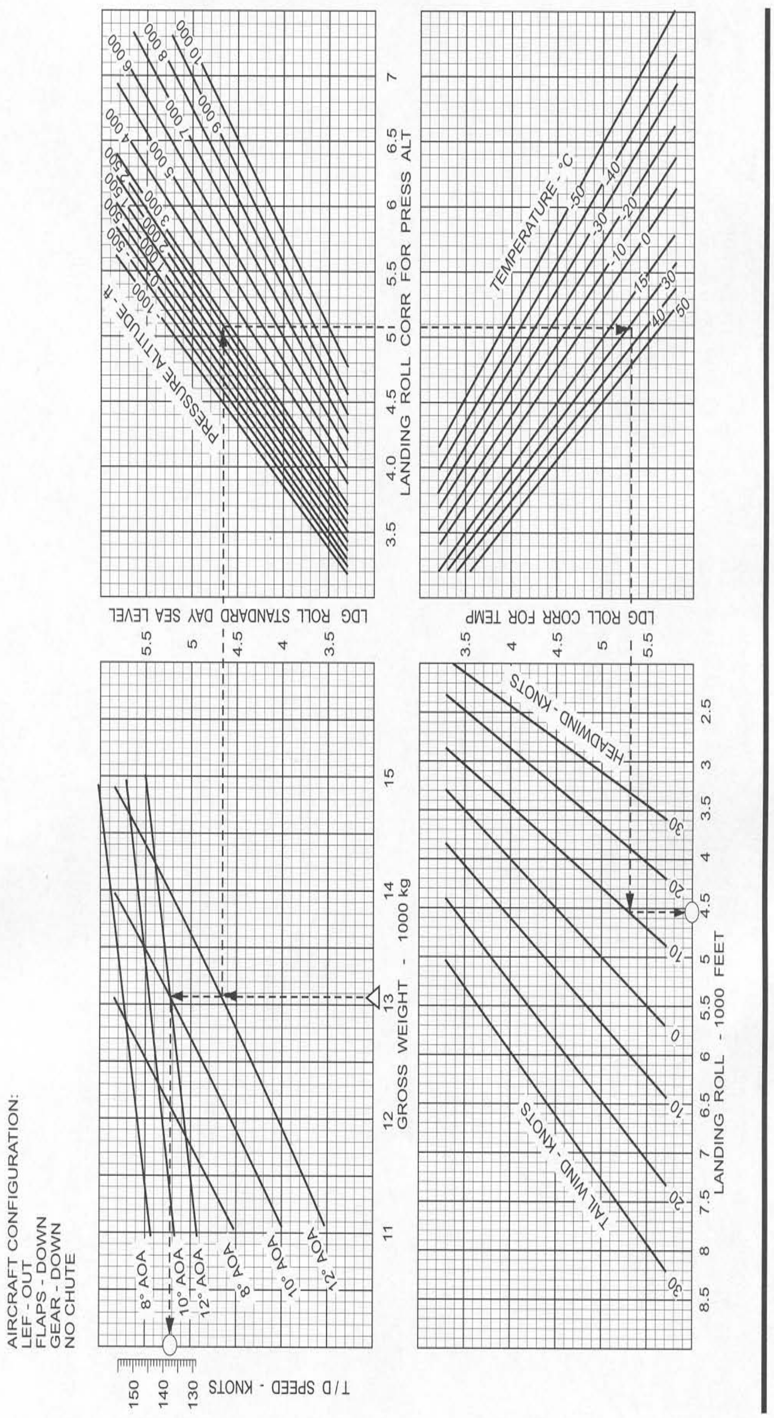


Figure A7-3

PART 8

TACTICAL / COMBAT PERFORMANCE

INTRODUCTION

This part contains information about zoom climbs, sustained turn capability, turn radius and time of turn, altitude loss for split S and during dive recovery.

ZOOM CLIMB

These charts present altitude gain during a zoom climb starting at 650 ft with MAX AB, MIN AB or MIL for NPM and MAX AB and MIL for LPM. Pitch angles up to 45° are initiated with 3.5 to 5 g. Pitch angles in excess of 45° are initiated with 5 to 6 g and terminated with an inverted recovery. Minimum entry airspeed is 320 KIAS for MAX AB, 375 KIAS for MIN AB and 400 KIAS for MIL. Separate charts are available for NPM and LPM.

USE

Enter these charts with entry airspeed (A) and project vertically to intersect the selected pitch angle (B). Continue horizontally to the left to obtain the altitude gain (C).

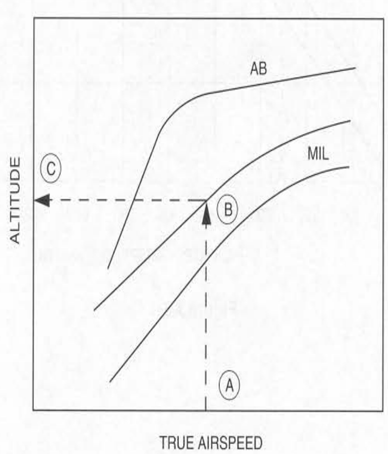
SAMPLE PROBLEM (NPM)

Initial speed	= 375 KIAS
Pitch angle	= 60°
Thrust	= MAX AB
Gain of altitude	= 29 500 ft

SAMPLE PROBLEM (LPM)

Initial speed	= 532 KIAS
Pitch angle	= 60°
Thrust	= MAX AB
Gain of altitude	= 29 500 ft

SAMPLE DESCENT



ZOOM CLIMB (NPM)

CONFIGURATION:
2 APHID
2 LAUNCHER APU-470

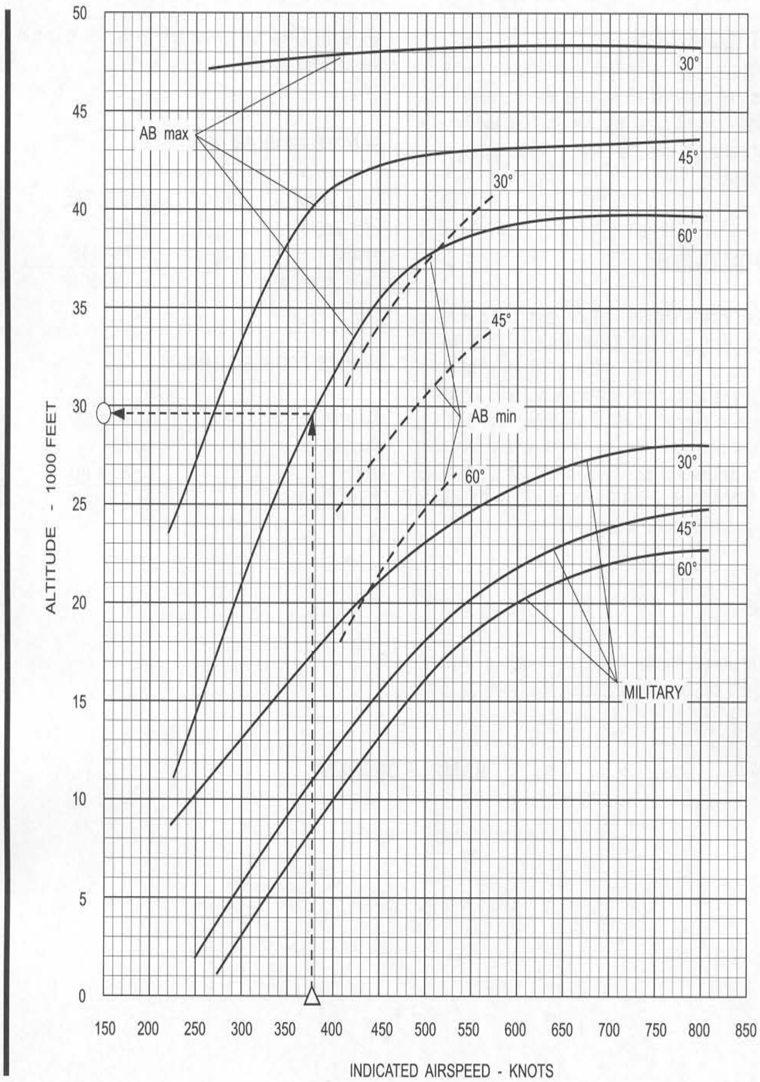


Figure A8-1

ZOOM CLIMB (LPM)

CONFIGURATION:
2 ARCHER
2 LAUNCHER APU-470

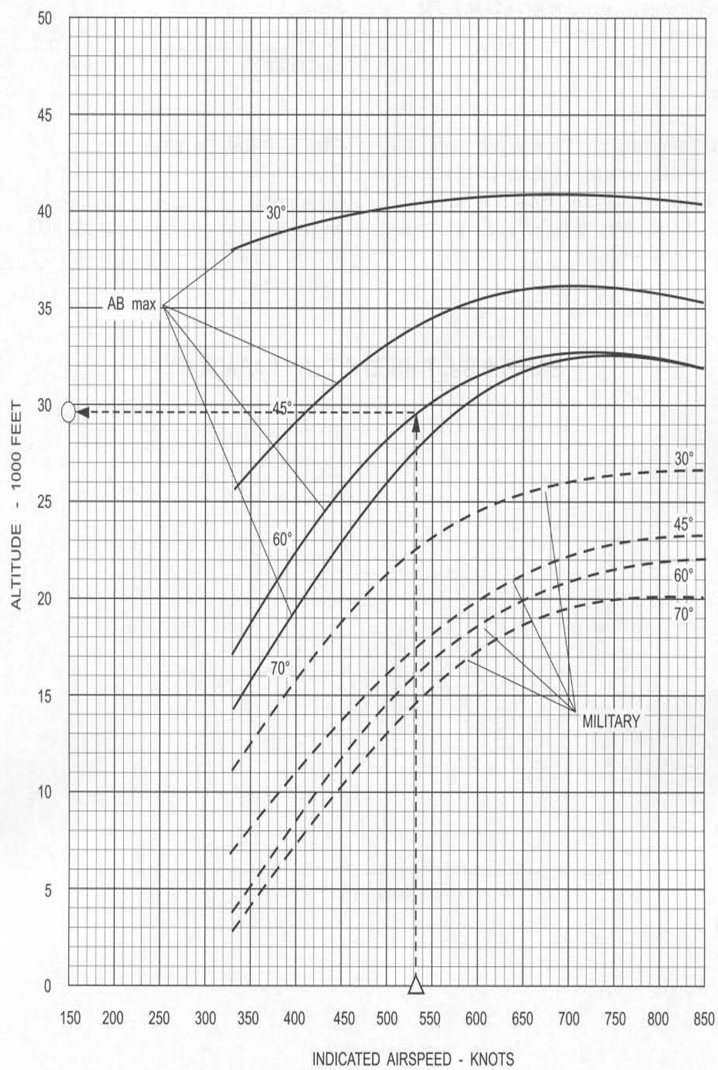


Figure A8-2

SUSTAINED G TURN CAPABILITY

These charts present the maximum load factor for various constant airspeed turns at altitudes from sea level to 49 000 ft with maximum thrust. Separate plots are provided for NPM and LPM.

USE

Enter these charts with the applicable airspeed (A) and proceed vertically upwards to intersect the applicable altitude (B). From this intersection proceed horizontally to the left and read the load factor attainable (C).

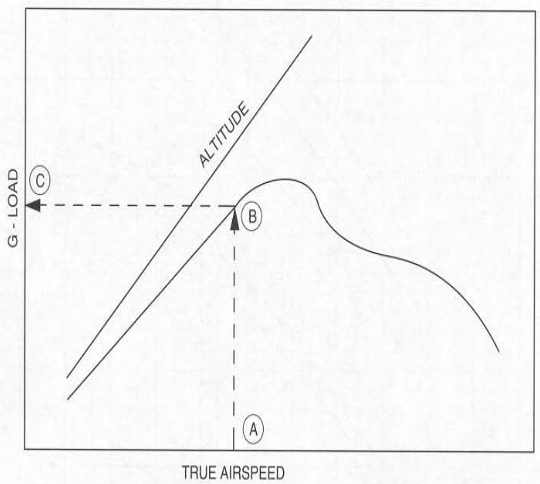
SAMPLE PROBLEM (NPM)

Gross weight	= 13 000 kg
Airspeed	= 366 KIAS
Altitude	= 26 000 ft
Load factor	= 4.4 g

SAMPLE PROBLEM (LPM)

Gross weight	= 13 250 kg
Airspeed	= 380 KIAS
Altitude	= 26 000 ft
Load factor	= 4.35 g

SAMPLE SUSTAINED G TURN CAPABILITY



SUSTAINED G TURN CAPABILITY MAX AB (NPM)

AIRCRAFT CONFIGURATION:
CLEAN OR 2 ARCHER
GROSS WEIGHT 13 000 kg

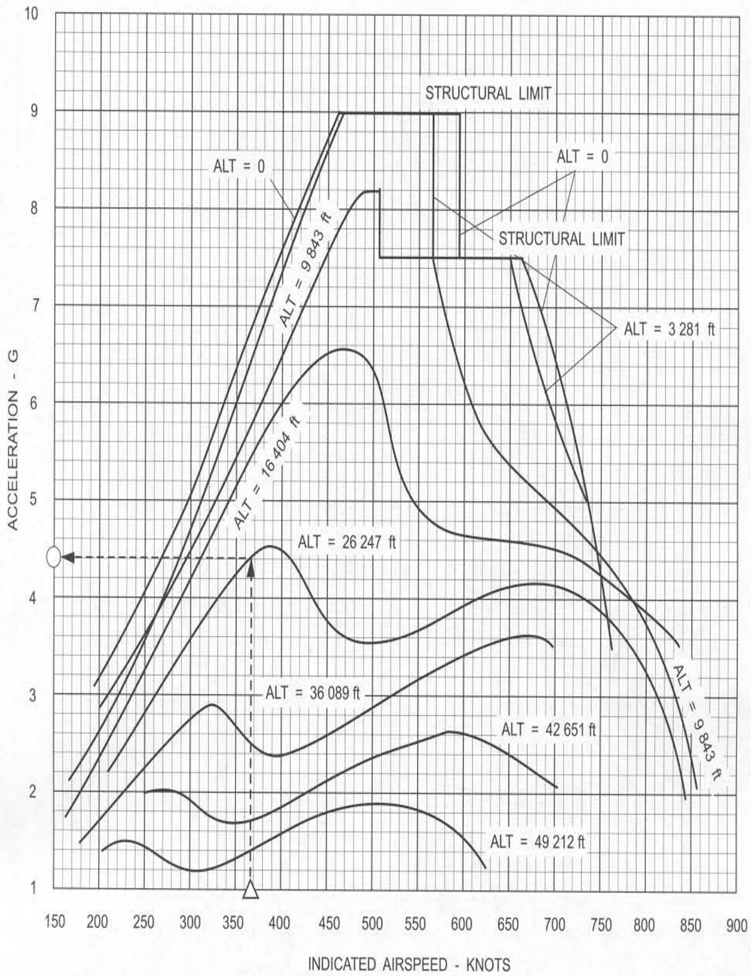


Figure A8-3

SUSTAINED G TURN CAPABILITY MAX AB (LPM)

AIRCRAFT CONFIGURATION:
CLEAN OR 2 ARCHER
GROSS WEIGHT 13 250 kg

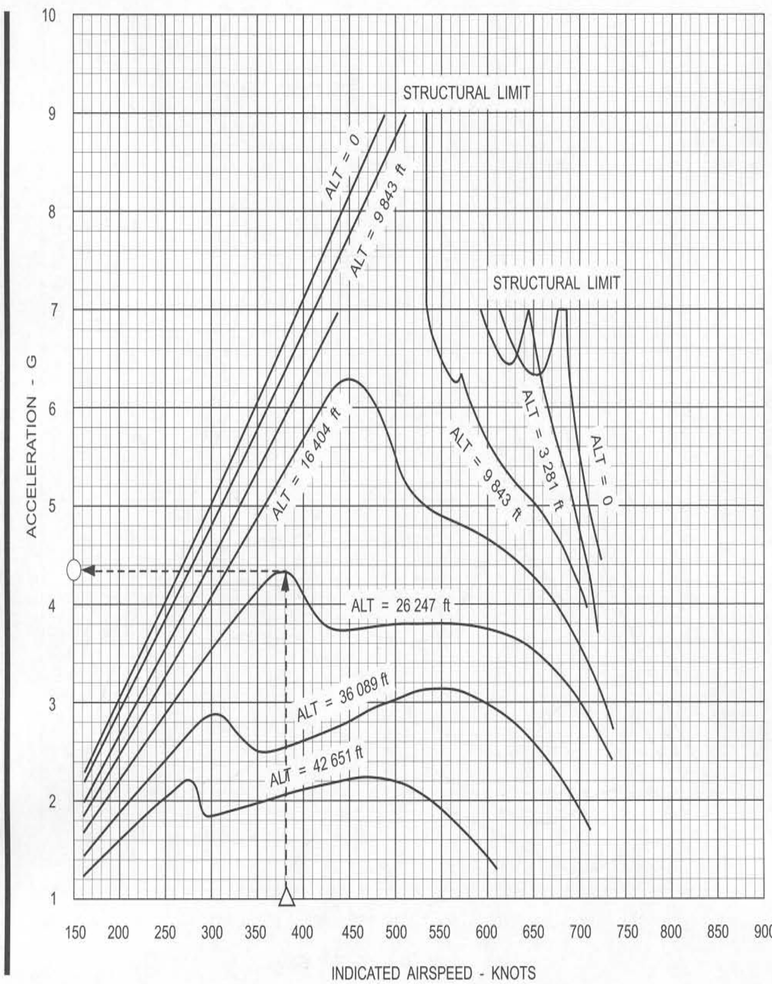


Figure A8-4

CALCULATED SUSTAINED G

These charts present the maximum calculated load factor for constant speed turns at maximum thrust. The charts are plotted for various constant airspeeds, all types of configuration and altitudes up to 43 000 ft. Separate plots are provided for subsonic and supersonic airspeeds.

USE

Before entering these charts, calculate equivalent altitude:

Divide the temperature deviation from ICAO standard temperature by 0.0065. Subtract the number received from the desired altitude to receive the applicable equivalent altitude.

Enter these charts with the applicable Mach number (A) and proceed vertically upwards to intersect the applicable equivalent altitude (B). Proceed horizontally to the left to intersect the applicable drag index line (C). Continue vertically downwards to the applicable Mach number (D), and project horizontally to the right to the applicable pressure altitude (E). Proceed vertically upwards to read the calculated g (F).

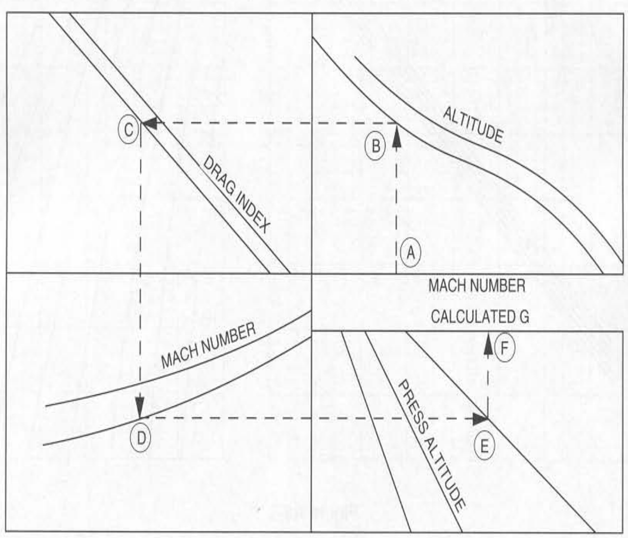
Refer to the chart calculated g versus available g to receive sustained g available.

SAMPLE PROBLEMS

Mach number	= 0.73
DI	= 280
Pressure altitude	= 10 000 ft
Calculated g	= 5.6 g

Mach number	= 1.7
DI	= 280
Pressure altitude	= 30 000 ft
Calculated g	= 3.2 g

SAMPLE CALCULATED SUSTAINED G



CALCULATED SUSTAINED G MAX THRUST (SUBSONIC)

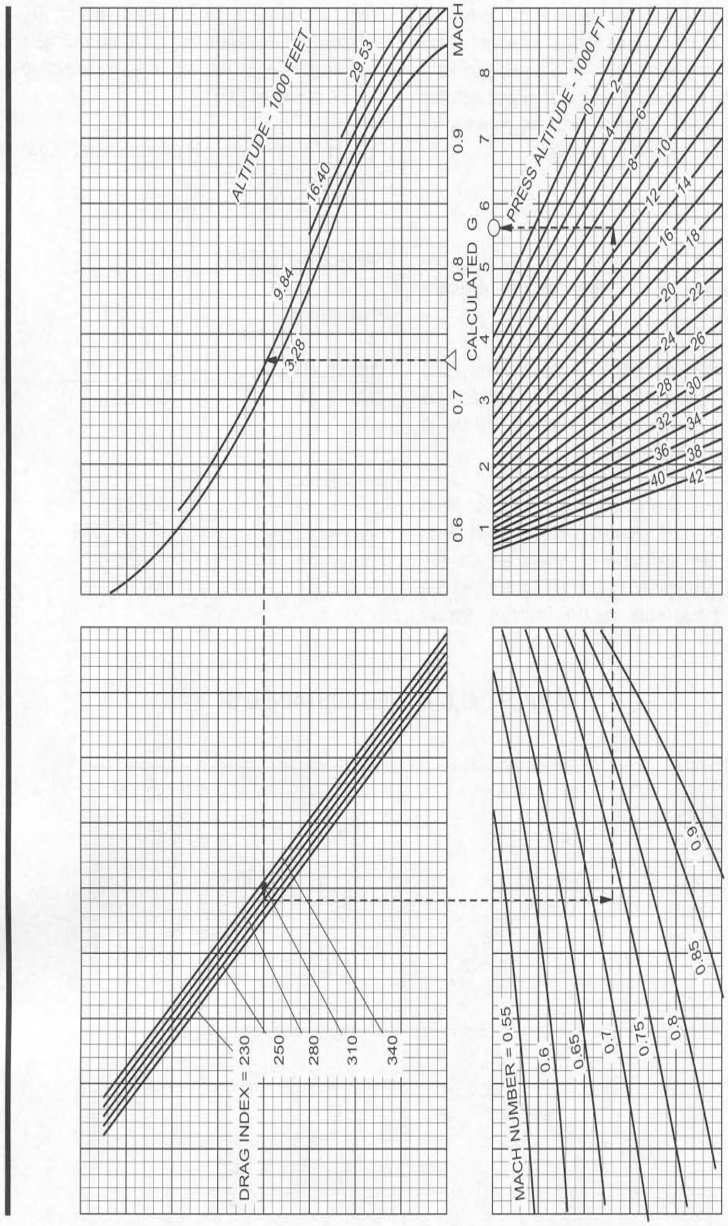


Figure A8-5

CALCULATED SUSTAINED G MAX THRUST (SUPERSONIC)

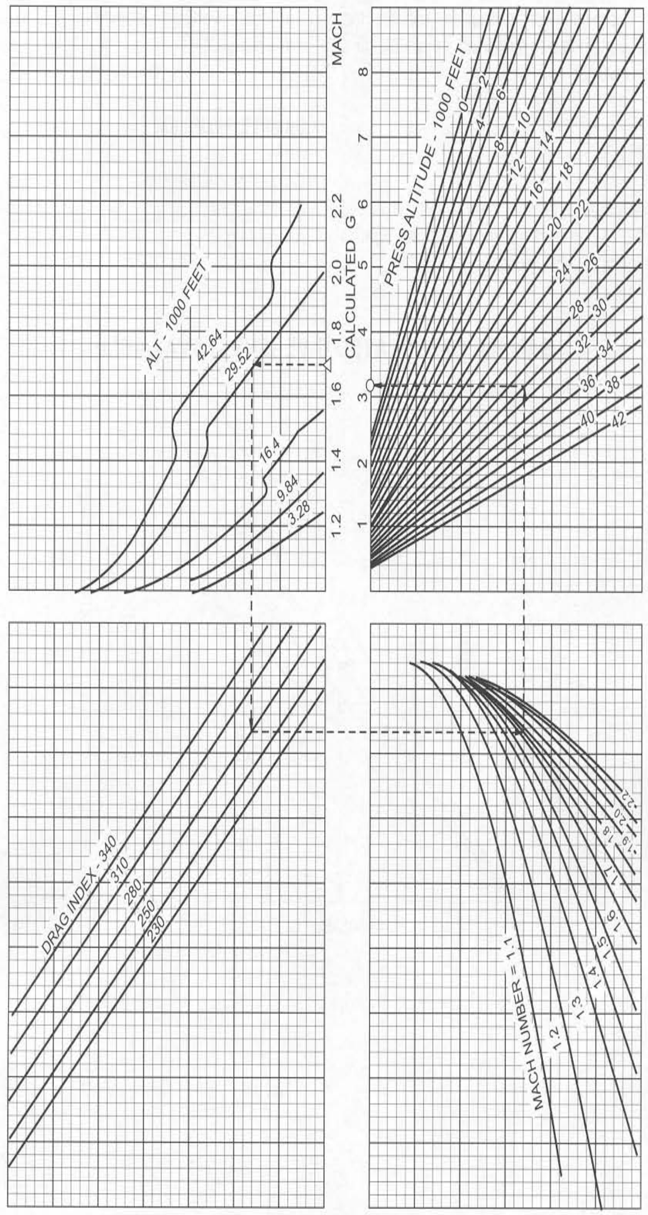


Figure A8-6

CALCULATED G VERSUS G AVAILABLE

The chart provides a means to convert the calculated sustained g to sustained g available for a given gross weight.

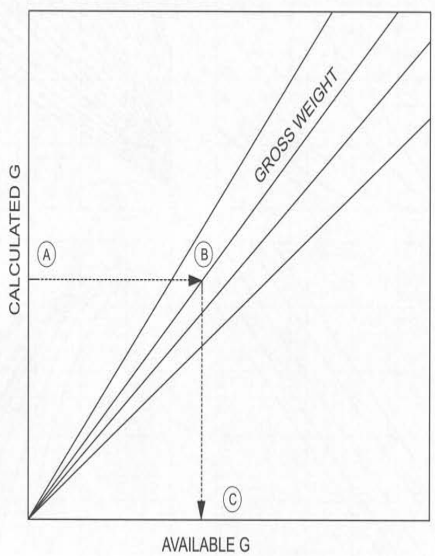
USE

Enter the chart with the previously calculated sustained g (A). Project horizontally to the right to intersect the applicable gross weight line (B). Continue vertically downwards to receive available g (C).

SAMPLE PROBLEM

Calculated sustained g	= 4.75 g
Gross weight	= 13 500 kg
Available g	= 5.25 g

SAMPLE CALCULATED G VERSUS G AVAILABLE



CALCULATED G VERSUS G AVAILABLE

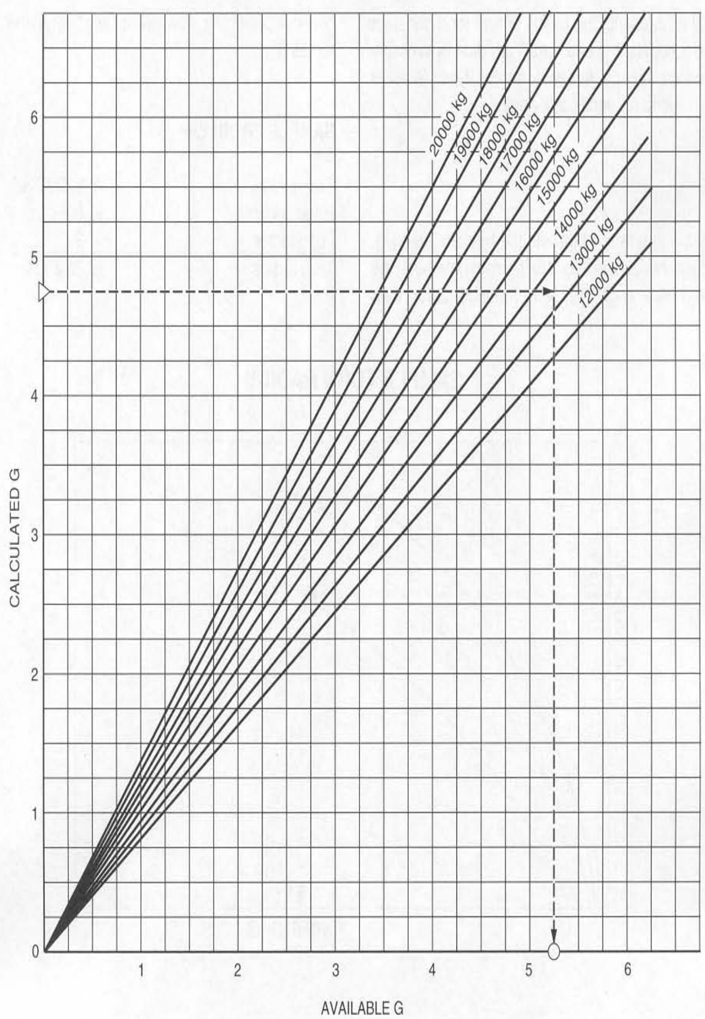


Figure A8-7

TURN RADIUS

The chart presents the radius of turn for a constant altitude, constant speed turn. Turn data is available for various speeds and bank angles. Load factor is also included for each bank angle.

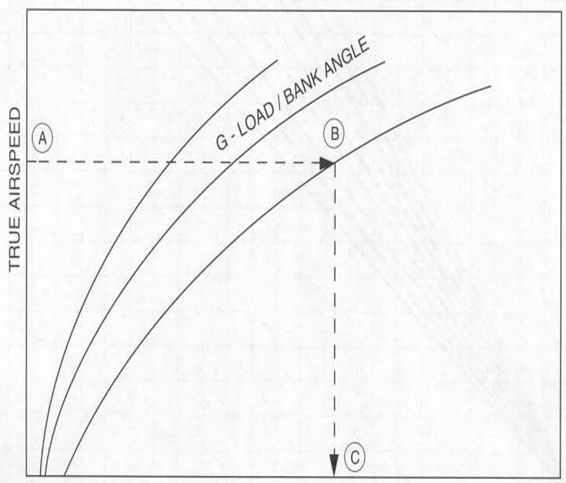
USE

Enter the turn radius plot with the true airspeed (A). Proceed horizontally to the right to intersect the desired bank angle (B). Note the load factor, then continue vertically downwards and read the turn radius (C).

SAMPLE PROBLEM

True airspeed	= 820 KTAS
Bank angle	= 60°
Load factor	= 2 g
Turn radius	= 36 800 ft

SAMPLE TURN RADIUS



TURN RADIUS

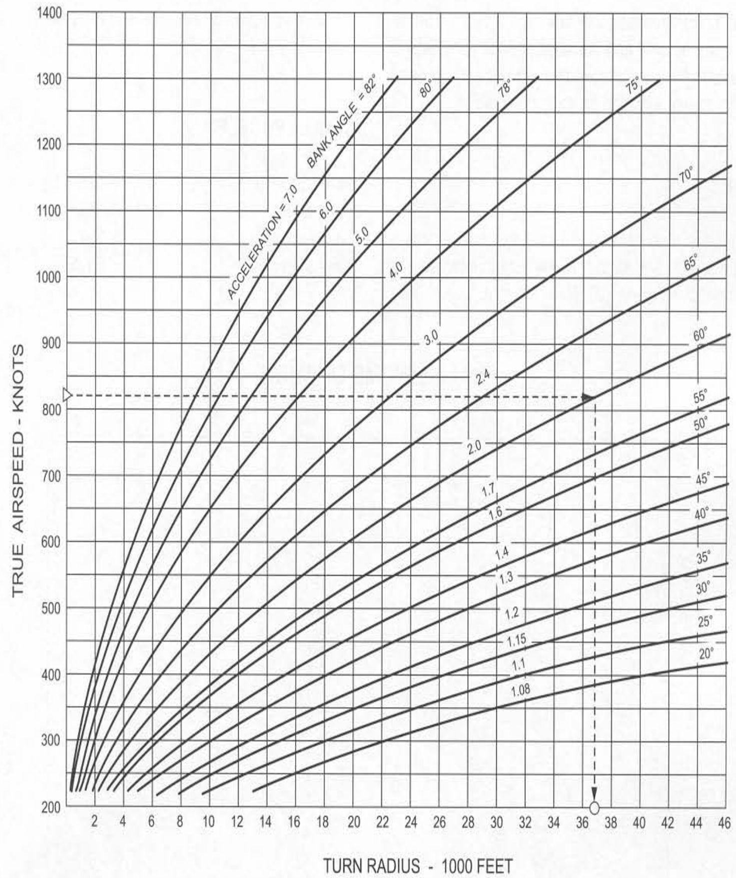


Figure A8-8

TIME OF TURN 180°

The chart presents the time for a 180° turn at constant altitude and constant speed. Turn data is available for various speeds and bank angles. Load factor is also included for each bank angle.

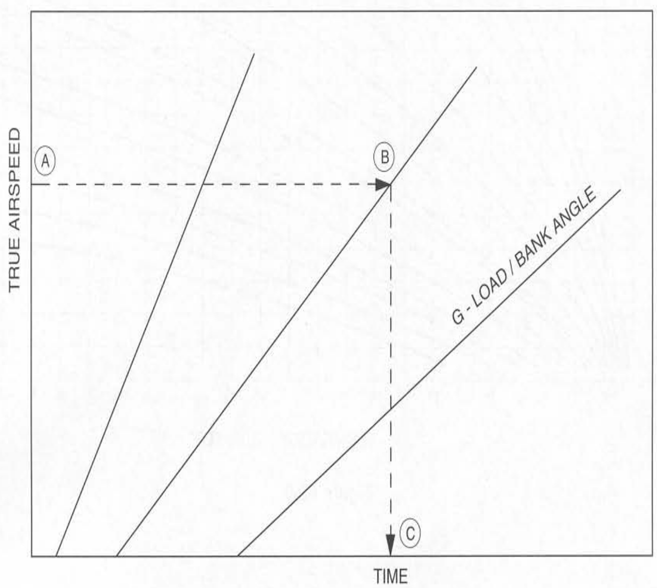
USE

Enter the time of turn plot with the true airspeed (A). Proceed horizontally to the right to intersect the desired bank angle (B). Note the load factor, then continue vertically downwards and read the time of turn (C).

SAMPLE PROBLEM

True airspeed	= 820 KTAS
Bank angle	= 60°
Load factor	= 2 g
Time of turn	= 81 sec

SAMPLE TIME OF TURN



TIME OF TURN 180°

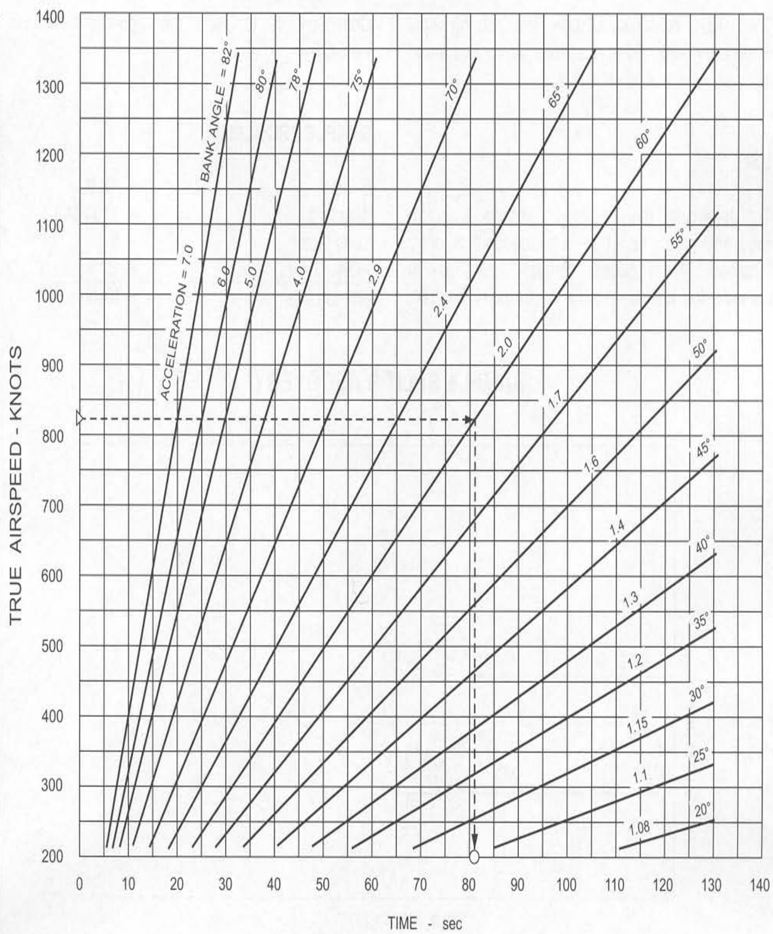


Figure A8-9

SPLIT S RECOVERY

The chart presents altitude loss during split S recovery from minimum altitude for various thrust settings, AOA and load factors.

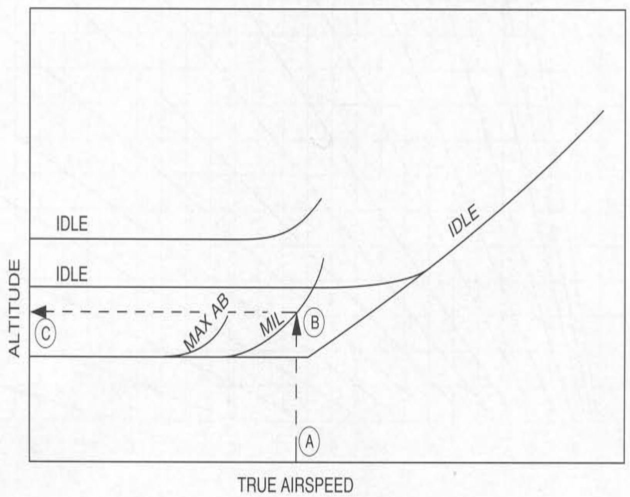
USE

To determine the minimum altitude loss for recovery, enter the chart with the split S entry airspeed (A). Proceed vertically upwards to intersect the desired recovery parameter line (B). Continue left to read the applicable altitude loss (C).

SAMPLE PROBLEM

Engine	= IDLE
Airspeed	= 410 KIAS
Load factor	= 5 g
AOA	= 12°
Altitude loss	= 6 600 ft

SAMPLE SPLIT S RECOVERY



SPLIT S RECOVERY MINIMUM ALTITUDE LOSS

AIRCRAFT CONFIGURATION:
CLEAN OR WITH A/A MISSILES

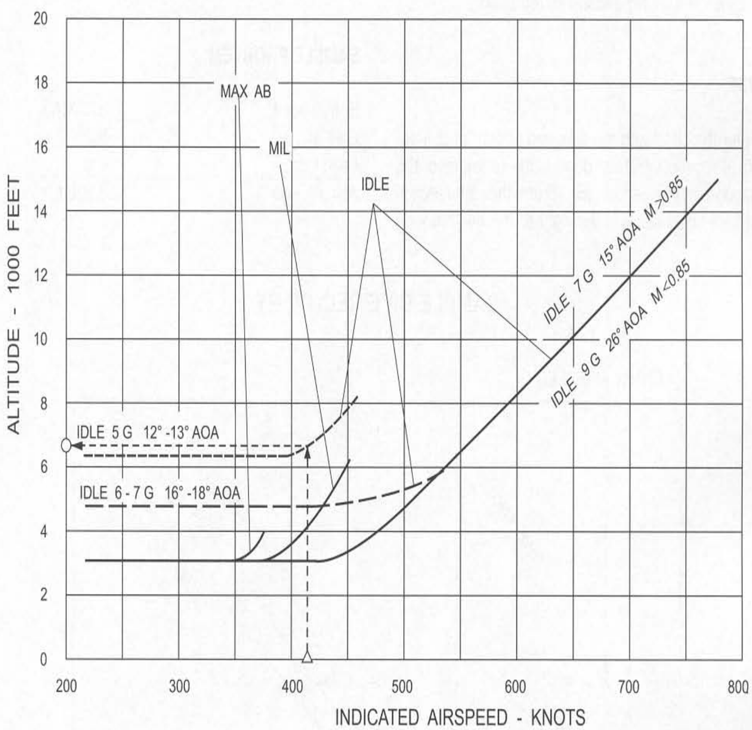


Figure A8-10

DIVE RECOVERY

The chart presents the dive recovery capability for various speeds, dive angles and load factors, engines in IDLE, speedbrakes retracted.

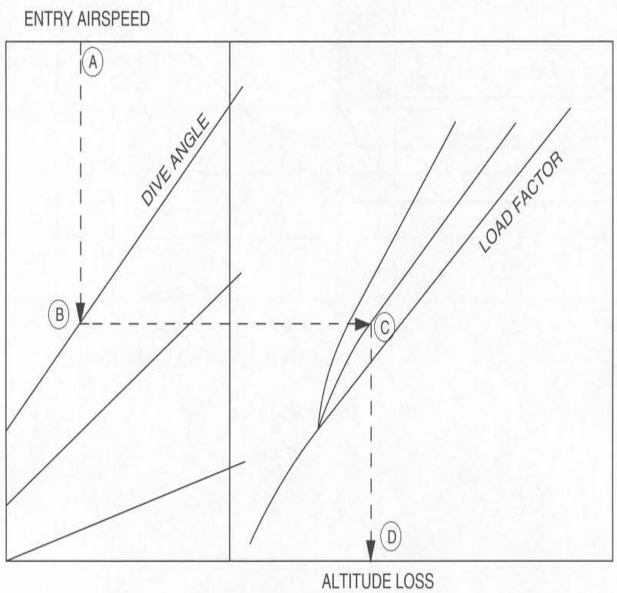
USE

Enter the chart with the airspeed at start of pull-out (A). Proceed vertically downwards to intersect the applicable dive angle (B). From this intersection project horizontally to the right to the desired load factor (C) and proceed vertically downwards to read the corresponding altitude loss (D).

SAMPLE PROBLEM

Entry speed	= 375 KIAS
Dive angle	= 80°
Load factor	= 6 g
Altitude loss	= 3 200 ft

SAMPLE DIVE RECOVERY



DIVE RECOVERY IDLE THRUST

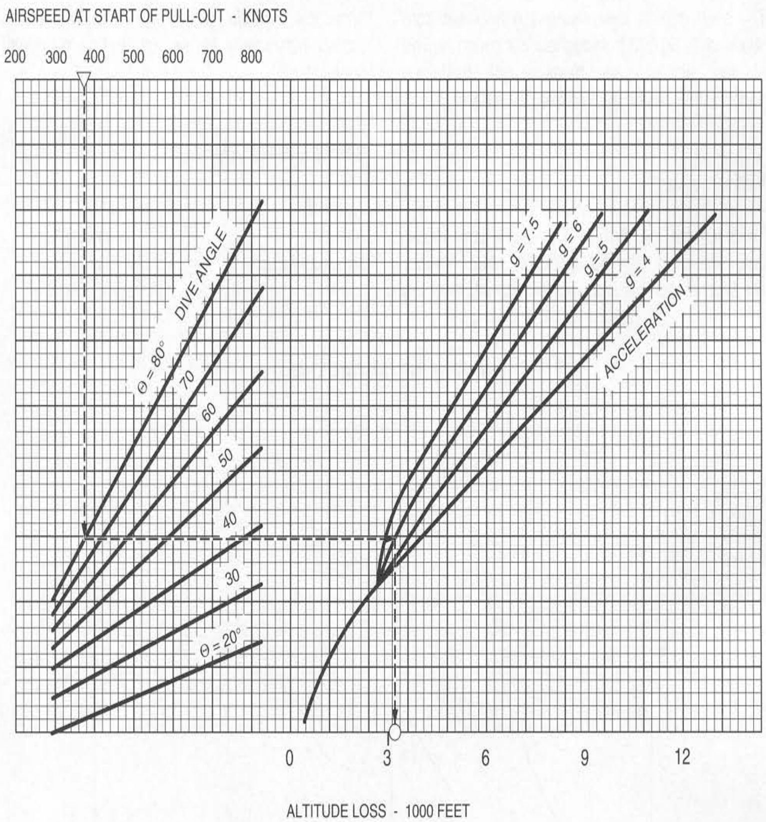


Figure A8-11

INSTANTANEOUS G AVAILABLE

The chart depicts instantaneous g available from sea level to 50 000 ft throughout the speed regime of the aircraft. No measure of sustained performance can be derived from this chart.

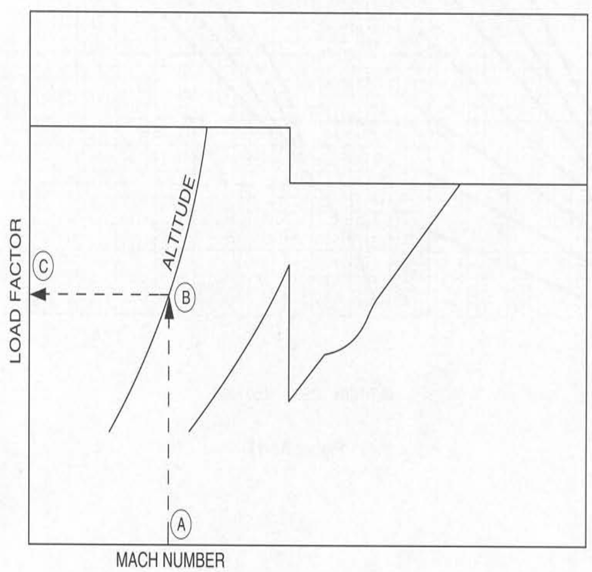
USE

To determine the maximum available load factor, enter the chart with the applicable Mach number (A) and proceed vertically upwards to intersect the applicable altitude (B). From this intersection project horizontally to the left to find maximum g available.

SAMPLE PROBLEM

Airspeed	= M 0.7
Altitude	= 26 000 ft
Max load factor	= 5 g

SAMPLE INSTANTANEOUS G



INSTANTANEOUS G CG = 25.50 % MAC

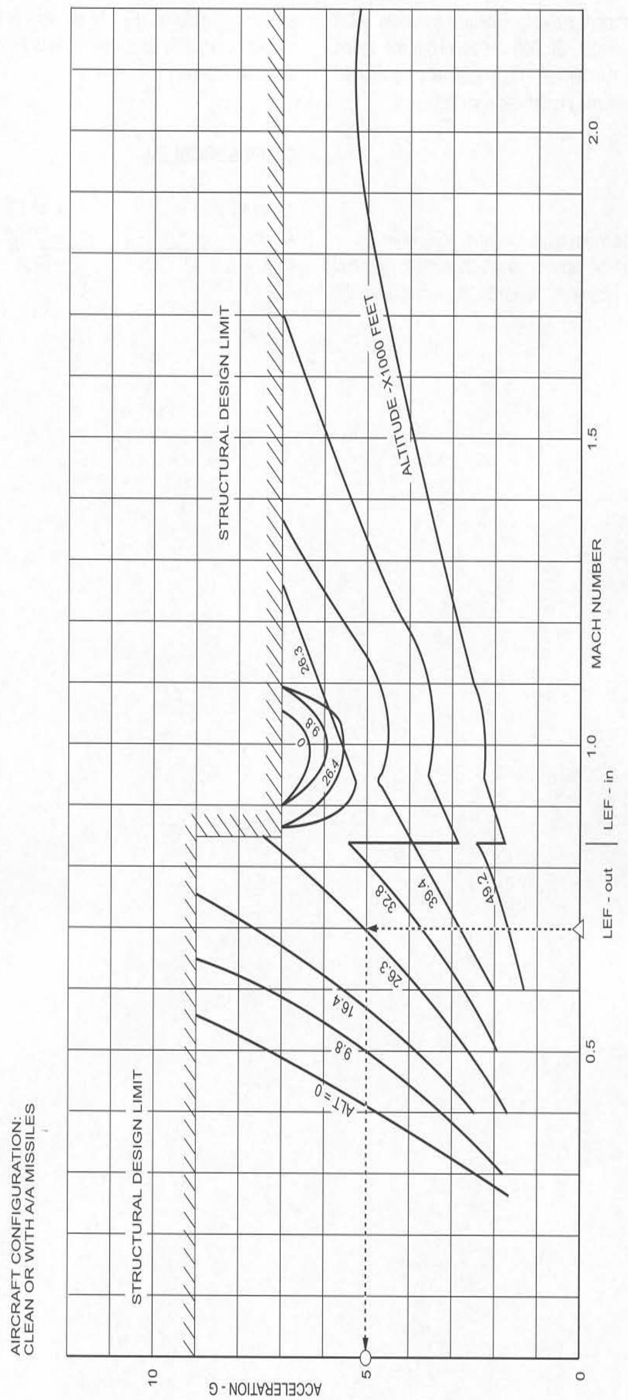


Figure A8-12

INSTANTANEOUS AVAILABLE AOA

The chart depicts instantaneous available AOA from sea level to 50 000 ft throughout the speed regime of the aircraft. No measure of sustained performance can be derived from this chart.

USE

To determine maximum available AOA, enter the chart with the applicable Mach number (A) and proceed vertically upwards to intersect the applicable altitude (B). From this intersection project horizontally to the left to find the maximum available AOA (C).

SAMPLE PROBLEM

Airspeed	= M 1.2
Altitude	= 26 000 ft
Max AOA	= 8.6°

MAXIMUM AVAILABLE AOA CG = 25.50 % MAC

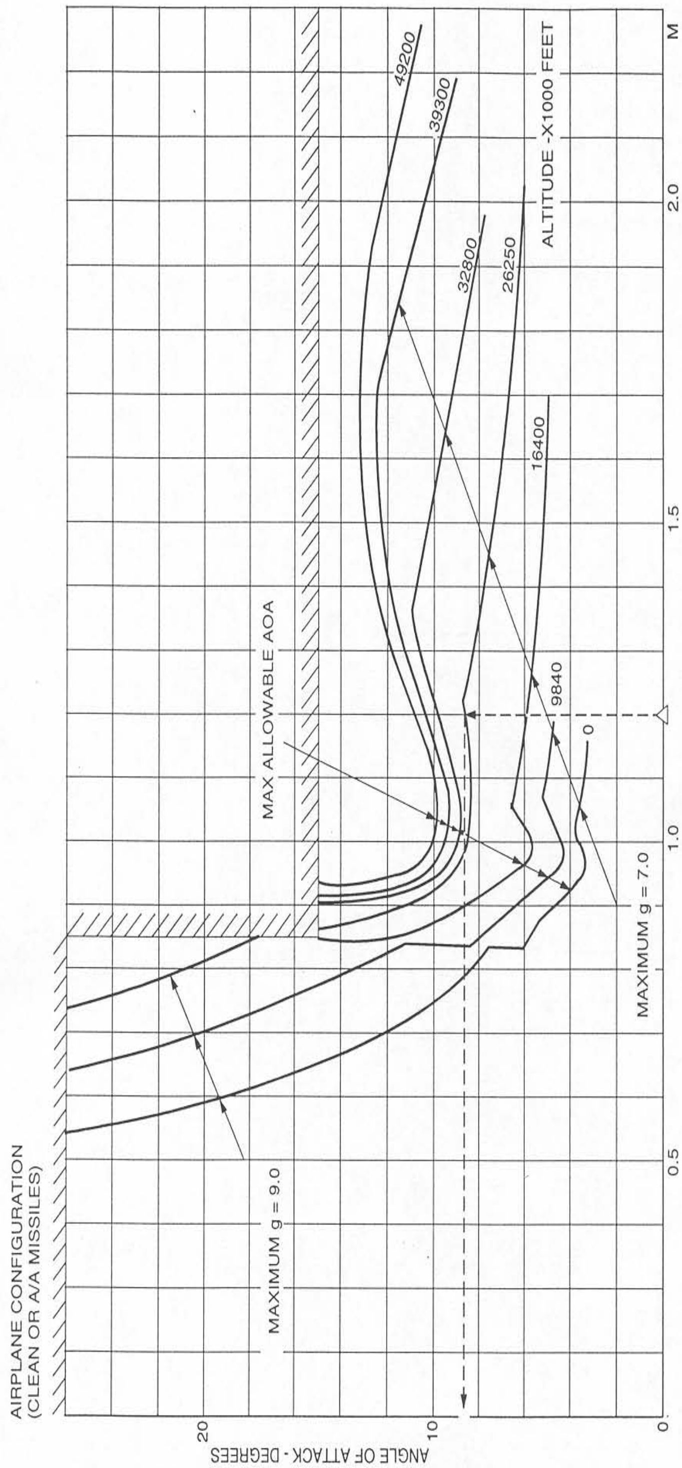


Figure MAXIMUM AVAILABLE AOA
CG = 25.5% MAC

Figure A8-13

LIFT COEFFICIENT

The chart is plotted to depict the relation between airspeed, AOA and coefficient of lift.

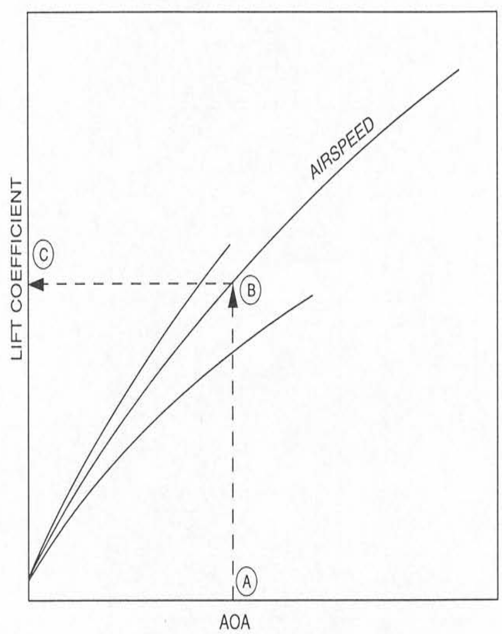
USE

To determine the coefficient of lift enter the chart with AOA (A), and project vertically to intersect the applicable airspeed value (B). At this intersection, read the value for equivalent lift coefficient (C).

SAMPLE PROBLEM

AOA	= 11°
Airspeed	= M 0.8
Lift coefficient	= 0.8

SAMPLE LIFT COEFFICIENT



LIFT COEFFICIENT VERSUS MACH NUMBER AND AOA

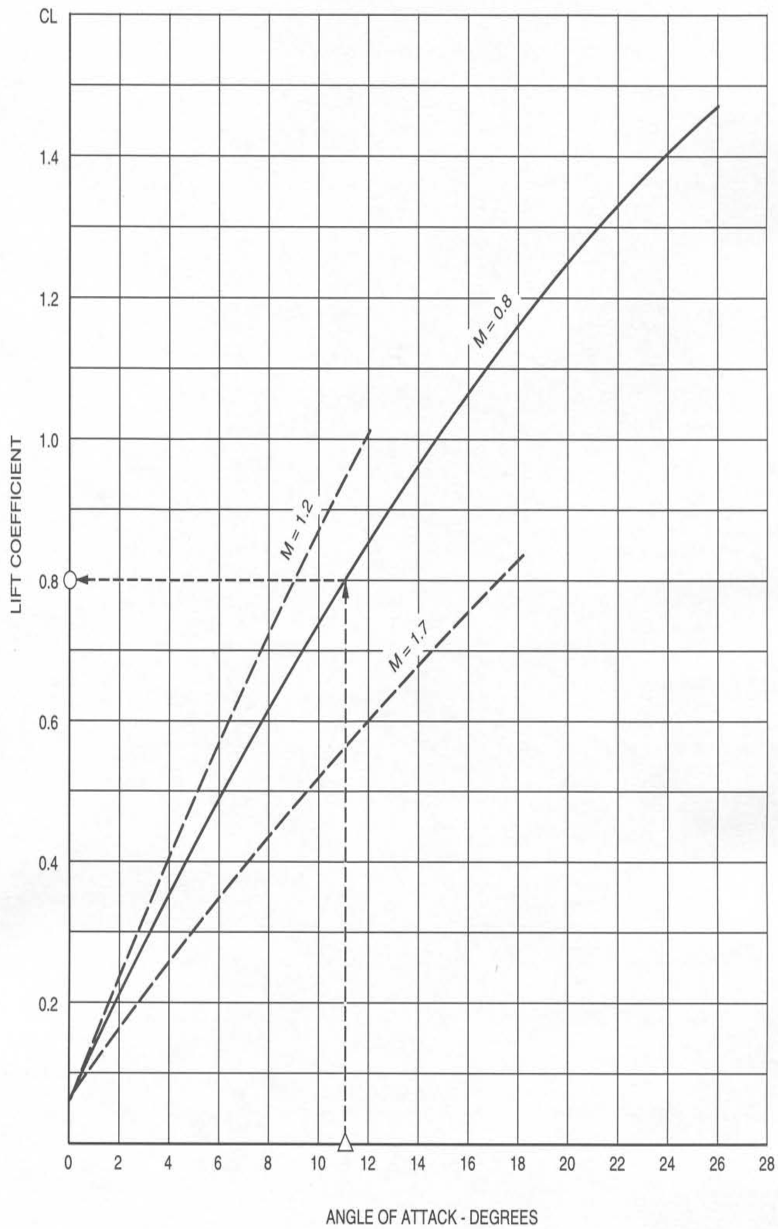


Figure A8-14

APPENDIX B

COCKPIT MARKING REFERENCE LIST

TABLE OF CONTENTS

	Page
COCKPIT G AND FRONT COCKPIT GT	
LH Side Wall	B-3
LH Console	B-5
Front Panel	B-9
Pedestal Panel	B-19
RH Console	B-21
RH Side Wall	B-27
Internal and External Refueling Panels	B-29
REAR COCKPIT	
LH Side Wall	B-31
LH Console	B-32
Front Panel	B-35
Pedestal Panel	B-45
RH Console	B-46
RH Side Wall	B-48
External Refueling Panel	B-49

COCKPIT MIG-29G

AND

FRONT COCKPIT MIG-29GT

LH SIDE WALL

G/GT (F/C):

LABELS		
AD-5A CHECK MAX MIN	KONTROLLE DRUCKAUTOMAT AD-5A MAXIMUM MINIMUM	ПРОВЕРКА АД-5-А МАК МИН.
ATTENTION WITH SUITS WKK-6M, WKK-15, PPK-3, SET ITEM AD-5A HEAD TO "MAX" WITH SUIT PPK-1U SET TO "MIN"	ACHTUNG! BEI DEN DRUCKANZÜGEN WKK-6M, WKK-15, PPK-3 IST DAS OBERTEIL DES AD-5A AUF "MAX". ZU STELLEN UND BEI DEM DRUCKANZUG PPK-1U AUF "MIN"	ВНИМАНИЕ! ГОЛОВКУ ДА-5А СТАВИТЬ НА МАК. С КОСТЮМАМИ ВКК-6М, ВКК-15, ППК-3 МИН. С КОСТЮМОМ ППК-1У
RPK-52 CHECK	ÜBERPRÜFUNG RPK-52	ПРОВЕРКА РПК-52
KP-52M ATTACH	BEFESTIGUNG KP-52M	ПОДВЕСКА КП-52М

G/GT (F/C):

CABLE ORK ATTACH		
CABLE ORK ATTACH	AUFHÄNGEVORRICHTUNG ORK-KABEL	ПОДВЕСКА ЭЛЕКТРОЖГУТА ОРК

G/GT (F/C):

CABIN EMERGENCY DECOMPRESSION LEVER		
CABIN EMERGENCY DECOMPRESSION	NOTENTHERMETISIERUNG KABINE (DEKOMPRESSION)	АВАР. РАЗГЕРМЕТ. КАБИНЫ
PRESSURE	HERMETISIERUNG	ЗАГЕРМ.

GT (F/C):

THROTTLE STROKE		
THROTTLE STROKE R/C - F/C	ANSCHLÄGE DROSSELHEBEL 2. KABINE - 1. KABINE	ПОДКЛЮЧЕНИЕ УПОРОВ РУД 2. КАБИНА - 1. КАБИНА

G/GT (F/C):

THROTTLE FRICTION ADJUSTMENT		
HEAVY	DROSSELHEBEL FESTSTELLEN	ТУГО

G:

THROTTLE		
LOCK-ON	BUGRADLENKUNG EIN ERFASSUNGSTASTE	МРК ЗАХВАТ ПЗ
	SENDETASTE	РАЦИЯ
	BREMSKLAPPEN	ТОРМ. ЩИТКИ
	DÜPPEL/IR-TÄUSCHKÖRPER	В. П.

GT (F/C):

THROTTLE		
	BUGRADLENKUNG EIN ERFASSUNGSTASTE	МРК ЗАХВАТ ПЗ
	SENDETASTE	РАЦИЯ
	BREMSKLAPPEN	ТОРМ. ЩИТКИ
	DÜPPEL/IR-TÄUSCHKÖRPER	В. П.
	AUFHÄNGUNGEN INNERE ÄUSSERE	ПОДВЕСКИ ВНУТР. ВНЕШН.
	BORDSPRECHANLAGE	СПУ

G/GT (F/C):

CHUTE DEPLOY BUTTON		
CHUTE DEPLOY	BREMSSCHIRMAUSWURF	ВЫПУСК ПАРАШЮТА

G:

EXTERNAL STORES SELECTOR SWITCH		
EXT STORES INBD OUTBD	AUFHÄNGUNGEN INNERE ÄUSSERE	ПОДВЕСКИ ВНУТР. ВНЕШН.

GT (F/C):

MARKER BEACON SWITCH		
OUTER INNER	FERNFUNKFEUER (FFF) NAHFUNKFEUER (NFF)	ДАЛЬН. БЛИЖН.
BEACON INNER	ARK NAHFUNKFEUER	АРК БПРС

G:

CANOPY OPERATING HANDLE		
CANOPY	KABINENDACH	ФОНАРЬ
LOCK CANOPY	SCHLIESSE KABINENDACH	ЗАПРИ ФОНАРЬ

GT (F/C):

CANOPY OPERATING HANDLE		
CANOPY	KABINENDACH OFFEN ROLLSTELLUNG GESCHLOSSEN	ФОНАРЬ ОТКРЫТ ПРИОТКРЫТ ЗАКРЫТ
LOCK CANOPY	SCHLIESSE KABINENDACH	ЗАПРИ ФОНАРЬ

LH CONSOLE

G/GT (F/C):

OXYGEN FLOW VALVE		
OXYGEN FLOW OPEN CLOSED	O_2-VENTIL ÖFFNEN GEÖFFNET GESCHLOSSEN	ОТКРЫТЬ КИСЛОРОД ОТКР. ЗАКР.
PILOT´S OXYGEN OPEN BEFORE FLIGHT CLOSE AFTER FLIGHT	O_2-ZUFUHR DES LFF VOR DEM FLUG ÖFFNEN UND NACH DEM FLUG SCHLIESSEN	КИСЛОРОД ЛЕТЧИКА ПЕРЕД ПОЛЕТОМ ОТКР. ПОСЛЕ ПОЛЕТА ЗАКР

G/GT (F/C):

SUIT VENTILATION CONTROL KNOB		
COLD HOT	KALT HEISS	ХОЛ. ГОР.
OPEN	GEÖFFNET	ОТКР.
CLOSED	GESCHLOSSEN	ЗАКР.
SUIT VENT.	VENTILATIONSANZUG	ВЕНТИЛ. ОДЕЖДЫ

G/GT (F/C):

OXYGEN CONTROL PANEL		
100% O_2 - MIXT	100% O_2-GEMISCH	100 % O_2-СМЕСЬ
EMERG ON EMERG OFF	NOT EIN NOT AUS	АВАР. ВКЛ. ВЫКЛ.
HELM VENT ON OFF	HELMVENTILATION EIN AUS	ВУШ. ВКЛ. ВЫКЛ.

G/GT (F/C):

CONTROL PANEL		
EMERG HYD PUMP	HYDRAULIKNOTPUMPE	АВАР. НАСОСН. СТАНЦ.
CHUTE JETTISON	ABWURF BREMSSCHIRM	СБОС ПАРАШЮТА
MRK EMERG OFF	NOTABSCHALTEN MRK	АВАР. ОТКЛ. МРК
FEEL UNIT AUTO EASY HEAVY OFF	ARU AUTOMATISCH LEICHT SCHWER AUS	АРУ АВТ. ЛЕТКО ТЯЖЕЛО ОТКЛ.

G/GT (F/C):

VHF/UHF FREQUENCY CONTROL PANEL		
VHF UHF	VHF UHF	
PRE MAN.	VORABSTIMMBARE KANÄLE FREI WÄHLBARE FREQUENZEN	

G/GT (F/C):

VHF/UHF RADIO PANEL		
GUARD RCVR	NOTEMPFÄNGER	АП
ADF	FUNKKOMPASS	РК
SQLCH	RAUSCHSPERRE	

G:

FLAP OPERATION CONTROL PANEL		
FLAPS DOWN DOWN UP OFF	LANDEKLAPPEN STELLUNG LANDUNG STELLUNG START STELLUNG EINGEFAHREN STELLUNG AUS	ЗАКРЫЛКИ ПОСАДКА ВЗЛЕТ УБРАНЫ ВЫКЛ.

GT (F/C):

FLAP OPERATION CONTROL PANEL		
FLAPS DOWN UP	LANDEKLAPPEN STELLUNG START/LANDUNG STELLUNG EINGEFAHREN	ЗАКРЫЛКИ ВЫП. УБР.

G/GT (F/C):

ENGINE EMERGENCY PANEL		
RAMP EMERG RETRACTION	NOTEINFAHREN DER KEILE	АВАР. УБОРКА КЛИНА
LH RH RETRACTION	LINKS RECHTS EINFAHREN	ЛЕВ. ПРАВ. УБОРКА
FIRE EXT GBX LH RH	FEUERLÖSCHER KSA LINKES TW RECHTES TW	ОГНЕТУШИТЕЛЬ КСА ЛЕВ. ПРАВ.
FUEL SHUT OFF LH OPEN CLOSED	BRANDHAHN LINKS OFFEN GESCHLOSSEN	ПЕРЕКР. КРАН ЛЕВ. ОТКР. ЗАКРЫТ
FUEL SHUT OFF RH OPEN CLOSED	BRANDHAHN RECHTS OFFEN GESCHLOSSEN	ПЕРЕКР. КРАН ПРАВ. ОТКР. ЗАКРЫТ
AB EMERG OFF	NACHBRENNER (NB) NOTAUSSCHALTEN NB	ФОРСАЖ АВАР. ОТКЛ.
AIR RELIGHT LH RH	ANLASSEN IN DER LUFT LINKES TW ANLASSEN IN DER LUFT RECHTES TW	ЗАПУСК В ВОЗДУХЕ ЛЕВ. ПРАВ.
GEN DRIVE EMERG OFF	NOTABSCHALTEN GENERATORANTRIEB	АВАР. ОТКЛ. ПРИВОД ГЕНЕРАТ.

G/GT (F/C):

EMERGENCY UHF RADIO		
COOP DRAG N DRAG	ZUSAMMENWIRKEN GEBREMST UNGEBREMST	ВЗМД ТОРМОЗ БЕЗ ТОРМ.
GUID	LEITEN	НАВЕД.
AIR GROUND	LUFT BODEN	ВОЗДУХ ЗЕМЛЯ
OFF R T/R	AUS EMPFANG SENDEN/EMPFANGEN	
VOL	LAUTSTÄRKEREGLER	
TEST	KONTROLLTASTE, KONTROLLAMPE	
EMERG UHF	UHF-NOTFUNKSTATION	
1 2 G	RESERVEKANAL 1 (243,4 MHz) RESERVEKANAL 2 (242,4 MHz) NOTKANAL GUARD (243,0 MHz)	

FRONT PANEL

G/GT (F/C):

RUDDER TRIM/IR VOLUME PANEL		
IR VOLUME	LAUTSTÄRKE ERFASSUNG	ЗАХВАТ ГРОМЧЕ
RUDDER TRIM	SEITENRUDERTRIMMUNG	ТРИММ РП
LEFT	LINKS	ЛЕВ.
RIGHT	RECHTS	ПРАВ.

G/GT (F/C):

AFCS CONTROL PANEL		
DAMPER	DÄMPFUNG	ДЕМПФ
AUTO RECOVER	AUTOMATISCHE HERAUSFÜH-RUNG AUS GEFÄHRLICHER HÖHE	УВОД
ALT HOLD	STABILISIERUNG BAROMETRISCHE HÖHE	СТАБ. ВЫС.
ATT HOLD	STABILISIERUNG WINKELLAGEN	АП
APPROACH	STEUERUNG LANDEANFLUG	ТРАЕК. УПР.
MISSED APPROACH	WIEDERHOLUNGSLANDEANFLUG	ПОВТ. ЗАХОД

G/GT (F/C):

RADAR CONTROL PANEL		
ΔH 0, 1, 2, 4, 6, 8, 10 - 6, -4, - 2, - 1	ΔH 0, 1, 2, 4, 6, 8, 10 - 6, -4, - 2, - 1	ΔH 0, 1, 2, 4, 6, 8, 10 - 6, -4, - 2, - 1
RADAR MODES	BETRIEBSARTEN RADAR	РЕЖИМЫ РЛС
AUTO	AUTOMATISCH	АВТ.
CLOSE CMBT	NAHLUFTKAMPF	БЛ. БОЙ
HEAD ON	GEGENKURS	В
PURSUIT	ABFANGEN AUS DER HIN-TEREN HALBSPHÄRE	Д
ILLUM	ABSTRAHLUNG	ИЗЛ.

DUMMY OFF	ÄQUIVALENT AUS	ЭКВ.
COMP	KOMPENSATION	КОМП.
TWF FHS RHS	STÖRUNGEN VORDERE HALB-SPHÄRE STÖRUNGEN HINTERE HALB-SPHÄRE	СНП ППС ЗПС
AJ	AKTIVE STÖRUNGEN	АП
ECCM OFF	STÖRUNGEN AUS	ОТКЛ.
CAJ	KOMPENSATION AKTIVER STÖRUNGEN	АПК

G/GT (F/C):

LANDING GEAR HANDLE		
RETRACTED	FW EINGEFAHREN	УБРАНЫ
LG	FW	ШАССИ
EXTENDED	FW AUSGEFAHREN	ВЫПУЩЕНЫ

G/GT (F/C):

EMERG MSL JETT BUTTON AND LAND LIGHT TAXI SWITCH		
EMERG MSL JETT	NOTABSCHUSS	РЕСЕРВ ПУСК
LAND LIGHT	LANDESCHEINWERFER	ФАРЫ ПОСАД.
TAXI	ROLLSCHEINWERFER	РУЛЕЖ
OFF	AUS	ОТКЛ.

G/GT (F/C):

IAS INDICATOR		
KNOTS	KNOTEN	

G/GT (F/C):

EMERGENCY BRAKE HANDLE		
EMERG BRAKE	NOTBREMSE	АВАР. ТОРМ.

G/GT (F/C):

ALTIMETER		
FEET	FUSS	

G/GT (F/C):

EMERGENCY LANDING GEAR HANDLE		
EMERG GEAR	NOTAUSFAHREN FAHRWERK	АВАР. ШАССИ

G/GT (F/C):

MAG HDG/COURSE PANEL		
MAG HDG SLAVE	ABSTIMMUNG MAGNETKURS	СОГЛАС. М. КУРСА
SET COURSE AUTO	SOLLKURS AUTOMATISCH	КУРС, ЗАДАН АВТОМ
MAN.	HANDEINGABE	РУЧН.

G/GT (F/C):

HORIZONTAL SITUATION INDICATOR		
NM	NAUTISCHE MEILEN (Blende)	
COURSE	SOLLKURS (Blende)	ЗПУ
HDG	KURS	К С
C G	KURS/GLEITEN (SCHAUZEICHEN)	К Г
TEST	EIGENKONTROLLE	ТЕСТ

G/GT (F/C):

ATTITUDE DIRECTOR INDICATOR		
CAGE	ARRETIERUNG	АРРЕТИР
	LÄNGSNEIGUNG	Т
	QUERNEIGUNG	К

G/GT (F/C):

WEAPON CONTROL PANEL		
MASTER ARM ARM SAVE	HAUPTWAFFENSCHALTER EIN AUS	ГЛАВН. ОТКЛ.
ZONE	ZONE	ЗОНА
IR GAIN/HELM BRIGHT.	VERSTÄRKUNG WÄRMEPEILER (IR-PEILER)/HELLIGKEIT HELMVISIER	УСИЛ. ТП, ЯРК. ШЛ.
ALL	GESAMT (KOMPLEX)	КОМПЛ.
SINGLE 0.5 ALL	EINZELN 0,5 GESAMT	ОДИН 0,5 КОМ.
PREPARE MAN.	VORBEREITUNG HAND(MANUELL)	ПОДГОТ. РУЧН.
AUTO	AUTOMATISCH	АВТ.
SPAN	BASIS (SPANNWEITE)	БАЗА
SMALL	KLEIN	М
LARGE	GROSS	Б
MED	MITTEL	С
WCS MODES	BETRIEBSARTEN	РЕЖИМЫ
TOSS	BOMBENWURF AUS DEM HOCH-ZIEHEN	КБР
NAV	NAVIGATION	НВГ
RADAR	RADAR	РЛ
IR	WÄRMEPEILER (IR-PEILER)	ТП
CC	NAHLUFTKAMPF	ББ
HELM	HELMVISIER	ШЛЕМ
OPT	BETRIEBSART OPTISCH	ОПТ.
BS	STARRE WAFFENACHSE	φ_0

G/GT (F/C):

VHF/UHF INDICATOR PANEL		
STORE	SPEICHER	
CHANNEL	KANALANZEIGE	
FREQUENCY	FREQUENZANZEIGE	
DIM	HELLIGKEITSREGLER	
VHF/UHF	VHF/UHF STATION	

G/GT (F/C):

MASTER CAUTION LIGHT		
MASTER CAUTION	ALLGEMEINES AUSFALLSIGNAL	КСЦ

G/GT (F/C):

COMBINED AOA/G METER		
α, n_y	ANZEIGE ANSTELLWINKEL, LASTVIELFACHES	α, n_y

GT (F/C):

RADIO SELECTOR		
RADIO SEL	FUNKSTATION R/C → F/C	

G/GT (F/C):

EMERGENCY RELEASE BUTTON		
EMERG RELEASE	NOTABWURF	АВАР. СБРОС

G/GT (F/C):

HUD		
BRIGHT.	HELLIGKEIT	ЯРК.
TEST	ÜBERPRÜFUNG	ТЕСТ
RETICLE	VISIERNETZ	СЕТКА
DAY	TAG	ДЕНЬ
NIGHT	NACHT	НОЧЬ

G/GT (F/C):

NOSE WHEEL BRAKE LEVER		
NOSE WHEEL BRAKE	BUGRADBREMSE	ТОРМОЗ ПЕРЕД. КОЛЕСА
ON OFF	EIN AUS	ВКЛ. ОТКЛ.

G/GT (F/C):

VERTICAL VELOCITY INDICATOR		
FT/MIN	FUSS PRO MINUTE	

G/GT (F/C):

TAS INDICATOR		
KNOTS	KNOTEN	
MACH	MACHZAHL	

G:

SWITCH PANEL		
OUTER INNER	FERNFUNKFEUER (FFF) NAHFUNKFEUER (NFF)	ДАЛН. БЛИЖН.
EMERG JETTISON	NOTABSCHUSS DÜPPEL/IR-SCHEINZIELE	АВАР. ОТСТРЕЛ
GROUND	BODEN	ЗРК
FHS	VORDERE HALBSPHÄRE	ППС
RHS	HINTERE HALBSPHÄRE	ЗПС
CARTS REMAINING	SCHEINZIELVORRATSZÄHLER	ОСТАТОК ЛТЦ
BEACON INNER	ARK NAHFUNKFEUER	АРК БПРС

G/GT (F/C):

COMBINED OXYGEN INDICATOR		
H_{CKPT}	KABINENHÖHE	$H_{КАБ}$.
O_2	ATMUNGSANZEIGE	O_2
ΔP	DIFFERENZDRUCK	ΔP
RESERVE %	VORRAT IN PROZENT	ЗАПАС %
FEED	ZUFUHR	ПОДАЧА

G/GT (F/C):

RADAR ALTIMETER		
FEET	HÖHENANZEIGE IN FUSS	
RADIO ALT	ANZEIGE RADARHÖHENMESSER	

G/GT (F/C):

COMBINED PRESSURE INDICATOR		
HYDRAULIC MAIN BOOST	HYDRAULIKANLAGE ALLGEMEIN VERSTÄRKER	ГИДРОСИТ. ОБЩ. БУСТЕР
PNEUMATIC MAIN EMERG	DRUCKLUFTANLAGE HAUPT NOT	ГАЗ. СИСТ. ОСН. АВАР.

G/GT (F/C):

RAMPS POSITION INDICATOR		
RAMPS	KEILE KEILE VOLL AUSGEFAHREN	КЛИН ВП

G/GT (F/C):

FUEL INDICATOR				
TAC		MOMENTANVERBRAUCH	ТЕК	
OPT		OPTIMALER VERBRAUCH	ОПТ	
TANKS	CL WING 3 1	ZUSATZBEHÄLTER TRAGFLÄCHENBEHÄLTER BEHÄLTER 3 BEHÄLTER 1	БАКИ	П КР 3 1
		KS-VORRAT	Т	
		KS-VERBRAUCH	Р	
NM		REICHWEITE IN NM	ДАЛЬНОСТЬ КМ	
		KRAFTSTOFF IN kg	ТОПЛИВО КГ	

G/GT (F/C):

HDD		
BRIGHT	HELLIGKEIT	ЯРК.

G/GT (F/C):

AEKRAN		
FAIL	AUSFALL	ОТКАЗ
TURN	PRIORITÄT, REIHENFOLGE	ОЧЕРЕДЬ
MEMORY	SPEICHER	ПАМЯТЬ
AEKRAN CALL	AUFRUF ÄKRAN ZUR EIGENKONTROLLE	ЭКРАН ВЫЗОВ

G/GT (F/C):

RHAW DISPLAY PANEL		
	ANZEIGE OBEN	В
	ANZEIGE UNTEN	Н
	MARKEN HAUPTTYP	П, З, Х, Н, Г,С
SOUND OFF	TONSIGNAL AUS	ЗВУК ОТКЛ.
TEST MAN. AUTO	KONTROLLE HAND (MANUELL) AUTOMATISCH	КОНТР. РУЧН. АВТ.
BRIGHT.	HELLIGKEIT (NACHT)	НОЧЬ

G/GT (F/C):

NAVIGATION CONTROL PANEL		
D < 21	D (ENTFERNUNG) KLEINER ALS 21 NM (40 km)	Д < 40 км
GYRO MAIN STBY	IKW HAUPT NEBEN	ИКВ ОСН. ЗАП.
CORR	KORREKTUR	КОРР.
CHANNELS AUTO MAN	KANÄLE AUTOMATISCH HAND (MANUELL)	КАНАЛЫ АВТ. РУЧН.
WP	WENDEPUNKTE (SCHALTER)	ППМ
A/D	FLUGPLÄTZE (SCHALTER)	АЭР
WP A/D (1, 2, 3)	WENDEPUNKTE/FLUGPLÄTZE (1, 2, 3) (LEUCHTTASTER)	ППМ-АЭР (1, 2, 3)
REL BEARING RSBN ADF	KURSWINKEL ZUM RSBN-FUNKFEUER KURSWINKEL ZUM ARK-FUNKFEUER	КУР РСБН АРК
BEACONS (1, 2, 3)	FUNKFEUER (1, 2, 3)	МАРКИ (1, 2, 3)
RESET	LÖSEN, ZURÜCKSETZEN	СБРОС
COURSE CMPTR ZERO	KOORDINATENPRÄZISIERUNG AUF 0 ZURÜCKSETZEN	ВК / ОБНУЛ.
RETURN	RÜCKKEHR	ВОЗВРАТ
COURSE 180°-359° 0°-179°	KURS 180°-359° 0°-179°	КУРС 180° -359° 0° -179°

CIRCLE LEFT RIGHT	PLATZRUNDE LINKS RECHTS	КРУГ ЛЕВ. ПРАВ.
LANDING	LANDUNG (SCHALTER)	ПОСАДКА
NAVIGATION	NAVIGATION	НАВИГАЦИЯ
LANDING	LANDUNG (KANALEINSTELLUNG)	ПОСАДКА
IDENT	KENNUNG, IDENTIFIKATION	ОПОЗН.

G/GT (F/C):

TELELIGHT PANEL		
GBX FIRE	FEUER KSA	ПОЖАР КСА
LH ENG FIRE	FEUER LINKES TRIEBWERK	ПОЖАР ЛЕВ.
RH ENG FIRE	FEUER RECHTES TRIEBWERK	ПОЖАР ПРАВ.
REDUCED RPM LH ENG	DREHZAHLABFALL LINKES TRIEBWERK	СБРОС ОБОР. ЛЕВ.
REDUCED RPM RH ENG	DREHZAHLABFALL RECHTES TRIEBWERK	СБРОС ОБОР. ПРАВ.
OIL PRESS LEFT	ABFALL SCHMIERSTOFFDRUCK LINKES TRIEBWERK	МАСЛО ЛЕВ.
OIL PRESS RIGHT	ABFALL SCHMIERSTOFFDRUCK RECHTES TRIEBWERK	МАСЛО ПРАВ.
OIL GBX	ABFALL SCHMIERSTOFFDRUCK KSA	МАСЛО КСА
550 KG REMAIN	550 kg KRAFTSTOFFREST-ANZEIGE	ОСТАЛОС 550 кг
DOUBLE HYD SYS	AUSFALL BEIDER HYDRAULIKANLAGEN	ОТКАЗ ДВУХ. ГИДР.
COC FAIL	AUSFALL COC	ОТКАЗ СОС
ARMED	SCHARF	ВЗРЫВ
DAMPER OFF	DÄMPFER AUS	ДЕМПФЕР ВЫКЛ.
LH ENG START	ANLASSEN LINKES TW	ЗАПУСК ЛЕВ.
RH ENG START	ANLASSEN RECHTES TW	ЗАПУСК ПРАВ.
LH ENG AB	LINKER NACHBRENNER	ФОРСАЖ ЛЕВ.
RH ENG AB	RECHTER NACHBRENNER	ФОРСАЖ ПРАВ.
RUD TRIM NEUTRAL	SEITENRUDERTRIMMUNG NEUTRAL	ТРИММЕР РП

STAB TRIM NEUTRAL	HÖHENRUDERTRIMMUNG NEUTRAL	ТРИММЕР СТАБИЛИЗ.
AIL TRIM NEUTRAL	QUERRUDERTRIMMUNG NEUTRAL	ТРИММЕР ЭЛЕРОН
FEEL UNIT TO/LD	ARU START/LANDUNG	АРУ ВЗЛЕТ ПОСАДКА
MARKER BEACON	MARKEREMPFÄNGER	МАРКЕР
EMERG HYD PUMP ON	NOTHYDRAULIKPUMPE EIN	АВАР. НАС. СТАНЦИЯ
MODE 4	MODE 4 AUSFALL	
RADAR READY	HOCHSPANNUNG RADAR	ВЫСОКОЕ РЛС

PEDESTAL PANEL

G/GT (F/C):

VOLTMETER		
VOLTS	BORDNETZGLEICHSPANNUNG	АККУМ. ГЕНЕР.

G:

CHAFF/FLARE DISPENSER		
DISPENSE READY	FLAREANLAGE BEREIT	ИСПРАВНОСТЬ СУВП.
DISPENSE CHECK	KONTROLLE FLAREANLAGE	КОНТРОЛЬ СУВП

G/GT (F/C):

WEAPON SYSTEM MAINTENANCE PANEL		
BIT	EIGENKONTROLLE	ВСК
INDIC	ANZEIGE	ИНДИК.
BIT RESET	EIGENKONTROLLE LÖSEN	ВСК / СБРОС
FAILURE BIT CONT	AUSFALL/FORTSETZUNG EIGENKONTROLLE	ОТКАЗ / ПРОД. ВСК
READY	BEREITSCHAFT	ГОТОВ
PHASE	ETAPPE	ЗТАП
EXP. TEST	ERWEITERTE EIGENKONTROLLE	ПП
TEST	VERKÜRZTE EIGENKONTROLLE	ПВ
AIR	LUFT	ВОЗД.
S-31	S-31 (OPTO.-ELEKTR. ZIEL-GERÄTEKOMPLEX)	С-31
N-019	N-019 (RADAR)	Н-019
1, 2, 3	ZEILENSTEUERUNG RADAR	1, 2, 3
OPER ITP 1 ... 9, 0	BETRIEBSARTENSCHALT. RADAR	ОПЕР/ПВК 1... 9, 0

G/GT (F/C):

CABIN TEMPERATURE CONTROL KNOB		
CABIN TEMPERATURE	KABINENTEMPERATUR	ЗАДАТЧИК ТЕМПЕРАТ.

G/GT (F/C):

PITOT SELECTOR SWITCH		
PITOT MAIN STBY	HAUPTSTAUROHR NEBENSTAUROHR	ПВД РАБОЧ. АВАР.

G/GT (F/C):

BRAKE PRESSURE INDICATOR		
BRAKE PRESSURE	BREMSDRUCKMANOMETER	МАНОМЕТР

G/GT (F/C):

CONTROL STICK		
AFCS MODES OFF	BETRIEBSARTEN SAU AUS	ВЫКЛ. РЕЖИМОВ САУ
PITCH, ROLL, TRIM	TRIMMER	ТРИММ.
LEVELLING	RÜCKFÜHRUNG ZUM HORIZONTALFLUG	ПРИВЕД. К ГОРИ.
INTERR RESET	LUFT-LUFT-ABFRAGE (NICHT GENUTZT) UND LÖSEN	ЗАПРОС (СБРОС)
	STEUERKNOPF ZIELZUWEISUNG	УПР. СТРОБА
	KANONE	Н. О.
CL RELEASE	NOTABWURF ZUSATZBEHÄLTER	СБРОС ПБ
	UNGELENKTE RAKETEN, GELENKTE RAKETEN	РС, СС, Б

RH CONSOLE

G/GT (F/C):

RHAW CONTROL PANEL		
SCAN OFF	ÜBERSICHTSBETRIEB AUS	ОБЗОР ОТКЛ.
SPO ON	SPO EIN	СПО
VOLUME	LAUTSTÄRKE	ГРОМЧЕ

G/GT (F/C):

AIR LEVER		
AIR OPEN PILOT	BELÜFTUNG KABINENDACH LUFTZUFUHR LFF	ОБДУВ ФОНАРЯ ЛЕТЧИКА

G:

FLARE INDICATOR LIGHTS		
FLARE DISPENSING	IR-ABSCHLUSS	ОТСТРЕЛ ЛТЦ
FLARE READY	IR-BEREITSCHAFT	ГОТОВНОСТЬ СУВП

G:

VOICE WARNING CHECK BUTTONS, ANTI COLLISION LIGHT AND AM/FM SWITCH		
REPEAT VOICE WARN	WIEDERHOLUNG SPRACHINFORMATOR	РИ ПОВТОР.
CHECK VOICE WARN	KONTROLLE SPRACHINFORMATOR	РИ ПРОВЕР.
AM	AMPLITUDENMODULATION	AM
FM	FREQUENZMODULATION	ЧМ
ANTI COLL	ZUSAMMENSTOSSWARNLEUCHTE	

GT (F/C):

VOICE WARNING CHECK BUTTONS		
REPEAT VOICE WARN	WIEDERHOLUNG SPRACHINFORMATOR	РИ ПОВТОР.
CHECK VOICE WARN	KONTROLLE SPRACHINFORMATOR	РИ ПРОВЕР.

GT (F/C):

ANTI COLL AND AM/FM SWITCH PANEL		
ANTI COLL	ZUSAMMENSTOSSWARNLEUCHTE	
AM	AMPLITUDENMODULATION	AM
FM	FREQUENZMODULATION	ЧМ

GT (F/C):

ADF/TACAN PANEL		
RSBN TACAN	RSBN TACAN	
TACAN SEL	STEUERUNG TACAN	
ADF SEL	STEUERUNG ARK	УПРАВЛ. АРК

G/GT (F/C):

ADF CONTROL PANEL		
CHANNEL ADF 1, 2, 3, 4, P	KANÄLE ARK 1, 2, 3, 4, P	КАНАЛЫ АРК 1, 2, 3, 4, П
VOICE CW	TELEFONIE TELEGRAFIE	ТЛФ ТЛГ
COMP ANT	KOMPASS ANTENNE	КОМП. АНТ.
VOLUME	LAUTSTÄRKE	ГРОМК.
LOOP	RAHMEN	РАМКА

GT (F/C):

INTERCOM PANEL		
IC MAIN STBY VOLUME	BORDSPRECHANLAGE HAUPT- RESERVE LAUTSTÄRKEREGLER BORDSPRECHANLAGE	СПУ ОСНОВ. РЕЗЕРВ СПУ ГРОМЧЕ

G:

ENGINE START PANEL		
APU MODE	ENERGIEVERSORGUNG HILFS- TRIEBWERK (HTW)	З/УЗЕЛ
START NORM	ANLASSEN	ЗАПУСК
COLD CRANK ENG APU	KALT ANLASSEN TW KALT ANLASSEN HTW	ПРОКРУТКА ДВИГ. Т, С,
START BOTH LH RH	ANLASSEN BEIDE TW LINKES TW RECHTES TW	ЗАПУСК ДВУХ ЛЕВ. ПРАВ.
GND START	ANLASSEN AM BODEN	ЗАПУСК НА ЗЕМЛЕ
RSBN TACAN	RSBN TACAN	
RSBN	RSBN	

GT (F/C):

ENGINE START PANEL		
APU MODE	ENERGIEVERSORGUNG HILFS-TRIEBWERK (HTW)	Э/УЗЕЛ
START NORM	ANLASSEN	ЗАПУСК
COLD CRANK ENG APU	KALT ANLASSEN TW KALT ANLASSEN HTW	ПРОКРУТКА ДВИГ. Т. С.
START BOTH LH RH	ANLASSEN BEIDE TW LINKES TW RECHTES TW	ЗАПУСК ДВУХ ЛЕВ. ПРАВ.
GND START	ANLASSEN AM BODEN	ЗАПУСК НА ЗЕМЛЕ

G/GT (F/C):

TACAN CONTROL PANEL		
CHANNEL	NAVIGATIONSKANÄLE	
TEST	TEST-TASTE MIT ANZEIGELAMPE	
VOL	LAUTSTÄRKEREGLER	
OFF	BETRIEBSARTENSCHALTER AUS	
REC	BA-SCHALTER EMPFANG	
T/R	SENDEN/EMPANG	
A/A REC	LUFT-LUFT EMPFANG	
A/A T/R	LUFT-LUFT SENDEN/EMPFANG	

G/GT (F/C):

IFF CONTROL PANEL		
REPLY	SENDEKONTROLLE MODE 4 (ANTWORT)	
MODE 2	KODEWAHLSCHALTER MODE 2	
TEST	KONTROLLTASTER	
CODE ZERO	KODE LÖSCHEN	
MODE 4	BETRIEBSARTENSCHALTER MODE 4	
HOLD	KODE ERHALTEN	
A	AKTUELLER KODE	
B	NACHFOLGENDER KODE	
ON OUT	EIN/AUS-SCHALTER FÜR MODE 4	

MASTER	HAUPTBETRIEBSARTENSCHALTER	
MIC	INDIVIDUELLE STANDORTBESTIMMUNG ÜBER SENDEKNOPF	
OUT	STANDORTBESTIMMUNG AUS	
I/P	INDIVIDUELLE STANDORTBESTIMMUNG M1; M2; M3/A	
OFF	AUS	
STBY	BEREITSCHAFT	
LOW	VERRINGERTE EMPFÄNGEREMPFINDLICHKEIT	
NORM	VOLLE EMPFÄNGEREMPFINDLICHKEIT	
EMER	NOTBETRIEB	
AUDIO	AKUSTISCHE UND OPTISCHE ANZEIGE MODE 4	
OUT	KEINE ANZEIGE MODE 4	
LIGHT	NUR OPTISCHE ANZEIGE MODE 4 (LAMPE REPLY)	
M1	MODEWAHLSCHALTER M1 (MILITÄRISCHE KENNUNG)	
M2	MODEWAHLSCHALTER M2 (INDIVIDUELLE KENNUNG)	
M3/A	MODEWAHLSCHALTER M3 (ZIVILE FLUGSICHERUNGSKENNUNG)	
MC	MODEWAHLSCHALTER MC (ÜBERTRAGUNG DER FLUGHÖHE)	
OUT	MODEWAHLSCHALTER AUS	
TEST	KONTROLLTASTER	
MODE 1	KODEWAHLSCHALTER M1	
MODE 3/A	KODEWAHLSCHALTER M3/A	
RAD TEST	ABSTRAHLUNGSTEST	
OUT	AUS	

G/GT (F/C):

CABIN AIR LEVER		
CABIN AIR OPEN CLOSED	KABINENVERSORGUNG OFFEN GESCHLOSSEN	ПИТАНИЕ КАБИНЫ ОТКР. ЗАКР.

G/GT (F/C):

SYSTEM POWER PANEL		
RADIO	FUNK	РАДИО
ACFT SYS	BORDSYSTEM	БОРТ. СИСТ.
GYRO MAIN	IKW HAUPT	КВ ОСН.
GYRO STBY	IKW NEBEN	КВ ЗАП.
NAVIGATION	NAVIGATION	НАВИГАЦИЯ
AFCS	SAU (FLUGREGELANLAGE)	САУ
	SCHALTER (62D) NICHT BELEGT	
RECORD	AUFNAHMEGERÄT	РЕГИСТР.
WEAPON	BEWAFFNUNG	ОРУЖИЕ
ACS	SUW (WAFFENSTEUERANLAGE)	СУВ

G/GT (F/C):

CONTROL AND TEST PANEL		
NAV READY	NORM. VORBEREITUNG IKW	ГОТОВ НАВИГАЦИЯ
FAST PREP	VERK. VORBEREITUNG IKW	УСКОР. ГОТОВ
TRANSFM FAIL	AUSFALL TRANSFORMATOR	ОТКАЗ ТРАНСФОРМ.
LH INLET CHECK	KONTROLLE LET LINKS	КОНТРОЛЬ ВХОД ЛЕВ.
RH INLET CHECK	KONTROLLE LET RECHTS	КОНТРОЛЬ ВХОД ПРАВ.
NO COC RESERVE	KEINE COC-RESERVE	НЕТ РЕЗЕРВА СОС
FKP	FKP (FOTOKONTROLLGERÄT)	ПРИСТРЕЛ ФКП
ICS	NAVIGATIONSKOMPLEX	НВК
SWS TEST	KONTROLLE SWS	КОНТР. СВС
OPER PREPARE	ARBEIT VORBEREITUNG	РАБОТА ПОДГОТОВ.

TEST COC MARKER FEEL UNIT AEKRAN	KONTROLLE COC RPM ARU ÄKRAN	КОНТРОЛЬ СОС-3 РПМ АРУ ЭКРАН
LG SIMUL SYSTEMS ARM	FW-IMITATION FÜR SPEZIALAUSRÜSTUNG FW- IMITATION FÜR BEWAFFNUNGSANLAGEN	ИМИТАЦИЯ ШАССИ Э/ОБОРУД. ИМИТАЦИЯ ШАССИ СИСТ. В
FEEL UNIT OK	ARU INTAKT	ИСПРАВНОСТЬ АРУ

RH SIDE WALL

G/GT (F/C):

PITOT HEAT/CABIN TEMP SWITCH		
CABIN TEMP AUTO HOT COLD	KABINENHEIZUNG AUTOMATISCH HEISS KALT	ОБОГРЕВ. КАБИНЫ АВТ. ГОР. ХОЛ.
PITOT HEAT	HEIZUNG FRONTSCHEIBE UND STAUROHRE	ОБОГРЕВ. СТЕКЛА ПВД

G/GT (F/C):

COCKPIT LIGHTING CONTROL PANELS		
LTS ILLUM BRIGHT	HELLIGKEITSREGLER	СИГНАЛИЗАТОРЫ ЯРЧЕ
LAMP TEST	LAMPENKONTROLLE	КОНТР. ЛАМП
FLOODLIGHT	FLUTLICHT DUNKEL HELL	ЗАЛИВАЮЩИЙ СВЕТ ЗАКР. ОТКР.
NAV LTS FLASH 100 % 10 % OFF	POSITIONSBELEUCHTUNG BLINKT 100 % 10 % AUS	АНО ПРОБЛ. 100 % 10 % ОТКЛ.
LIGHTING	BELEUCHTUNG	ОСВЕЩЕНИЕ
PANEL	PANEELBELEUCHTUNG	ТАБЛО ЯРЧЕ
MAP ILLUM	KARTENBELEUCHTUNG	ПОДСВЕТ КАРТЫ
CONSOLE	PULTBELEUCTUNG	ПУЛЬТЫ НАДПИСИ ЯРЧЕ
INSTRUMENT	GERÄTEBELEUCHTUNG	ПРИБОРЫ ЯРЧЕ

G:

CANOPY EMERGENCY JETTISON HANDLE		
PUSH AND DOWN	VON SICH UND NACH UNTEN DRÜCKEN	ОТ СЕБЯ И ВНИЗ
CANOPY EMERG JETTISON	KABINENDACHABWURF	АВТОНОМНЫЙ СБРОС ФОНАРЯ
PIN FLUSH CANOPY CLOSED	STIFT VERSENKT KABINENDACH VERSCHLOSSEN	ШТЫРЬ УТОПЛЕН ФОНАРЬ ЗАКРЫТ

GT (F/C):

CANOPY EMERGENCY JETTISON HANDLE		
PUSH AND DOWN	VON SICH UND NACH UNTEN DRÜCKEN	ОТ СЕБЯ И ВНИЗ
CANOPY EMERG JETTISON	KABINENDACHABWURF	АВТОНОМНЫЙ СБРОС ФОНАРЯ
DOUBLE SYSTEM RESCUE	DOUBLIERTER ANTRIEB RETTUNGSEINRICHTUNG	ДУБЛИРОВАНИЕ ПРИВОДА САПС
PIN FLUSH CANOPY CLOSED	STIFT VERSENKT KABINENDACH VERSCHLOSSEN	ШТЫРЬ УТОПЛЕН ФОНАРЬ ЗАКРЫТ

G:

ELECTRICAL POWER PANEL		
BAT-GND SUPPLY	BORDAKKUMULATOR, AUSSEN-BORDSTROMVERSORGUNG	АККУМ. БОРТ АЭРОДРОМ.
DC GEN	GLEICHSTROMGENERATOR	ГЕНЕР. = ТОКА
AC GEN	WECHSELSTROMGENERATOR	ГЕНЕР. ~ ТОКА
PTO	UMFORMER	ПТО
ENG SYS	TRIEBWERKSANLAGEN	ДВИГАТ. СИСТЕМЫ
FUEL PUMP	KRAFTSTOFFPUMPE	ТОПЛИВН. НАСОС
ANTI SURGE	ANTIPOMPAGEANLAGE	СПП

GT (F/C):

ELECTRICAL POWER PANEL		
BAT-GND SUPPLY	BORDAKKUMULATOR, AUSSEN- BORDSTROMVERSORGUNG	АККУМ. БОРТ АЗРОДРОМ.
LH RH	LINKS RECHTS	ЛЕВ. ПРАВ
DC GEN	GLEICHSTROMGENERATOR	ГЕНЕР. = ТОКА
AC GEN	WECHSELSTROMGENERATOR	ГЕНЕР. ~ ТОКА
PTO	UMFORMER	ПТО
ENG SYS	TRIEBWERKSANLAGEN	ДВИГАТ. СИСТЕМЫ
FUEL PUMP	KRAFTSTOFFPUMPE	ТОПЛИВН. НАСОС
ANTI SURGE	ANTIPOMPAGEANLAGE	СПП

INTERNAL AND EXTERNAL REFUELING PANELS

G/GT (F/C):

REFUELING PANEL (BEHIND EJECTION SEAT)		
SELECT FUEL I II III AUT MAN.	EINSTELLUNG KRAFTSTOFF RT TS-1 T-1 AUTOMATISCH MANUELL	УСТАНОВКА Р РТ ТС-1 Т-1 АВТ. РУЧН.
TEST T A P 77 R D	KONTROLLE T A P 77 R D	КОНТРОЛЬ Т А П 77 Р Д
ADJUSTMENT	REGULIERUNG T	РЕГУЛИРОВКА Т

G/GT (F/C):

REFUELING PANEL (LH MAIN WHEEL WELL)		
FUEL 50% 100% 130% CL	KRAFTSTOFF 50% 100% 130% ZB	ТОПЛИВО 50 100 130 ПБ
STOP REFUEL	UNTERBRECHUNG BETANKUNG	ПРЕКР. ЗАПРАВ.
REFUEL COMPL	BETANKUNG BEENDET	ЗАПРАВКА ОКОНЧЕНА
POWER	STROMVERSORGUNG	ПИТАН
OIL N LH GBX RH	SCHMIERÖL N LINKES TW KSA RECHTES TW	МАСЛО Н ЛЕВ КСА ПР ДВ ДВ
LAMP TEST	KONTROLLE DER LAMPEN	КОНТРОЛЬ ЛАМП
HYDRAULIC BOOST MAIN N N	HYDRAULIKANLAGEN VERSTÄRKER- HAUPT- ANLAGE ANLAGE N N	ГИДРО - СМЕСЬ БУСТ. ОБЩ. Н Н

FILLER PIPE AND PRESSURE GAUGE, PRESSURIZATION SYSTEM (LH MAIN WHEEL WELL)		
PRESS. AIR REFILL	Auffüllen Druckluftanlage	ЗАРЯДКАОСНОВНОЙ ПНЕВМОСИСТЕМЫ

REAR COCKPIT MIG-29GT

LH SIDE WALL

GT (R/C):

LABELS		
AD-5A CHECK MAX MIN	KONTROLLE DRUCKAUTOMAT AD-5A MAXIMUM MINIMUM	ПРОВЕРКА АД-5-А МАК МИН.
ATTENTION WITH SUITS WKK-6M, WKK-15, PPK-3, SET ITEM AD-5A HEAD TO "MAX" WITH SUIT PPK-1U SET TO "MIN"	ACHTUNG! BEI DEN DRUCKANZÜGEN WKK-6M, WKK-15, PPK-3 IST DAS OBERTEIL DES AD-5A AUF "MAX" ZU STELLEN UND BEI DEM DRUCKANZUG PPK-1U AUF "MIN"	ВНИМАНИЕ! ГОЛОВКУ ДА-5А СТАВИТЬ НА МАК. С КОСТЮМАМИ ВКК-6М, ВКК-15, ППК-3 МИН. С КОСТЮМОМ ППК-1У
RPK-52 CHECK	ÜBERPRÜFUNG RPK-52	ПРОВЕРКА РПК-52
KP-52M ATTACH	BEFESTIGUNG KP-52M	ПОДВЕСКА КП-52М

GT (R/C):

CABLE ORK ATTACH		
CABLE ORK ATTACH	AUFHÄNGEVORRICHTUNG ORK-KABEL	ПОДВЕСКА ЭЛЕКТРОЖГУТА ОРК

GT (R/C):

CABIN EMERGENCY DECOMPRESSION LEVER		
CABIN EMERGENCY DECOMPRESSION	NOTENTHERMETISIERUNG KABINE (DEKOMPRESSION)	АВАР. РАЗГЕРМЕТ КАБИНЫ
PRESSURE	HERMETISIERUNG	ЗАГЕРМ.

GT (R/C):

THROTTLE STROKE		
THROTTLE STROKE R/C - F/C	ANSCHLÄGE DROSSELHEBEL 2. KABINE - 1. KABINE	ПОДКЛЮЧЕНИЕ УПОРОВ РУД 2. КАБИНА - 1. КАБИНА

GT (R/C):

THROTTLE		
	SENDETASTE	РАЦИЯ
	BORDSPRECHANLAGE	СПУ
	BREMSKLAPPEN	ТОРМ. ЩИТКИ

GT (R/C):

CHUTE DEPLOY BUTTON		
CHUTE DEPLOY	BREMSSCHIRMAUSWURF	ВЫПУСК ПАРАШЮТА

GT (R/C):

MARKER BEACON SWITCH		
OUTER INNER	FERNFUNKFEUER (FFF) NAHFUNKFEUER (NFF)	ДАЛЬН. БЛИЖН.
BEACON INNER	ARK NAHFUNKFEUER	АРК БПРС

GT (R/C):

CANOPY OPERATING HANDLE		
CANOPY	KABINENDACH OFFEN ROLLSTELLUNG GESCHLOSSEN	ФОНАРЬ ОТКРЫТ ПРИОТКРЫТ ЗАКРЫТ
LOCK CANOPY	SCHLIESSE KABINENDACH	ЗАПРИ ФОНАРЬ.

LH CONSOLE

GT (R/C):

OXYGEN FLOW VALVE		
OXYGEN FLOW OPEN CLOSED	O2-VENTIL ÖFFNEN GEÖFFNET GESCHLOSSEN	ОТКРЫТЬ КИСЛОРОД ОТКР. ЗАКР.
PILOT´S OXYGEN OPEN BEFORE FLIGHT CLOSE AFTER FLIGHT	O2-ZUFUHR DES LFF VOR DEM FLUG ÖFFNEN UND NACH DEM FLUG SCHLIESSEN	КИСЛОРОД ЛЕТЧИКА ПЕРЕД ПОЛЕТОМ ОТКР. ПОСЛЕ ПОЛЕТА ЗАКР.

GT (R/C):

SUIT VENTILATION CONTROL KNOB		
COLD HOT	KALT HEISS	ХОЛ. ГОР.
OPEN	GEÖFFNET	ОТКР.
CLOSED	GESCHLOSSEN	ЗАКР.
SUIT VENT	VENTILATIONSANZUG	ВЕНТИЛ. ОДЕЖДЫ

GT (R/C):

OXYGEN CONTROL PANEL		
100% O_2 - MIXT	100% O_2-GEMISCH	100 O_2-СМЕСЬ
EMERG ON EMERG OFF	NOT EIN NOT AUS	АВАР. ВКЛ. ВЫКЛ.
HELM VENT ON OFF	HELMVENTILATION EIN AUS	ВУШ. ВКЛ. ВЫКЛ.

GT (R/C):

CONTROL PANEL		
EMERG HYD PUMP	HYDRAULIKNOTPUMPE	АВАР. НАСОСН. СТАНЦ.
CHUTE JETTISON	ABWURF BREMSSCHIRM	СБОС ПАРАШЮТА
MRK EMERG OFF	NOTABSCHALTEN MRK	АВАР. ОТКЛ. МРК
FEEL UNIT AUTO EASY HEAVY OFF	ARU AUTOMATISCH LEICHT SCHWER AUS	АРУ АВТ. ЛЕТКО ТЯЖЕЛО ОТКЛ.

GT (R/C):

VHF/UHF FREQUENCY CONTROL PANEL		
VHF UHF	VHF UHF	
PRE MAN.	VORABSTIMMBARE KANÄLE FREI WÄHLBARE FREQUENZEN	

GT (R/C):

VHF/UHF RADIO PANEL		
GUARD RCVR	NOTEMPFÄNGER	АП
ADF	FUNKKOMPASS	РК
SQLCH	RAUSCHSPERRE	

GT (R/C):

FLAP OPERATION CONTROL PANEL		
FLAPS DOWN UP	LANDEKLAPPEN STELLUNG START/LANDUNG STELLUNG EINGEFAHREN	ЗАКРЫЛКИ ВЫП. УБР.

GT (R/C):

ENGINE EMERGENCY PANEL		
FUEL SHUT OFF LH OPEN CLOSED RH OPEN CLOSED	BRANDHAHN LINKS OFFEN GESCHLOSSEN RECHTS OFFEN GESCHLOSSEN	ПЕРЕКР. КРАН ЛЕВ. ОТКР. ЗАКРЫТ ПРАВ. ОТКР. ЗАКРЫТ
FIRE EXT GBX LH RH	FEUERLÖSCHER KSA LINKES TWK RECHTES TWK	ОГНЕТУШИТЕЛЬ КСА ЛЕВ. ПРАВ.
RAMP EMERG RETRACTION LH RH RETRACTION	NOTEINFAHREN DER KEILE LINKS RECHTS EINFAHREN	АВАР. УБОРКА КЛИНА ЛЕВ. ПРАВ. УБОРКА
AB EMERG OFF	NACHBRENNER (NB) NOTAUSSCHALTEN NB	ФОРСАЖ АВАР. ОТКЛ.
AIR RELIGHT LH RH	ANLASSEN IN DER LUFT LINKES TWK ANLASSEN IN DER LUFT RECHTES TWK	ЗАПУСК В ВОЗДУХЕ ЛЕВ. ПРАВ.
GEN DRIVE EMERG OFF	NOTABSCHALTEN GENERATORANTRIEB	АВАР. ОТКЛ. ПРИВОД ГЕНЕРАТ.

FRONT PANEL

GT (R/C):

LH VERTICAL PANEL		
PERISCOPE EXTENDED RETRACTED	PERISKOP AUSGEFAHREN EINGEFAHREN	ПЕРИСКОП ВЫПУЩ. УБРАН.
LG RETRACTED NEUTRAL EXTENDED	FAHRWERK EINGEFAHREN NEUTRAL AUSGEFAHREN	ШАССИ УБРАНО НЕЙТРАЛЬ ВЫПУЩ.
RUD TRIM LH RH	SEITENRUDERTRIMMUNG LINKS RECHTS	ТРИММЕР РП ЛЕВ. ПРАВ.
EMERG RELEASE	NOTABSCHUSS/-ABWURF	АВАР. СБРОС ПУСК
F/C	1. KABINE	1. КАБИНА
LG CONTROL	UMSCHALTER FAHRWERK	ШАССИ МЕХАНИЗАЦ.
FEEL UNIT	HEBELVERSTELLEINRICHTUNG	АРУ
SPEED BRAKE	BREMSKLAPPEN	ТОРМ. ЩИТКИ
TRIM	TRIMMER	ТРИММЕР
TEMP	TEMPERATURANZEIGE TWK (UMSCHALTER)	ИТГ
R/C	2. KABINE	2. КАБИНА

GT (R/C):

IAS INDICATOR		
KNOTS	KNOTEN	

GT (R/C):

EMERGENCY BRAKE HANDLE		
EMERG BRAKE	NOTBREMSE	АВАР. ТОРМ.

GT (R/C):

ALTIMETER		
FEET	FUSS	

GT (R/C):

EMERGENCY LANDING GEAR HANDLE		
EMERG GEAR	NOTAUSFAHREN FAHRWERK	АВАР. ШАССИ

GT (R/C):

MAG HDG SWITCH		
MAG HDG SLAVE	ABSTIMMUNG MAGNETKURS	СОГЛАС. М. КУРСА

GT (R/C):

HORIZONTAL SITUATION INDICATOR		
NM	NAUTISCHE MEILEN (Blende)	
COURSE	SOLLKURS (Blende)	ЗПУ
HDG	KURS	К С
C G	KURS/GLEITEN (SCHAUZEICHEN)	К Г
TEST	EIGENKONTROLLE	ТЕСТ

GT (R/C):

ATTITUDE DIRECTOR INDICATOR		
CAGE	ARRETIERUNG	АРРЕТИР
	LÄNGSNEIGUNG	Т
	QUERNEIGUNG	К

GT (R/C):

AFCS FAILURE SIMULATION PANEL		
LEFT	LINKS	ЛЕВО
RIGHT	RECHTS	ПРАВО
DESC.	SINKFLUG	ПИКИР
TOSS	STEIGFLUG	КАБР
INPUT FAIL	FEHLEREINGABE	ВВОД ОТКАЗ
RESET	LÖSEN, ZURÜCKFÜHREN	СБРОС
PIO-211 ON OFF	AUSFALLSIMULATOR SAU EIN AUS	САУ ПИО
BOOSTER	RUDERMASCHINE	АРМ
FEEDBACK PITCH FAIL	VERLUST DER RÜCKKOPPLUNG	ОБРЫВ ОС
RUN AWAY TRIM	SELBSTÄNDIGES FAHREN DER TRIMMER	БЫСТР. УХОД МТ
SWITCH OFF SIGNAL	ABSCHALTEN DES SIGNALS	ОТКЛ. СИГНАЛ
ACT NOM	IST SOLL	ТЕК. ЗАД.
RUN AWAY BOOSTER	SELBSTÄNDIGES FAHREN DER RUDERMASCHINE	БЫСТРЫЙ УХОД
PITCH	LÄNGSNEIGUNG	ТАНГ
BANK	QUERNEIGUNG	КРЕН
YAW	GIEREN	РЫСК
OVER-G	ÜBERLAST (n_y)	ПЕРЕГР
ROLL STAB	LÄNGSSTABILISIERUNGS-AUTOMAT	АПУС

GT (R/C):

MASTER CAUTION LIGHT		
MASTER CAUTION	ALLGEMEINES AUSFALLSIGNAL	КСЦ

GT (R/C):

DAMPER LIGHT		
DAMPER	DÄMPFUNG	ДЕМП.

GT (R/C):

COMBINED AOA/G METER		
α, n_y	ANZEIGE ANSTELLWINKEL, LASTVIELFACHES	α, n_y

GT (R/C):

RADIO SELECTOR SWITCH		
RADIO SEL	FUNKSTATION F/C → R/C	

GT (R/C):

RADIO EMERGENCY SWITCH		
RADIO EMERG NORM	FUNKSTATION NOT NORMAL	

GT (R/C):

VHF/UHF INDICATOR PANEL		
STORE	SPEICHER	
CHANNEL	KANALANZEIGE	
FREQUENCY	FREQUENZANZEIGE	
DIM	HELLIGKEITSREGLER	
VHF/UHF	VHF/UHF STATION	

GT (R/C):

NAVIGATION FAILURE SIMULATION PANEL		
SPEED	GESCHWINDIGKEIT	СКОР.
GLIDEPATH READY	BEREITSCHAFT GLEITPFAD	ГОТ. Г
AZIMUTH	AZIMUT	АЗИМУТ
COURSE	KURS	КУРС
ALT	HÖHE	ВЫСОТА
COURSE READY	BEREITSCHAFT KURSWINKEL	ГОТ. К
DISTANCE	ENTFERNUNG	ДАЛЬН.
PITCH	LÄNGSNEIGUNG	ТАНГАЖ
SWS RESET	AUSSCHALTEN SWS	СБРОС СВС

MAIN RESET	ALLGEMEINES ABSCHALTEN	ОБЩ. СБРОС
BANK	QUERNEIGUNG	КРЕН
PIO-1 ON OFF	SCHALTER AUSFALLPULT	ПУЛЬТ ОТКАЗОВ

GT (R/C):

RADAR SIMULATION PANEL		
27V 2A	27V 2A	27В 2А
TEST SEI	KONTROLLE SEI	КОНТР. СЕИ
HUD	FRONTSCHEIBENPROJEKTOR ILS-31 (HEAD-UP-DISPLAY)	ИЛС
BCWM	BORDRECHNER BCWM	БЦВМ
INPUT FAILURE	FEHLEREINGABE	ВВОД ОТКАЗОВ
IMITATION MODES 1 TO 11	IMITATIONSBETRIEBSARTEN 1 BIS 11	РЕЖИМЫ ИМИТАЦИИ 1...11
27V LIMIT	27V-BEGRENZER	27В ОГР
INPUT	EINGABE	ВВОД
TOSS	BOMBENWURF AUS DEM HOCHZIEHEN	КБР
NAV	NAVIGATION	НВГ
RADAR	RADAR	РЛ
IR	WÄRMEPEILER (IR-PEILER)	ТП
BS	STARRE WAFFENACHSE	φ_0
OPT	BETRIEBSART OPTISCH	ОПТ
HELM	HELMVISIER	ШЛЕМ
CC	NAHLUFTKAMPF	ББ
TWF	BEGLEITEN IM ÜBERSICHTSBETRIEB	СНП
MASTER ARM ON	HAUPTWAFFENSCHALTER EIN	ГЛ. ВКЛ.
ALL	GESAMT (KOMPLEX)	КОМПЛ.
SINGLE 0,5 ALL	EINZELN 0,5 GESAMT	ОДИН 0,5К-ТА
ILLUM	ABSTRAHLUNG	ИЗЛ.
HEAD ON	GEGENKURS	В

GUIDE	LEITEN	НАВЕД.
MAN PREPARE	VORBEREITUNG HAND (MANUELL)	ПОДГ. РУЧН.
FHS	VORDERE HALBSPHÄRE	ППС
FIRE TRIGGER	KAMPFKNOPF	БК
LOCK ON	ERFASSUNG	ЗАХВ.
PURSUIT	ABFANGEN AUS DER HINTEREN HALBSPHÄRE	Д
RHS	HINTERE HALBSPHÄRE	ЗПС
GUN	KANONE	НО
AIR	LUFT	ВОЗД.
GROUND	BODEN	ЗЕМЛЯ

GT (R/C):

VERTICAL VELOCITY INDICATOR		
FT/MIN	FUSS PRO MINUTE	

GT (R/C):

TAS INDICATOR		
KNOTS	KNOTEN	
MACH	MACHZAHL	

GT (R/C):

COMBINED OXYGEN INDICATOR		
H_{CKPT}	KABINENHÖHE	$H_{КАБ}$
O_2	ATMUNGSANZEIGE	O_2
ΔP	DIFFERENZDRUCK	ΔP
RESERVE %	VORRAT IN PROZENT	ЗАПАС %
FEED	ZUFUHR	ПОДАЧА

GT (R/C):

RADAR ALTIMETER		
FEET	HÖHENANZEIGE IN FUSS	
RADIO ALT	ANZEIGE RADARHÖHENMESSER	

GT (R/C):

COMBINED PRESSURE INDICATOR		
HYDRAULIC MAIN BOOST	HYDRAULIKANLAGE ALLGEMEIN VERSTÄRKER	ГИДРОСИТ. ОБЩ. БУСТЕР
PNEUMATIC MAIN EMERG	DRUCKLUFTANLAGE HAUPT NOT	ГАЗ. СИСТ. ОСН. АВАР.

GT (R/C):

RAMPS POSITION INDICATOR		
RAMPS	KEILE KEILE VOLL AUSGEFAHREN	КЛИН ВП

GT (R/C):

FUEL INDICATOR					
TAC		MOMENTANVERBRAUCH	ТЕК		
OPT		OPTIMALER VERBRAUCH	ОПТ		
TANKS	CL WING 3 1	ZUSATZBEHÄLTER TRAGFLÄCHENBEHÄLTER BEHÄLTER 3 BEHÄLTER 1	БАКИ	П КР 3 1
		KS-VORRAT	Т	
		KS-VERBRAUCH	Р	
NM		REICHWEITE IN NM	ДАЛЬНОСТЬ КМ	
		KRAFTSTOFF IN kg	ТОПЛИВО КГ	

GT (R/C):

AEKRAN		
FAIL	AUSFALL	ОТКАЗ
TURN	PRIORITÄT, REIHENFOLGE	ОЧЕРЕДЬ
MEMORY	SPEICHER	ПАМЯТЬ
AEKRAN CALL	AUFRUF ÄKRAN ZUR EIGENKONTROLLE	ЭКРАН ВЫЗОВ

GT (R/C):

RHAW DISPLAY PANEL				
		ANZEIGE OBEN	В	
		ANZEIGE UNTEN	Н	
		MARKEN HAUPTTYP	П, З, Х, Н, Г,С	
SOUND OFF		TONSIGNAL AUS	ЗВУК ОТКЛ.	
TEST	MAN. AUTO	KONTROLLE HAND (MANUELL) AUTOMATISCH	КОНТР.	РУЧН. АВТ.
BRIGHT.		HELLIGKEIT (NACHT)	НОЧЬ	

GT (R/C):

HDD		
BRIGHT	HELLIGKEIT	ЯРК.

GT (R/C):

TELELIGHT PANEL		
GBX FIRE	FEUER KSA	ПОЖАР КСА
LH ENG FIRE	FEUER LINKES TRIEBWERK	ПОЖАР ЛЕВ.
RH ENG FIRE	FEUER RECHTES TRIEBWERK	ПОЖАР ПРАВ.
REDUCED RPM LH ENG	DREHZAHLABFALL LINKES TRIEBWERK	СБРОС ОБОР. ЛЕВ.
REDUCED RPM RH ENG	DREHZAHLABFALL RECHTES TRIEBWERK	СБРОС ОБОР. ПРАВ.
OIL PRESS LEFT	ABFALL SCHMIERSTOFFDRUCK LINKES TRIEBWERK	МАСЛО ЛЕВ.
OIL PRESS RIGHT	ABFALL SCHMIERSTOFFDRUCK RECHTES TRIEBWERK	МАСЛО ПРАВ.
OIL GBX	ABFALL SCHMIERSTOFFDRUCK KSA	МАСЛО КСА
550 KG REMAIN	550 kg KRAFTSTOFFREST-ANZEIGE	ОСТАЛОС 550 кг
DOUBLE HYD SYS	AUSFALL BEIDER HYDRAULIKANLAGEN	ОТКАЗ ДВУХ. ГИДР.
COC FAIL	AUSFALL COC	ОТКАЗ СОС
DAMPER OFF	DÄMPFER AUS	ДЕМПФЕР ВЫКЛ.
LH ENG START	ANLASSEN LINKES TWK	ЗАПУСК ЛЕВ.
RH ENG START	ANLASSEN RECHTES TWK	ЗАПУСК ПРАВ.
LH ENG AB	LINKER NACHBRENNER	ФОРСАЖ ЛЕВ.
RH ENG AB	RECHTER NACHBRENNER	ФОРСАЖ ПРАВ.
RUD TRIM NEUTRAL	SEITENRUDERTRIMMUNG NEUTRAL	ТРИММЕР РП
STAB TRIM NEUTRAL	HÖHENRUDERTRIMMUNG NEUTRAL	ТРИММЕР СТАБИЛИЗ.
AIL TRIM NEUTRAL	QUERRUDERTRIMMUNG NEUTRAL	ТРИММЕР ЭЛЕРОН
FEEL UNIT TO/LD	ARU START/LANDUNG	АРУ ВЗЛЕТ ПОСАДКА
ATT. HOLD	STABILISIERUNG WINKELLAGEN	АП

AUTORECOVER	AUTOMATISCHES HERAUS-FÜHREN AUS GEFÄHRLICHER HÖHE	УВОД
EMERG HYD PUMP ON	NOTHYDRAULIKPUMPE EIN	АВАР. НАС. СТАНЦИЯ
ALT. HOLD	STABILISIERUNG BAROMETRISCHE HÖHE	СТАБИЛИЗ. ВЫСОТЫ
APPROACH	STEUERUNG LANDEANFLUG	ТРАЕКТОР. УПРАВЛЕН.
MARKER BEACON	MARKEREMPFÄNGER	МАРКЕР
SET COURSE MAN.	SOLLKURS HANDEINGABE	КУРС ЗАД. РУЧНОЙ
MISSED APPROACH	WIEDERHOLUNGSLANDEANFLUG	ПОВТОР. ЗАХОД

GT (R/C):

NAVIGATION CONTROL PANEL		
WP A/D	WENDEPUNKTE/FLUGPLÄTZE	ППМ-АЭР
CORR	KORREKTUR	КОРР.
D < 21	D (ENTFERNUNG) KLEINER ALS 21 NM (40 km)	Д < 40 км
BEACONS (1, 2, 3)	FUNKFEUER (1, 2, 3)	МАРКИ (1, 2, 3)
REL BEARING	KURSWINKEL	КУР
CHANNELS	KANÄLE	КАНАЛЫ.
RSBN	NAHNAVIGATIONSANLAGE	РСБН
MAN	MANUELL	РУЧН.
RESET	LÖSEN, ZURÜCKSETZEN	СБРОС
COURSE CMPTR	KURSPRÄZISIERUNG	ВК
COURSE	KURS	КУРС
CIRCLE	PLATZRUNDE	КРУГ
GYRO	IKW	ИКВ
RETURN	RÜCKKEHR	ВОЗВРАТ
LEFT	LINKS	ЛЕВ.
LANDING	LANDUNG	ПОСАД.
STBY	RESERVE	ЗАПАС
F/C - R/C	1. - 2. KABINE	1. К. - 2. К.

REL BEARING RSBN ADF	KURSWINKEL ZUM RSBN-FUNKFEUER KURSWINKEL ZUM ARK-FUNKFEUER	КУР РСБН АРК
GYRO MAIN STBY	IKW HAUPT RESERVE	ИКВ ОСН. ЗАПАС
NAVIGATION - LANDING	NAVIGATION - LANDUNG	НАВИГАЦИЯ - ПОСАДКА
IDENT	KENNUNG, IDENTIFIKATION	ОПОЗН.

PEDESTAL PANEL

GT (R/C):

REFUELING PANEL		
SELECT FUEL I II III AUT MAN.	EINSTELLUNG KRAFTSTOFF RT TS-1 T-1 AUTOMATISCH MANUELL	УСТАНОВКА Р РТ ТС-1 Т-1 АВТ. РУЧН.
TEST T A P 77 R D	KONTROLLE T A P 77 R D	КОНТРОЛЬ Т А П 77 Р Д
ADJUSTMENT	REGULIERUNG T	РЕГУЛИРОВКА Т

GT (R/C):

BRAKE PRESSURE INDICATOR		
BRAKE PRESSURE	BREMSDRUCK	МАНОМЕТР

GT (R/C):

CONTROL STICK		
AFCS MODES OFF	BETRIEBSARTEN SAU AUS	ВЫКЛ. РЕЖИМОВ САУ
PITCH, ROLL, TRIM	TRIMMER	ТРИММ.
LEVELLING	RÜCKFÜHRUNG ZUM HORIZONTALFLUG	ПРИВЕД. К ГОРИ.
CL RELEASE	NOTABWURF ZUSATZBEHÄLTER	СБРОС ПБ

RH CONSOLE

GT (R/C):

VOICE WARNING CHECK BUTTONS		
REPEAT VOICE WARN	WIEDERHOLUNG SPRACHINFORMATOR	РИ ПОВТОР.
CHECK VOICE WARN	KONTROLLE SPRACHINFORMATOR	РИ ПРОВЕР.

GT (R/C):

INTERCOM CONTROL		
IC MAIN STBY HOT COLD	BORDSPRECHANLAGE HAUPT- RESERVE "STÄNDIG" "AUS"	СПУ ОСНОВ. РЕЗЕРВ ПОСТОЯННО
CONTIN	STÄNDIG	ПОСТОЯННО
VOLUME	LAUTSTÄRKEREGLER	СПУ ГРОМЧЕ

GT (R/C):

ADF CONTROL PANEL		
CHANNEL ADF 1, 2, 3, 4, P	KANÄLE ARK (LEUCHTTASTE) 1, 2, 3, 4, P	КАНАЛЫ АРК 1, 2, 3, 4, П
VOICE CW	TELEFONIE TELEGRAFIE	ТЛФ ТЛГ
COMP ANT	KOMPASS ANTENNE	КОМП. АНТ.
VOLUME	LAUTSTÄRKE	ГРОМК.
LOOP	RAHMEN	РАМКА

GT (R/C):

ADF/TACAN/RSBN CAPTIONS		
ADF SEL	STEUERUNG ARK	УПРАВЛ. АРК
RSBN TACAN	RSBN TACAN	
TACAN SEL	STEUERUNG TACAN	

GT (R/C):

TACAN CONTROL PANEL		
CHANNEL	NAVIGATIONSKANÄLE	
TEST	TEST-TASTE MIT ANZEIGELAMPE	
VOL	LAUTSTÄRKEREGLER	
OFF	BETRIEBSARTENSCHALTER AUS	
REC	BA-SCHALTER EMPFANG	
T/R	SENDEN/EMPANG	
A/A REC	LUFT-LUFT EMPFANG	
A/A T/R	LUFT-LUFT SENDEN/EMPFANG	

GT (R/C):

CONTROL AND TEST PANEL		
ILLUM CONSOLE 139S 140S 141S	PULTBELEUCHTUNG 139S 140S 141S	ПОДСВЕТ НАДПСИЕЙ 139 С 140 С 141 С
TEST COC	KONTROLLE COC	КОНТР. СОС
ILLUM INSTRUMENT 142S 143S 144S	GERÄTEBELEUCHTUNG 142S 143S 144S	ПОДСВЕТ ПРИБОРОВ 142 С 143 С 144 С
FLOOTLIGHT F/C R/C	FLUTLICHT 1. KABINE 2. KABINE	ЗАЛИВ. СВЕТ БЕЛЫЙ 1. К. 2. К
NAV READY	NORM. VORBEREITUNG IKW	ГОТОВ НАВИГАЦИЯ
FAST PREP	VERK. VORBEREITUNG IKW	УСКОР. ГОТОВ
NO COC RESERVE	KEINE COC-RESERVE	НЕТ РЕЗЕРВА СОС
PREPARE	VORBEREITUNG	ПОДГОТОВКА
TEST SWS	KONTROLLE SWS	КОНТР. СВС
UTILITY SPOTLIGHT	HANDLAMPE (STECKDOSE)	ПЕРЕНОСНАЯ ЛАМПА

RH SIDE WALL

GT (R/C):

COCKPIT LIGHTING CONTROL PANELS		
LTS ILLUM BRIGHT	HELLIGKEITSREGLER	СИГНАЛИЗАТОРЫ ЯРЧЕ
LAMP TEST	LAMPENKONTROLLE	КОНТР. ЛАМП
FLOODLIGHT	FLUTLICHT DUNKEL HELL	ЗАЛИВАЮЩИЙ СВЕТ ЗАКР. ОТКР.
LIGHTING	BELEUCHTUNG	ОСВЕЩЕНИЕ
PANEL	PANEELBELEUCHTUNG	ТАБЛО ЯРЧЕ
MAP ILLUM	KARTENBELEUCHTUNG	ПОДСВЕТ КАРТЫ
CONSOLE	PULTBELEUCTUNG	ПУЛЬТЫ НАДПИСИ ЯРЧЕ
INSTRUMENT	GERÄTEBELEUCHTUNG	ПРИБОРЫ ЯРЧЕ

GT (R/C):

CANOPY EMERGENCY JETTISON HANDLE		
PUSH AND DOWN	VON SICH UND NACH UNTEN DRÜCKEN	ОТ СЕБЯ И ВНИЗ
CANOPY EMERG JETTISON	KABINENDACHABWURF	АВТОНОМЫЙ СБРОС ФОНАРЯ
PIN FLUSH CANOPY CLOSED	STIFT VERSENKT KABINENDACH VERSCHLOSSEN	ШТЫРЬ УТОПЛЕН ФОНАРЬ ЗАКРЫТ

EXTERNAL REFUELING PANEL

GT (R/C):

REFUELING PANEL (LH MAIN WHEEL WELL)		
FUEL 50% 100% 130% CL	KRAFTSTOFF 50% 100% 130% ZB	ТОПЛИВО 50 100 130 ПБ
STOP REFUEL	UNTERBRECHUNG BETANKUNG	ПРЕКР. ЗАПРАВ.
REFUEL COMPL	BETANKUNG BEENDET	ЗАПРАВКА ОКОНЧЕНА
POWER	STROMVERSORGUNG	ПИТАН
OIL N LH GBX RH	SCHMIERÖL N LINKES TW KSA RECHTES TW	МАСЛО Н ЛЕВ КСА ПР ДВ ДВ
LAMP TEST	KONTROLLE DER LAMPEN	КОНТРОЛЬ ЛАМП
HYDRAULIC BOOST MAIN N N	HYDRAULIKANLAGEN VERSTÄRKER- HAUPT- ANLAGE ANLAGE N N	ГИДРО - СМЕСЬ БУСТ. ОБЩ. Н Н

FILLER PIPE AND PRESSURE GAUGE, PRESSURIZATION SYSTEM (LH MAIN WHEEL WELL)		
PRESS. AIR REFILL	Auffüllen Druckluftanlage	ЗАРЯДКАОСНОВНОЙ ПНЕВМОСИСТЕМЫ

INDEX

ALPHABETICAL INDEX

A

AB Fails to Light 3-16
AB Fails to Shut Down or
Blows out During Flight 3-17
Abort 3-6
Acceleration Data A5-1
Acceleration Limitations 5-10*
Acceleration Time, High Altitude A5-4, A5-5*
Acceleration Time, Low Altitude A5-1, A5-2*
Accessory Gearbox 1-38
Indications and Warnings 1-39
AC Generator Failure or
AC Generator Drive Failure 3-20
AC Transformer Failure 3-20
Adapter Assembly TACAN / RSBN 1-113
Controls and Indicators 1-113*
Address and Prefix Numbers 1-110C*
ADF 1-114
Controls and Indicators 1-114*
ADF Operation 1-114
ADF Self-Test 1-114
AEKRAN 1-120
Controls and Indicators 1-120*
AEKRAN Indications 1-121*
AEKRAN Operation 1-120
AEKRAN Self-Test 1-120
AEKRAN Signals 3-35
AFCS Control Panel 1-72*
AFCS Failure Simulation Panel (GT) 4-3, 4-5*
Afterburner Control System 1-19
Afterburner Fuel System 1-18
Afterburner Ignition 1-18
Indications and Warnings 1-18
Afterburner Operation, Limitations 5-3
Afterburner Takeoff 2-16
After Man / Seat Separation 3-9
After Takeoff 2-16
Ailerons 1-62
Roll 1-63
Air Conditioning and
Pressurization System 1-90A, FO-29*
Controls and Indicators 1-91*, 1-92
Indications and Warnings 1-92
Air Conditioning System Failure 3-28
Aircraft 1-3
Aircraft Abandoning 3-7
Aircraft Battery Check 2-7
Aircraft, Description and Operation 1-1
Aircraft Dimensions MIG-29G 1-4A*
Aircraft Dimensions MIG-29GT 1-4B*
Aircraft Fuel System 1-40, FO-17*
Indications and Warnings 1-46H
Transfer System 1-41
Aircraft General Arrangement FO-2A*
Aircraft Gross Weight 1-4
Air Data Computer 1-75, 1-75*
Indications and Warnings 1-75
Air Data System Failure 3-23
Airspeed Conversion A1-2, A1-3*, A1-4*
Airspeed Limitations 5-8*
All Weather Operation 7-1
Antenna System 1-97
Anti Collision Lights 1-94
Anti G Valve 1-91
Anti-Skid System 1-57
Altimeter 1-77, 1-77*
Altimeter GT, R/C 1-77, 1-77*
AOA / G Control System 1-67, 1-67A*
Combined AOA / G Meter 1-77, 1-77*
AOA Limitations 5-9*
AOA Limiter 1-67
Indications and Warnings 1-67B
Approach and Landing Emergencies 3-24
APU, Limitations 5-3
Armament System 1-118
Arm Protection System 1-89
Attitude Director Indicator 1-78, 1-78*
Automatic Direction Finding 1-114
Automatic Flight Control System 1-68, FO-27*
AFCS BITE 1-71
Altitude Hold Mode 1-70
Attitude Hold Mode 1-68
Approach Mode 1-69
Automatic Landing Approach Control 1-70
Auto Recover Mode 1-69
Controls and Indicators 1-72
Damper 1-68
Levelling Mode 1-71
Automatic Pitch Control 6-4*
Automatic Relight 3-13
Autopilot (AFCS) Failure 3-23

Auxiliary Power System 1-37, FO-15*
Auxiliary Power Unit 1-37
APU / Engine Cold Cranking 1-38
APU Starting System 1-37
Indications and Warnings 1-37
Internal Power Supply Mode 1-38
Avionic System Failures 3-23

B

Barrier Engagement 3-26
Before Ejection 3-7
Before Exterior Inspection 2-3
Before Exterior Inspection GT 2-26
Before Landing 2-17
Before Takeoff 2-14
Before Taxiing 2-12
Before Starting Engines 2-8
Before Starting Engines GT 2-27
Blown Tire During Takeoff Roll 3-6
Both Generator Failure 3-18
Both Gyro Failure 3-24
Both Hydraulic System Failure 3-21
Brake Pressure Indicator 5-11*
Brake System 1-57
Controls and Indicators 1-58, 1-58*

C

Cabin Icing 3-29
Cabin Pressurization MIG29G 1-90A
Cabin Pressurization MIG29GT 1-90B
Cabin Pressurization Schedule MIG29G 1-90A*
Cabin Pressurization Schedule MIG29GT ... 1-90B*
Indications and Warnings 1-90B
Cabin Temperature Control 1-90A
Calculated Sustained G A8-7, A8-8*, A8-9*
Calculated G versus G available A8-10, A8-11*
Canopy 1-84
Canopy Internal and External Controls 1-85*
Canopy Jettison 1-84
Canopy Operation 1-84
Indications and Warnings 1-85
Centerline Tank Transfer Failure 3-18
CG Limitations 5-6
CG Travel 6-10, 6-10*
Circling Approach 7-4
Climb / Cruise 2-17
Climb Data A3-1
Clock 1-79, 1-79*
COC Actuator Failure 3-22
COC Failure 3-22
Cockpit Layout MIG-29G FO-3*
Cockpit Layout MIG-29GT, Front Cockpit FO-5*
Cockpit Layout MIG-29GT, Rear Cockpit FO-7*
Cockpit Marking Reference List, R/C B-31
Cockpit Marking Reference List, G, GT B-1
Cold Weather Procedures 7-8
Combined AOA and G-Meter 5-11*
Combined Oxygen Indicator 1-96, 1-96*, 5-11*
Combined Pressure Indicator 5-11*
Communication and Avionic Equipment 1-97
Constant Altitude Cruise A4-10, A4-11*
Constant MACH Cruise A4-7, A4-8*, A4-9*
Control and Test Panel 1-46D, 1-46D*
Controllability Check 3-30
Control Stick 1-65, 1-65*
Crew Duties 4-1
Crew Requirements 5-3
Crosswind Limitations 5-9
Crosswind Takeoff 2-16
Cruise Data A4-1

D

Damper Pushbutton (GT) 4-13
Danger Areas 2-11*, 2-11A*, 2-11B*
DC Generator Failure 3-19
Dead Reckoning Mode 1-106
Defensive Aids Subsystem 1-118
Departure from Controlled Flight 6-13
Descent Chart A6-2*
Descent Data A6-1
Descent / Recovery 2-17
Dive Recovery A8-18, A8-19*
Drag Chute Operation 1-59
Drag Chute System 1-59
Drag Index and Weights A1-1*
Drogue Gun 1-88
Dual Ejection 1-90
Dynamic Longitudinal Stability 6-7

E

Ejection G 3-8, 3-8*
Ejection GT 3-9
Ejection Gun 1-88
Ejection Procedures 3-7
Ejection Seat 1-86, FO-37*
Ejection Seat System 1-86
Delay Unit 1-88
Safety Features 1-86
Windshield 1-89
Ejection Sequence 1-86, 1-87*, 3-9*, 3-10*
Electrical Power Panel 1-48
Electrical Power Supply 1-47
Controls and Indicators 1-47
Indications and Warnings 1-48,1-49

Electrical Power Supply System 1-47
AC Electrical Power 1-47, FO-19*
Batteries 1-47
DC / AC Converter 1-47
DC Electrical Power 1-47, FO-21*
Electrical System Failures 3-18
Emergency Brake System 1-57
Emergency Gear Extension 3-27
Emergency Ground Egress 3-7
Emergency Oxygen System 1-89
Emergency Procedures 3-1
Emergency UHF Radio 1-99, 1-99*
Controls and Indicators 1-100
Operation 1-100
Test Pushbutton and Indicator Light 1-100
Engine Air Intake System 1-22, FO-13*
Engine Anti Surge System 1-17
Indications and Warnings 1-17
Engine Chips 3-15
Engine Cold Crank 2-10
Engine Controls and Indicators 1-31
Engine Control System 1-8, 1-9*, 1-10*
Control Unit 1-11, 1-11*, 1-12*
Indications and Warnings 1-12
NH Speed Controller 1-12A, 1-12A*, 1-13*
NH Overspeed 1-14
NL Speed Control 1-15
NL Overspeed 1-15
Steady State Control 1-14
Transients Control 1-14
Engine Control System Failures 3-16
Engine Emergency Panel 1-34, 1-34*
Engine Exhaust Temperature Limitations 5-4*
Engine Failures or Malfunctions 3-14
Engine Fault Detection Unit 1-15
Indications and Warnings 1-15, 1-16
Engine Fire Detection System 1-33, 1-33*
Indications and Warnings 1-34, 1-35
Engine Fire during Flight 3-11
Engine Fire during Takeoff Roll 3-11
Engine Fire on the Ground 3-11
Engine Fires 3-11
Engine Flameout 3-12
Engine Fuel System 1-8, FO-11*
Engine Gearbox 1-39
Engine G-Limitations 5-5*
Engine Ignition System 1-27
Indications and Warnings 1-27
Engine Limitations 5-3
Engine Mechanical Failure 3-14
Engine Oil Pressure low or Overtemperature ... 3-16
Engine Operation 1-36
Combat Mode 1-36
Limited Power Mode 1-36
Normal Power Mode 1-36
Running Time Meters 1-36
Engine or AB Failure during Takeoff 3-14
Engine Overheat during Flight 3-15
Engine Overspeed 3-16
Engine Relight 3-13
Engine RPM Indicator 1-32, 1-32*
Engines 1-5
Bleed Air System 1-6
Oil System 1-6, FO-9*
Indications and Warnings 1-6, 1-7
Engine Shut-Down 2-23
Engine Start Panel 1-31, 1-31*
Engine Start / Shut-Down, Limitations 5-3
Engine Starting System 1-28
Automatic Relight 1-29
Automatic Start of both Engines 1-28
Manual Relight 1-29
Manual Start 1-28
Preventive Relight 1-29
Relight Modes 1-29
Semi-Automatic Relight 1-29
Starting / Relight Modes 1-28
Engine Surge 3-15
Engine Vibration 3-14
Exhaust Gas Temperature Indicator 1-32, 1-32*, 5-4*
Exhaust Nozzle System 1-19
Indications and Warnings 1-20
Nozzle Area Control 1-20, 1-21*
Exterior Inspection 2-4, 2-4*
External Lighting 1-94
External Stores 1-118
External Stores Limitations 5-12*, 5-13*
External Tank Jettison System 1-46, 1-46*

F

Feel Control Unit Failure 3-22
Feel and Trim Controls and Indicators 1-64*
Flight Characteristics 6-1
Flight Control Malfunctions 3-22
Flight Controls 1-61, FO-25*
Flight Data Recorder 1-101
Controls and Indications 1-101
List of Recorded Parameters 1-101
Operation 1-101
Flight Planning 2-3
Flight Restrictions 2-3
Flight with Asymmetric Load 6-12
Flight with Wing Drop Tanks 6-12
Fuel Boost Pump Failure 3-17
Fuel Boost System 1-45
Active Fuel 1-46
Cooling Fuel 1-46
Starter Fuel Pump 1-46
Fuel Consumption Data A5-7
Maximum Thrust Fuel Flow A5-8*
Fuel Control Failure 3-17
Fuel Index Number A4-5, A4-6*

Fuel Indication System 1-46D, 1-46E*
Fuel Indicator........................ 1-46F, 1-46F*, 1-46G*
Fuel Pressurization and Ventilation System......1-45
Fuel Required for Acceleration
  Low Altitude...................................... A5-1, A5-3*
  High Altitude..................................... A5-4, A5-6*
Fuel Required to Climb.......................... A3-3, A3-4*
Fuel Signals Calibration Panel 1-46B, 1-46C*
Fuel System Failures..3-17
Fuel Tanks Arrangement.................................. 1-41*
Fuel Transfer Sequence........................1-43*, 1-44*
Fuel Quantity Data 1-46A*

G

GCA (PAR) Approach 7-6, 7-7*
Gearbox Failure / Vibration 3-20A
Gearbox Fire 3-20A
Gearbox Malfunctions 3-20A
Go Around..2-20, 2-21*
Gross Weight Limitations....................................5-6
Ground Refuelling / Defuelling 1-46A
Ground Start..2-9
Gyro Alignment..1-105
  Fast Alignment 1-105, 2-24
  Long Alignment 1-105, 2-25
Gyro Operation..1-106
  Indications and Warnings...........................1-106
Gyro Systems..1-105

H

Handling...6-11
Harness Powered Retraction Unit.....................1-88
HDD...1-83, 1-83*
Holding 7-3
Horizontal Situation Indicator.................. 1-79, 1-79*
Hot Weather / Desert Procedures 7-9
HSI Indication 1-80*
HUD/HDD..1-82
HUD...1-82, 1-82*
HUD Controls 1-82
HUD Display 1-83*
Hydraulic Accumulator......................................1-50
  Combined Pressure Indicator............ 1-51, 1-51*
  Controls and Indicators 1-51
  Indications and Warnings.............................1-51
Hydraulic Boost System Failures.......................3-21
Hydraulic Cooling 1-50
Hydraulic Pumps 1-50
Hydraulic Power Supply System 1-50, FO-23*
Hydraulic System Failures.................................3-21

I

IAS Indicator 1-76, 1-76*
IFF Control Panel............................... 1-115, 1-115*
IFF Equipment 1-115
IFF Normal Operation 1-117
Initial Optimum Cruise Altitude...............A4-1, A4-2*
Instantaneous G Available A8-20, A8-21*
Instruments 1-76
Instrument Approaches.......................................7-4
Instrument Climb...7-3
Instrument Descent...7-3
Instrument Flight 7-3
Instrument Markings 5-11
Instrument Takeoff..7-3
Inertial Navigation Mode 1-107
Intercom System 1-100
Interior Check..2-6
Internal Lights 1-94
Inverted Spin...6-14

L

Landing 2-18
Landing Data...A7-1
Landing Gear Controls........................... 1-55, 1-55*
Landing Gear Emergencies 3-26
Landing Gear Emergency Chart 3-28
Landing Gear Emergency Lowering System 1-55
Landing Gear Indicator System Failure 3-26
Landing Gear Operation 1-56
Landing Gear Retraction Failure.......................3-26
Landing Gear System 1-54
  Main Landing Gear 1-54
  Nose Landing Gear......................................1-54
Landing Gear Unsafe or Fails to Extend...........3-26
Landing Roll..2-22
Landing Roll Distance A7-3, A7-4*, A7-5*
Landing Speed.......................................A7-1, A7-2*
Landing System Signal Panel 1-56, 1-56*
Landing / Taxi Lights...1-94
Landing with a known blown Tire......................3-25
Landing with Flap / LEF System Failures 3-25
Landing with one full Wing Drop Tank 3-25
Lap Retraction Unit 1-88
Last Chance..2-14
Lateral and Directional Stability and Roll 6-7
Leg Restraint Lines 1-89
Lift Coefficient A8-24, A8-25*
Lighting System 1-93
Lighting System Controls 1-93*
Lightning 7-9
Load Classification...5-10
Longitudinal Stability 6-4
Lost Canopy...3-29

M

Main Engine Control Failure....3-16
Main Gear unsafe or fails to extend....3-27
Main Hydraulic System Failure....3-21
Main or STBY Gyro Failure....3-23
Main Oxygen System....1-95
Main Pitot Boom Failure....3-29
Maneuvering Flight, Characteristics....6-11
Maneuver Stability....6-6
Manual Relight....3-13
Master Caution Light....1-118
Maximum Abort Speed....A2-10, A2-11, A2-12*
Maximum available AOA....A8-22, A8-23*
Maximum Ceiling after Takeoff....A3-5, A3-6*
Military Takeoff....2-15, 2-15*
Minimum Equipment List....5-14*
Minimum Go Speed....A2-7, A2-8*, A2-9*
Miscellaneous Emergency Procedures....3-28
Missed Approach....7-6
Moisture in Cockpit....3-30

N

NAV Architecture....1-103*
Navigational Options....1-107
  Manual Station Select....1-108
  Point-to-Point Navigation....1-107
  Return....1-107
  Traffic Re-Entry (Missed Approach)....1-108
Navigation Computer....1-106
  Indications and Warnings....1-110A
  Operating Modes....1-106
  Update Mode....1-107
  Visual Update....1-107
Navigation Computer Programming....1-110
  Coordinates....1-110
  Entering Data Set....1-110A
  Headings....1-110
  RSBN / ILS Channels....1-110A
Navigation Computer Programming Panel....1-110B*
Navigation Control Panel....1-108*, 1-109
Navigation Failure Simulation Panel....4-6, 4-7*
Navigation Lights....1-94
Navigation System....1-103
Navigation System Controls....1-104*
Navigation System Failure....3-24
Night Flying....7-8
Normal Flight, Characteristics....6-11
Normal Landing....2-18
Normal Landing Pattern....2-19*
Normal Procedures....2-1
Nose Gear Unsafe or Fails to Extend....3-27
Nose Wheel Steering Failure after Landing....3-25
Nose Wheel Steering System....1-54

O

Optimum Cruise Summary....A4-3, A4-4*
Out of Control....3-30
Oxygen Control Panel....1-96
Oxygen Flow Valve....1-96
Oxygen Pressure Regulator....1-96
Oxygen System....1-95, FO-31*
  Controls and Indicators....1-95*
  Indications and Warnings....1-96
Oxygen System Failure....3-28

P

Panel Priority Changeover (GT)....4-13
Periscope System (GT)....4-12, 4-12*
Performance Data....A-1
Personal Parachute....1-89
Pitch Feel Control Unit....1-62, 1-62*
  Indications and Warnings....1-63
Pitot Static System....1-73, 1-73*
Pitot Static System Controls....1-74, 1-74*
Pneumatic Power Supply System....1-52, 1-53*
Pneumatic Reservoirs....1-52
  Controls and Indicators....1-52
Pneumatic System Failure....3-29
Power Distribution Panel MIG-29G....FO-33*
Power Distribution Panel MIG-29-GT....FO-35*
Preflight Check....2-3
Prohibited Maneuvers....5-6

R

R/C Navigation System Control Panel....4-11, 4-11*
R/C Telelight Panel....4-12, 4-12*
Radar Altimeter....1-81, 1-81*
  Indications and Warnings....1-81
Radar Simulation Modes (GT)....4-9*
Radar Simulation Panel (GT)....4-7, 4-8*
Radio Marker Receiver....1-115
Ramp Control Failure....3-17
Ramps Remain Closed during Takeoff....3-6
Rapid Decompression....3-28
Rear Cockpit Interior Check....2-26
Recorders....1-101
Reference Latitude....1-110
Refuelling Panel....1-46B, 1-46B*
Relight Envelope....3-13, 5-3
Remaining Fuel Quantity....1-46F*, 1-46G*
Rocket Motor....1-88
Roll Coupling....6-9
Roll Rate versus Mach Number, Stability....6-8*
RPM Fluctuation Limitations....5-5*
RPM Limitations....5-5*
Rudder Maneuvering, Limitations....5-6

Rudder Pedals....1-66
Rudders....1-62
Artificial Feel System....1-62
Yaw....1-63

S

Safe Ejection Envelope....5-8*
Seat Position Switch....1-89
Semiautomatic Relight....3-13
Services Lost Chart
AC Gen Failure / Drive Failure....3-20
Services Lost Chart
Both Gen or DC Gen Failure....3-19
Services Lost Chart
Hydraulic System Failures....3-21
Servicing Diagram....1-123*, 1-124*
Simulation Panels (GT)....4-3
Single Engine Approach and Landing....3-25
Single Engine GCA....7-6
Single Engine Flameout during Flight....3-13
Single Engine Flameout during Takeoff Roll....3-12
Smoke or Fumes in Cockpit....3-30
Speedbrake System....1-61, 6-13
Spin....6-14
Steep Spin....6-14
Moderate Flat Spin....6-14
Flat Spin....6-14
Inverted Spin....6-15
Spin Prevention....3-30
Spin Recovery....3-31
Stability and Controls....6-3
Stability Effects....6-4*
Stall....6-14
Deep Stall....6-14
Standard Atmosphere Table....A1-6*
Starting Engines....2-9
Static Longitudinal Stability....6-4
Supersonic Flight, Characteristics....6-12
Survival Pack....1-90
Sustained G Turn Capability....A8-4, A8-5*, A8-6*
System Operating Limitations....5-7*

T

T/O and Landing Limitations....5-9

TACAN....1-111
Automatic Self Test....1-113
Inflight Confidence Test....1-113
TACAN Antennas....1-111
TACAN Approach....7-4, 7-5*
TACAN Approach, Single Engine....7-4
TACAN Controls and Indicators....1-111*, 1-112
Tactical / Combat Performance Data....A8-1
Tailerons....1-61
Takeoff....2-14
Takeoff Data....A2-1
Takeoff Distance Chart....A2-3, A2-4*, A2-5*
Takeoff Speed Chart....A2-1, A2-2*
TAS Indicator....1-76, 1-76*
TAS Indicator GT, R/C....1-76, 1-76*
Taxi Checks....2-12
Taxiing....2-14
Taxiing Back....2-23
Telelight Panel....1-118
Telelight Panel Caption Index....3-32
Temperature Conversion....A1-5*
Throttles....1-30
Throttle Assembly....1-30*
Thunderstorm Penetration....7-9
Time / Distance Required to Climb....A3-1, A3-2*
Time of Turn 180°....A8-14, A8-15*
Touch and Go....2-20
Trainer Variant (GT) Checks....2-26
Transonic Region, Characteristics....6-12
Trim Failure....3-22
Trim System....1-63
Controls and Indicators....1-63
Turbulence and Thunderstorms....7-9
Turn and Slip Indicator....1-80, 1-80*
Turn Radius....A8-12, A8-13*
Turning Radius and GND Clearance....2-13*

V

Variable Duct Ramp System....1-22, 1-22*
Air Intake Control....1-23
Air Intake Louvers....1-23
Built-In Test Equipment....1-25, 1-25*
Engine Air Intake System....1-24*
Indications and Warnings....1-26
Manual Wedge Retraction....1-26
Preventive Ramp Extension....1-25
Ramp Position Indicator....1-26, 1-26*
Variable Ramps System Operation....1-23
Wedge Travel Programs....1-26
Variable Stator System....1-27
Vent Suit Valve....1-91
Vertical Velocity Indicator....1-80, 1-80*
VHF / UHF Frequency Control Panel....1-98, 1-98*
VHF / UHF Indicator Control Panel....1-99, 1-99*
VHF / UHF Radio....1-98
VHF / UHF Radio Operation....1-99
VIWAS Reports and Advices....3-33
Voice Information and
Warning System....1-122, 1-122*

W

Weapon and Armament
Controls.. 1-119A*, 1-119B*
Warning and Information
Equipment.. 1-118, 1-119*
Warning Light Test..1-122
Weight and Balance..2-3
Wheelbrake Failure...3-25
Wind Components Chart....................... A1-7, A1-8*
Windshield Defogging.................................... 1-90B
Wing Drop Tank Transfer Failure......................3-18
Wing Flap System...1-59
  Controls and Indicators..................... 1-60, 1-60*
  Maneuvering LEF..1-59
  Selective Flaps...1-59

X, Y

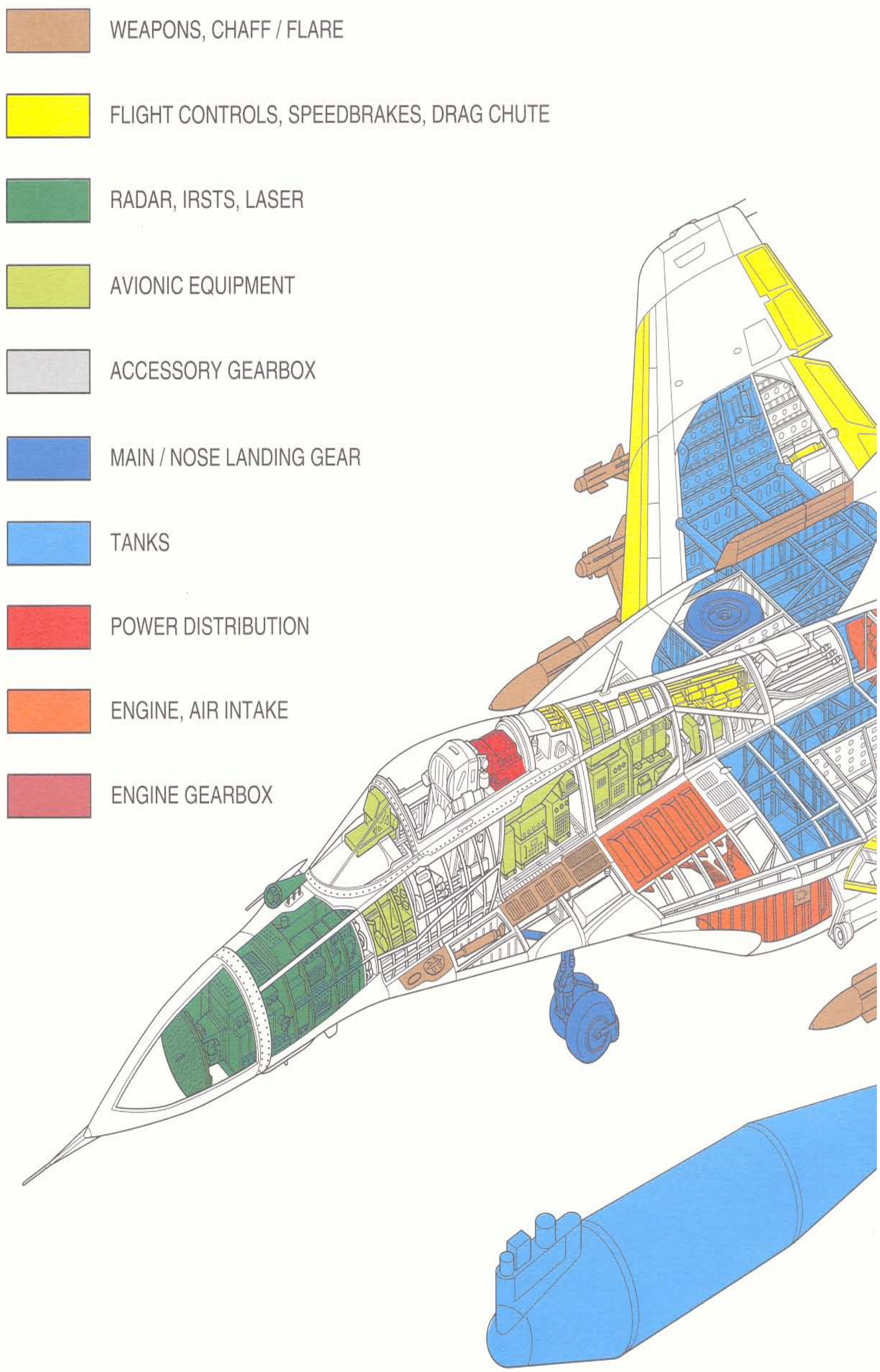
Z

Zoom Climb................................ A8-1, A8-2*, A8-3*

FOLDOUT PAGES

TABLE OF CONTENTS

	Figure
General Arrangement	FO-0
Cockpit Layout MIG-29G	FO-1
Front Cockpit Layout MIG-29GT	FO-2
Rear Cockpit Layout MIG-29GT	FO-3
Engine Oil System	FO-4
Engine Fuel System	FO-5
Engine Air Intake System	FO-6
Auxiliary Power System	FO-7
Aircraft Fuel System	FO-8
AC Power System	FO-9
DC Power System	FO-10
Hydraulic Power System	FO-11
Mechanical Flight Control System	FO-12
Automatic Flight Control System	FO-13
Air Conditioning and Pressurization System	FO-14
Oxygen Supply System	FO-15
Power Distribution Panel MIG-29G	FO-16
Power Distribution Panel MIG-29GT	FO-17
Ejection Seat	FO-18


WEAPONS, CHAFF / FLARE
FLIGHT CONTROLS, SPEEDBRAKES, DRAG CHUTE
RADAR, IRSTS, LASER
AVIONIC EQUIPMENT
ACCESSORY GEARBOX
MAIN / NOSE LANDING GEAR
TANKS
POWER DISTRIBUTION
ENGINE, AIR INTAKE
ENGINE GEARBOX

GENERAL ARRANGEMENT

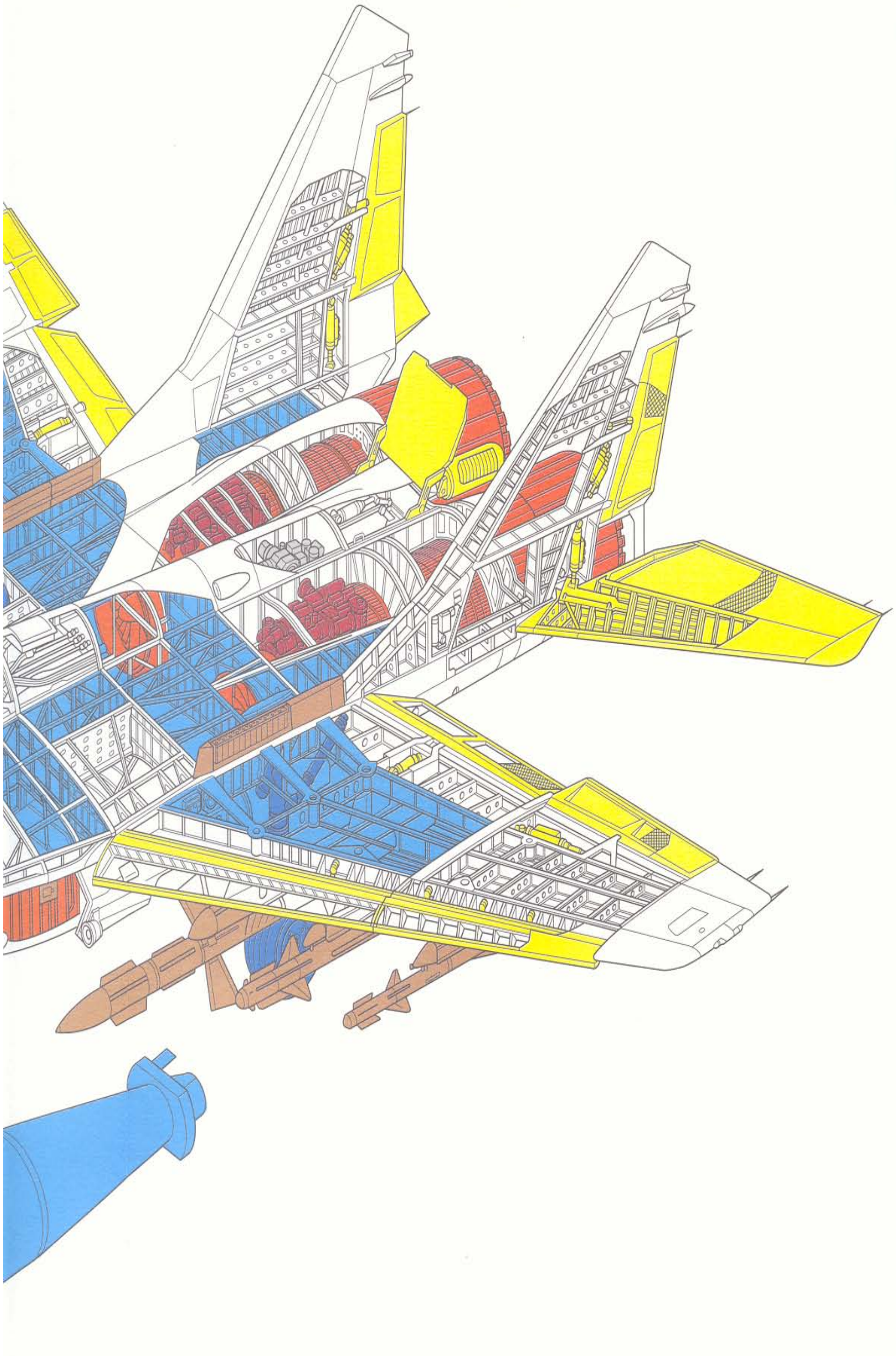
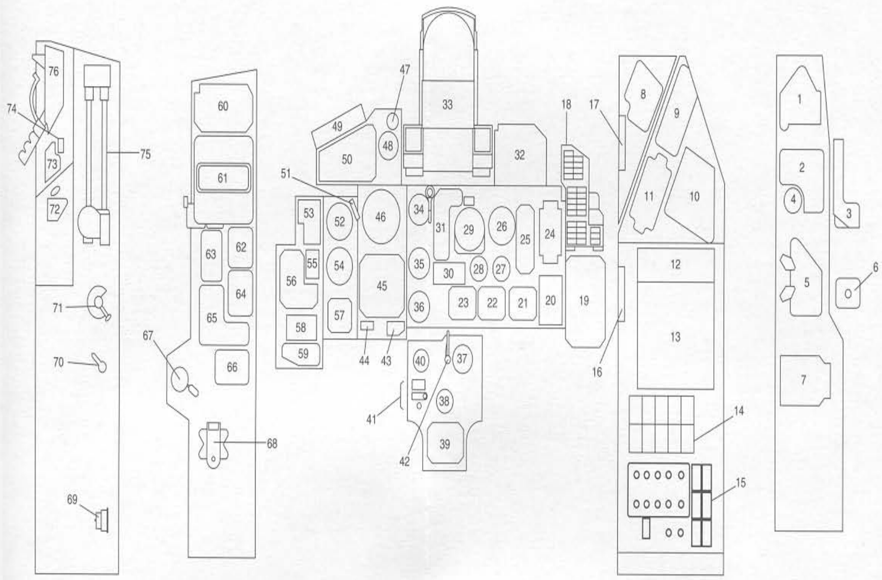
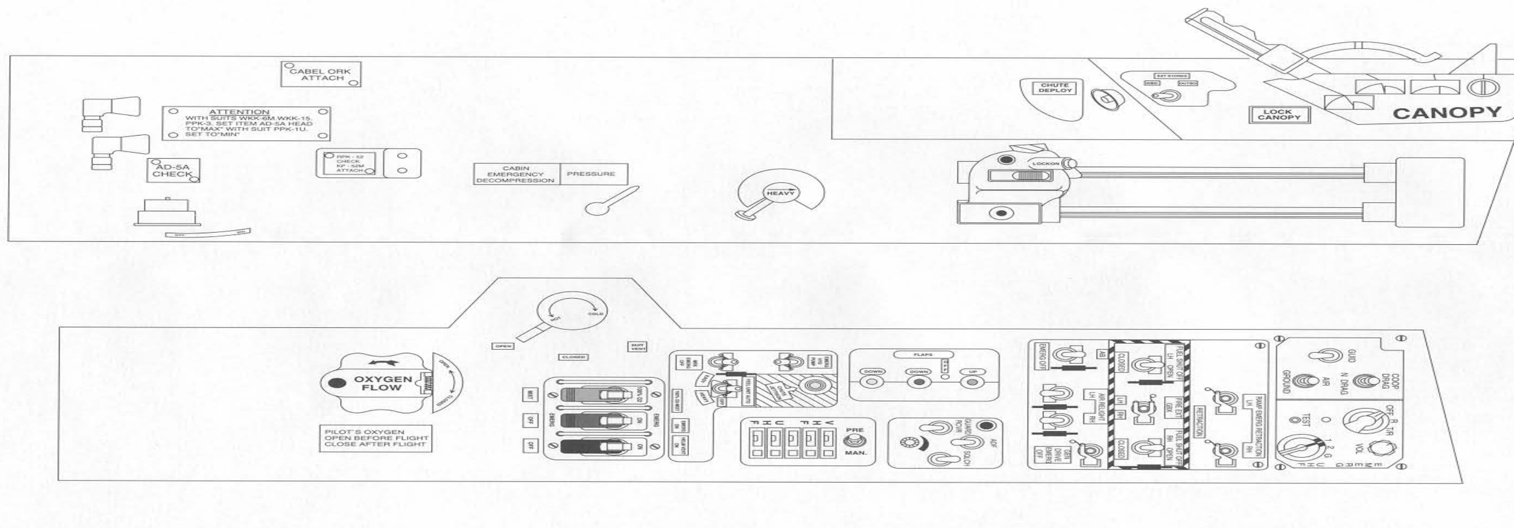
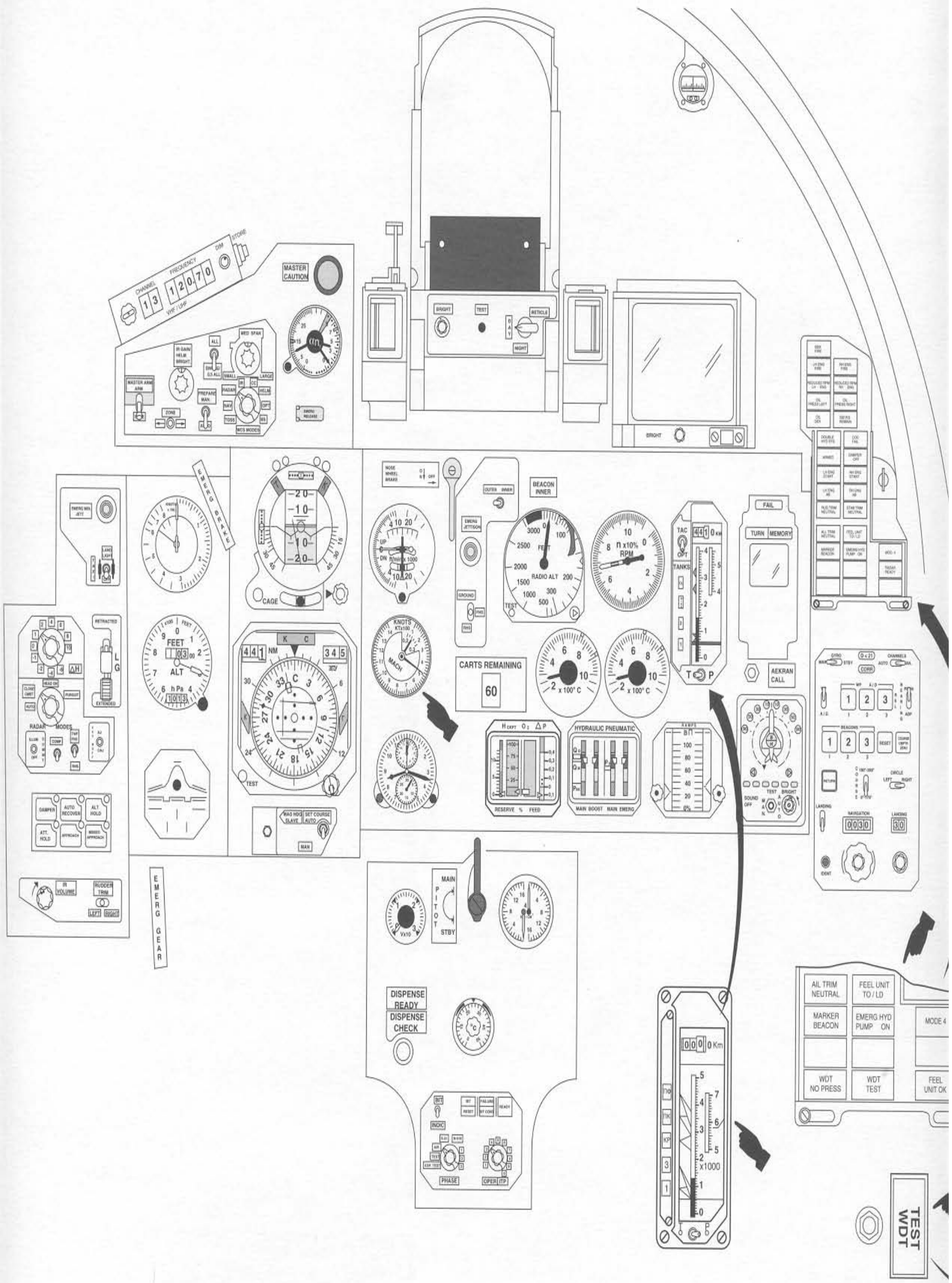


Figure FO-0



1. PITOT HEAT/CABIN TEMP SWITCH
2. FWD LIGHTING CONTROL PANEL
3. INTERNAL CANOPY EMERGENCY JETTISON HANDLE
4. FLOODLIGHT BRIGHTNESS CONTROL KNOB
5. AFT LIGHTING CONTROL PANEL
6. CANOPY CLOSED CONTROL PIN
7. ELECTRICAL POWER PANEL
8. RHAW CONTROL PANEL
9. VOICE WARNING CHECK BUTTONS
10. ENGINE START PANEL
11. ADF CONTROL INDICATOR
12. TACAN CONTROL PANEL
13. IFF CONTROL PANEL
14. SYSTEM POWER PANEL
15. CONTROL AND TEST PANEL
16. CABIN AIR LEVER
17. AIR LEVER
18. TELELIGHT PANEL (TLP)
19. NAVIGATION CONTROL PANEL
20. RHAW DISPLAY PANEL
21. RAMPS POSITION INDICATOR
22. COMBINED PRESSURE INDICATOR
23. COMBINED OXYGEN INDICATOR
24. AEKRAN
25. FUEL INDICATOR
26. ENGINE RPM INDICATOR
27. EGT INDICATOR
28. EGT INDICATOR
29. RADAR ALTIMETER
30. CARTS REMAINING
31. SWITCH PANEL
32. HDD
33. HUD
34. VERTICAL VELOCITY INDICATOR (VVI)
35. TAS INDICATOR
36. CLOCK
37. BRAKE PRESSURE INDICATOR
38. CABIN TEMPERATURE CONTROL KNOB
39. WEAPON SYSTEM MAINTENANCE PANEL
40. VOLTMETER
41. CHAFF/FLARE DISPENSER
42. PITOT SELECTOR LEVER
43. SET COURSE SWITCH
44. MAG HDG SLAVE BUTTON
45. HORIZONTAL SITUATION INDICATOR (HSI)
46. ATTITUDE DIRECTOR INDICATOR (ADI)
47. MASTER CAUTION LIGHT
48. COMBINED AOA/G-METER
49. VHF/UHF INDICATOR CONTROL PANEL
50. WEAPON CONTROL PANEL
51. EMERGENCY BRAKE HANDLE
52. IAS INDICATOR
53. EMERG MSL JETT AND LAND LIGHT/TAXI SWITCH
54. ALTIMETER
55. LANDING GEAR HANDLE
56. RADAR CONTROL PANEL
57. LANDING SYSTEM SIGNAL PANEL
58. AFCS CONTROL PANEL
59. RUDDER TRIM/IR VOLUME PANEL
60. EMERGENCY UHF RADIO (XT-2000)
61. ENGINE EMERGENCY PANEL
62. VHF/UHF RADIO PANEL
63. FLAP OPERATION CONTROL PANEL
64. VHF/UHF FREQUENCY CONTROL PANEL
65. CONTROL PANEL
66. OXYGEN CONTROL PANEL
67. SUIT VENT CONTROL KNOB
68. OXYGEN FLOW VALVE
69. PRESSURE REGULATOR
70. CABIN EMERG DECOMP LEVER
71. THROTTLE FRICTION ADJUSTMENT
72. CHUTE DEPLOY BUTTON
73. EXT STORES SELECTOR SWITCH
74. LOCK CANOPY CONTROL LIGHT
75. THROTTLE
76. INTERNAL CANOPY OPERATING HANDLE


CANOPY
LOCK CANOPY
CHUTE DEPLOY
LOCKON
HEAVY
CABEL ORK ATTACH
ATTENTION
WITH SUITS WKK-6M WKK-15, PPK-3, SET ITEM AD-5A HEAD TO"MAX" WITH SUIT PPK-1U, SET TO"MIN"
AD-5A CHECK
CABIN EMERGENCY DECOMPRESSION
PRESSURE
OXYGEN FLOW
PILOT'S OXYGEN OPEN BEFORE FLIGHT CLOSE AFTER FLIGHT
COOP DRAG
N DRAG
GUID
AIR
GROUND
OFF
T/R
VOL
TEST
RAMP EMERG RETRACTION
LH
RH
RETRACTION
FUEL SHUT OFF
OPEN
CLOSED
FIRE EXT
AIR RELIGHT
EMERG OFF
ADF
GUARD RCVR
SQLCH
FLAPS
UP
DOWN
PRE
MAN.
EMERG
ON
OFF
OPEN
CLOSED
HOT
COLD



AFTER MODIFICATION
WITH WING DROP TANKS

COCKPIT LAYOUT MIG-29G

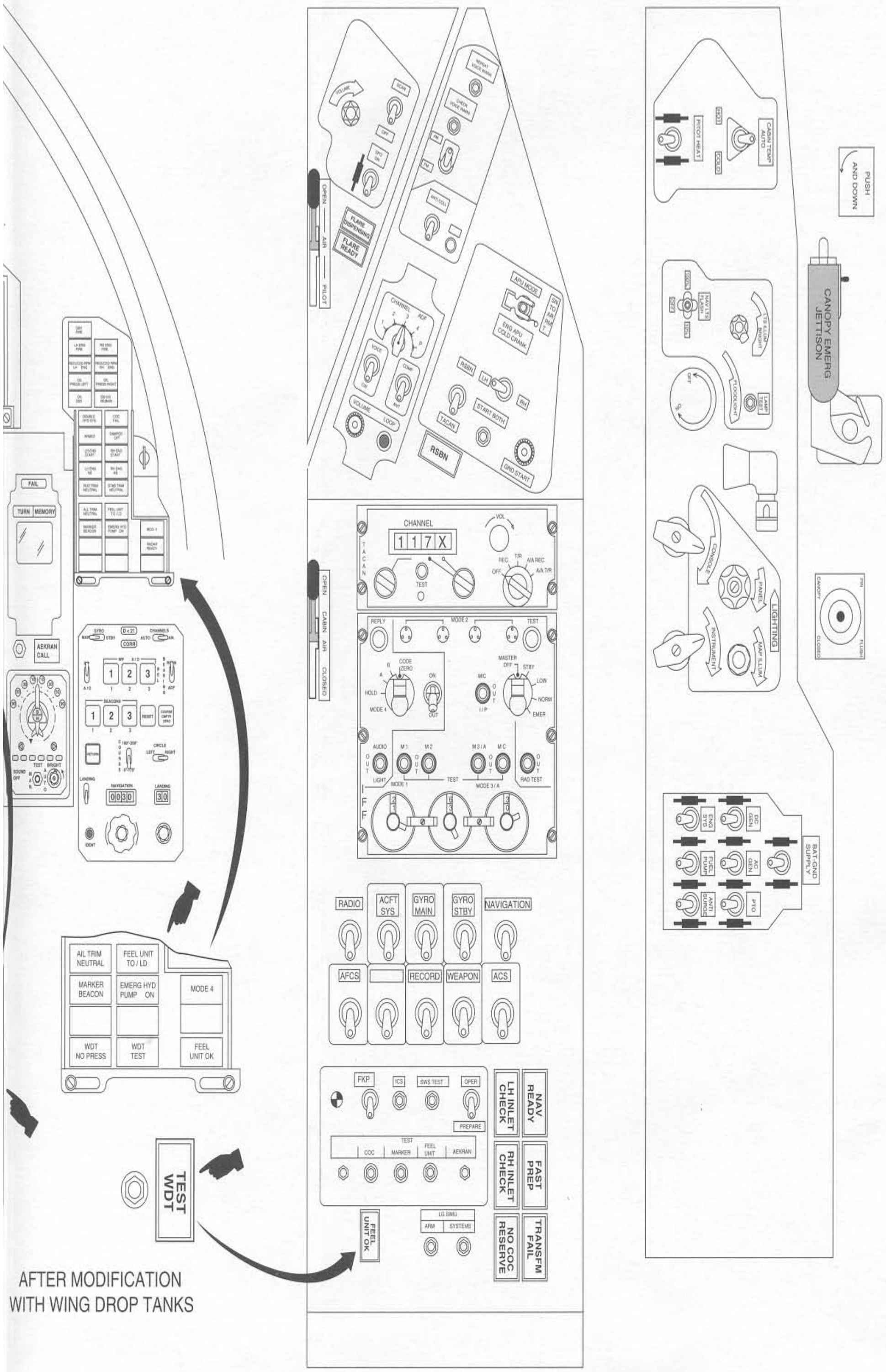
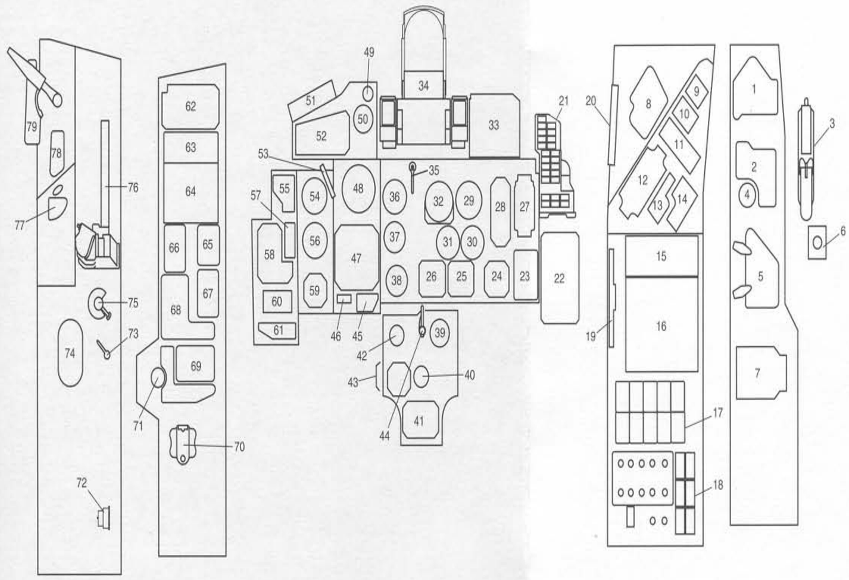
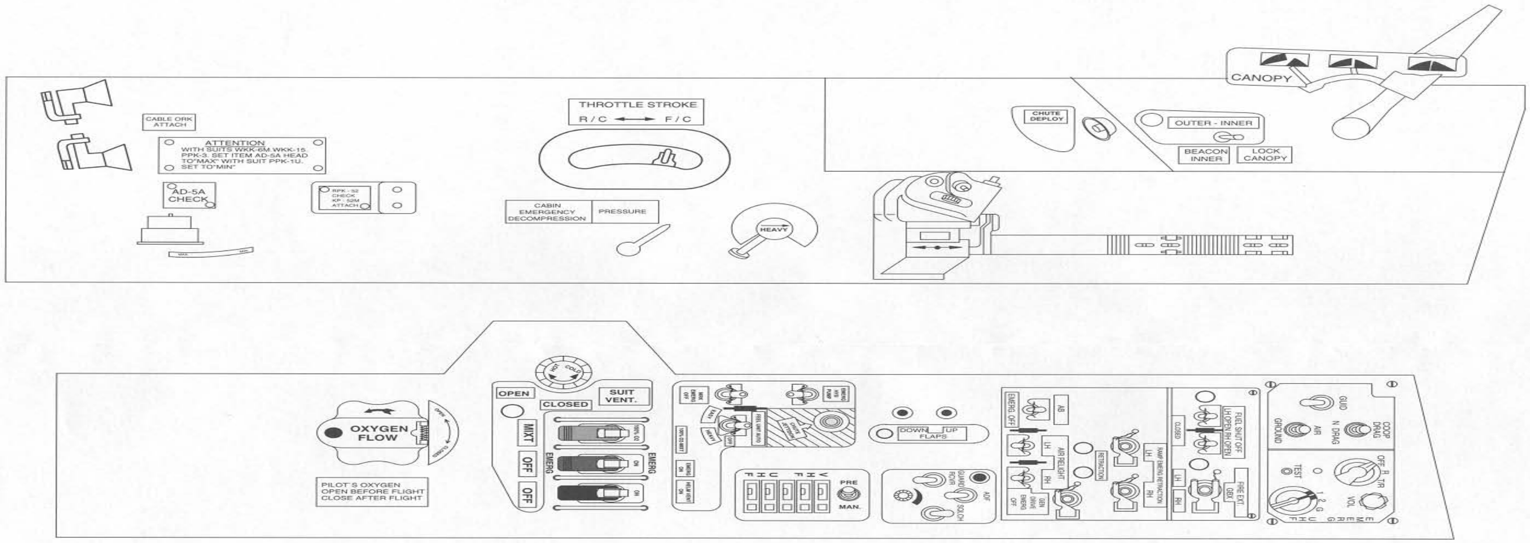


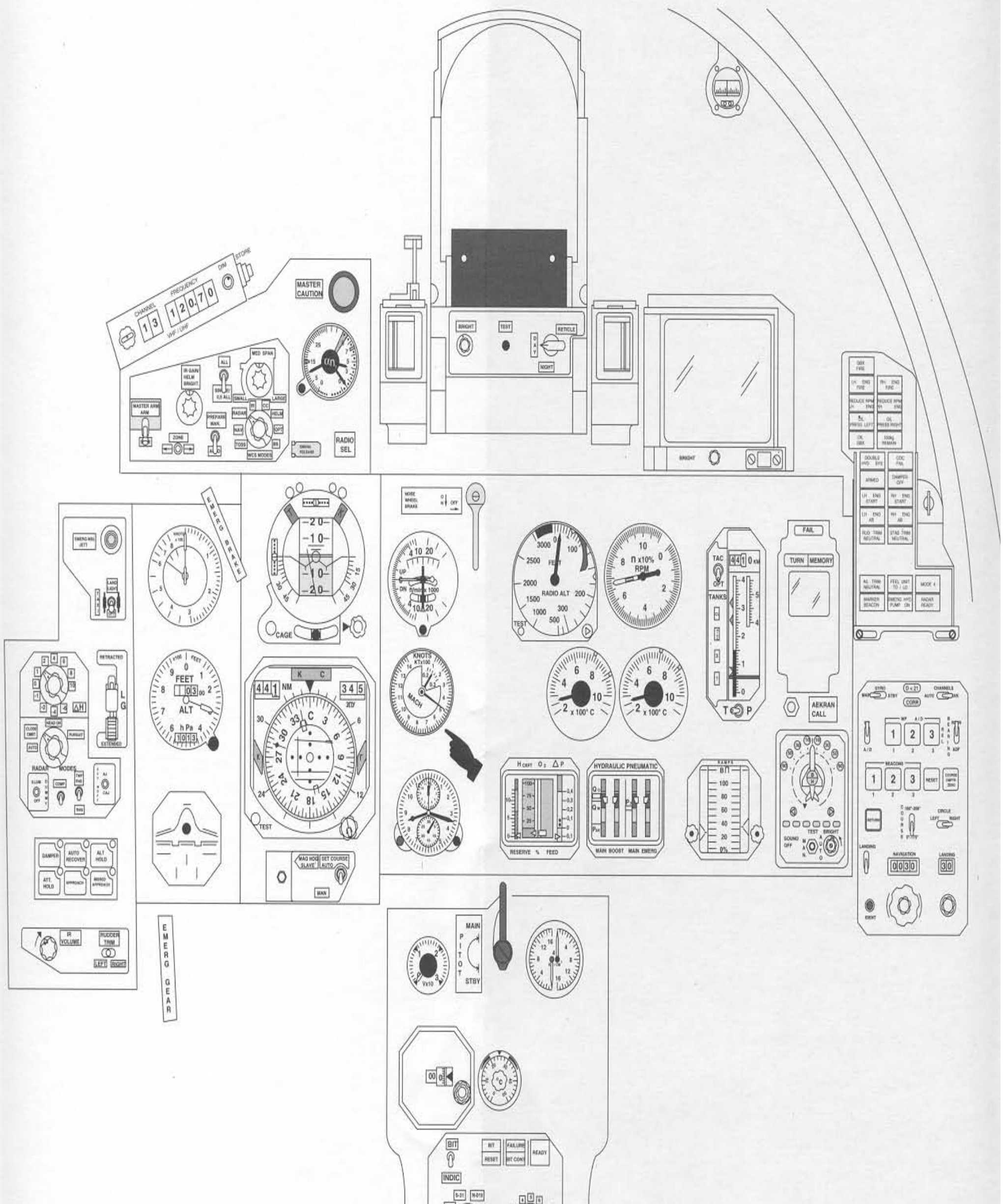
Figure FO-1



1. PITOT HEAT/CABIN TEMP SWITCH
2. FWD LIGHTING CONTROL PANEL
3. INTERNAL CANOPY EMERGENCY JETTISON HANDLE
4. FLOODLIGHT BRIGHTNESS CONTROL KNOB
5. AFT LIGHTING CONTROL PANEL
6. CANOPY CLOSED CONTROL PIN
7. ELECTRICAL POWER PANEL
8. RHAW CONTROL PANEL
9. VOICE WARNING CHECK BUTTONS
10. ANTI COLL AND AM/FM SWITCH PANEL
11. ADF/TACAN/RSBN CAPTIONS
12. ADF CONTROL INDICATOR
13. INTERCOM CONTROL
14. ENGINE START PANEL
15. TACAN CONTROL PANEL
16. IFF CONTROL PANEL
17. SYSTEM POWER PANEL
18. CONTROL AND TEST PANEL
19. CABIN AIR LEVER
20. AIR LEVER
21. TELELIGHT PANEL (TLP)
22. NAVIGATION CONTROL PANEL
23. RHAW DISPLAY PANEL
24. RAMPS POSITION INDICATOR
25. COMBINED PRESSURE INDICATOR
26. COMBINED OXYGEN INDICATOR
27. AEKRAN
28. FUEL INDICATOR
29. ENGINE RPM INDICATOR
30. EGT INDICATOR
31. EGT INDICATOR
32. RADAR ALTIMETER
33. HDD
34. HUD
35. NOSE WHEEL BRAKE LEVER
36. VERTICAL VELOCITY INDICATOR (VVI)
37. TAS INDICATOR
38. CLOCK
39. BRAKE PRESSURE INDICATOR
40. CABIN TEMPERATURE CONTROL KNOB
41. WEAPON SYSTEM MAINTENANCE PANEL
42. VOLTMETER
43. MAG DECLINATION CONTROL
44. PITOT SELECTOR LEVER
45. SET COURSE SWITCH
46. MAG HDG SLAVE BUTTON
47. HORIZONTAL SITUATION INDICATOR (HSI)
48. ATTITUDE DIRECTOR INDICATOR (ADI)
49. MASTER CAUTION LIGHT
50. COMBINED AOA/G-METER
51. VHF/UHF INDICATOR CONTROL PANEL
52. WEAPON CONTROL PANEL
53. EMERGENCY BRAKE HANDLE
54. IAS INDICATOR
55. EMERG MSL JETT AND LAND LIGHT/TAXI SWITCH
56. ALTIMETER
57. LANDING GEAR HANDLE
58. RADAR CONTROL PANEL
59. LANDING SYSTEM SIGNAL PANEL
60. AFCS CONTROL PANEL
61. RUDDER TRIM/IR VOLUME PANEL
62. EMERGENCY UHF RADIO (XT-2000)
63. FUEL SHUT-OFF/FIRE EXTINGUISHER CONTROL PANEL
64. AIR RELIGHT PANEL
65. VHF/UHF RADIO PANEL
66. FLAP OPERATION CONTROL PANEL
67. VHF/UHF FREQUENCY CONTROL PANEL
68. CONTROL PANEL
69. OXYGEN CONTROL PANEL
70. OXYGEN FLOW VALVE
71. SUIT VENT CONTROL KNOB
72. PRESSURE REGULATOR
73. CABIN EMERG DECOMP LEVER
74. THROTTLE STROKE
75. THROTTLE FRICTION ADJUSTMENT
76. THROTTLE
77. CHUTE DEPLOY BUTTON
78. MARKER BEACON SWITCH
79. INTERNAL CANOPY OPERATING HANDLE



CANOPY
THROTTLE STROKE
R/C F/C
CABLE ORK ATTACH
ATTENTION
WITH SUITS WKK-6M WKK-15. PPK-3. SET ITEM AD-5A HEAD TO"MAX" WITH SUIT PPK-1U. SET TO"MIN"
AD-5A CHECK
CABIN EMERGENCY DECOMPRESSION
PRESSURE
HEAVY
CHUTE DEPLOY
OUTER - INNER
BEACON INNER
LOCK CANOPY
OXYGEN FLOW
PILOT'S OXYGEN OPEN BEFORE FLIGHT CLOSE AFTER FLIGHT
OPEN
CLOSED
SUIT VENT.
MIXT
OFF
OFF
EMERG
EMERG
DOWN
UP
FLAPS
PRE
MAN.
AB
EMERG. OFF
AIR RELIGHT
LH
RH
RETRACTION
FUEL SHUT OFF
FIRE EXT.
GBX
COOP DRAG
N DRAG
GUID
AIR
GROUND
TEST
OFF
VOL



MASTER CAUTION
RADIO SEL
BRIGHT
TEST
RETICLE
NIGHT
EMERG BRAKE
CAGE
TEST
NM
KNOTS
MACH
FEET
ALT
hPa
RADIO ALT
RPM
x 100° C
x 100° C
TANKS
FAIL
TURN
MEMORY
AEKRAN CALL
HYDRAULIC PNEUMATIC
MAIN BOOST
MAIN EMERG
RESERVE % FEED
RADAR MODES
RUDDER TRIM
EMERG GEAR
MAIN
PITOT
STBY
BIT
FAILURE
READY
RESET
INDIC
PHASE
OPER ITP
NAVIGATION
LANDING
RESET

FRONT COCKPIT LAYOUT MIG-29GT

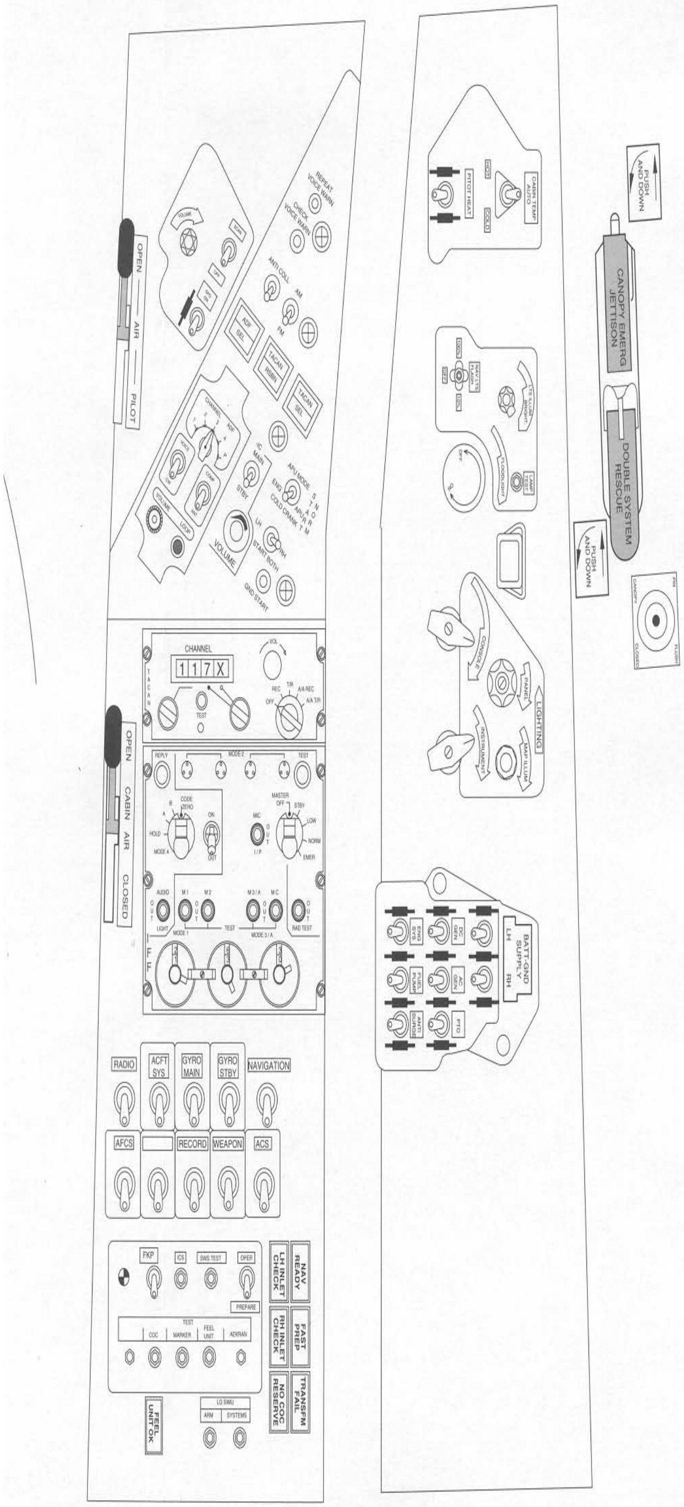
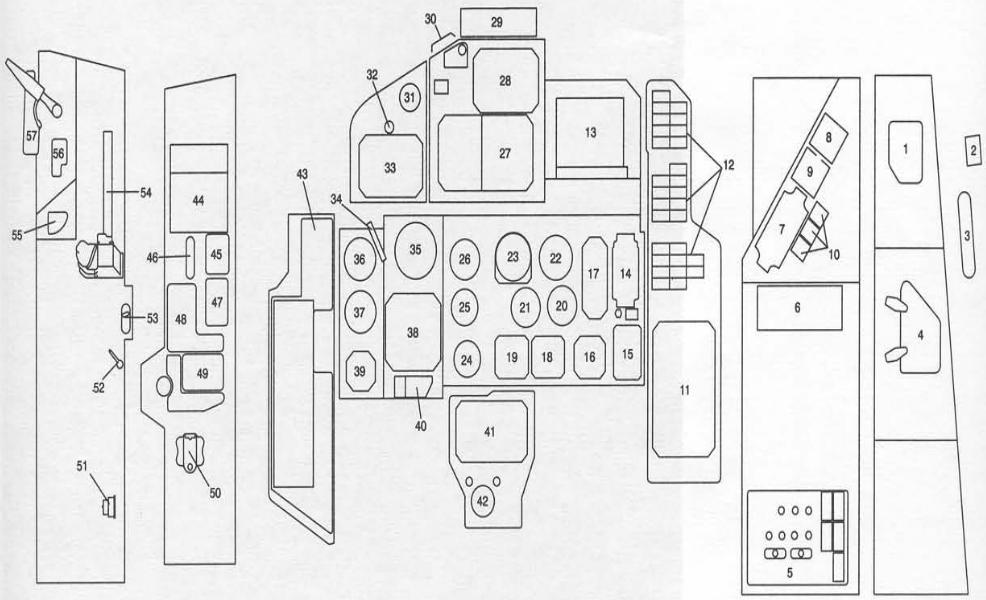
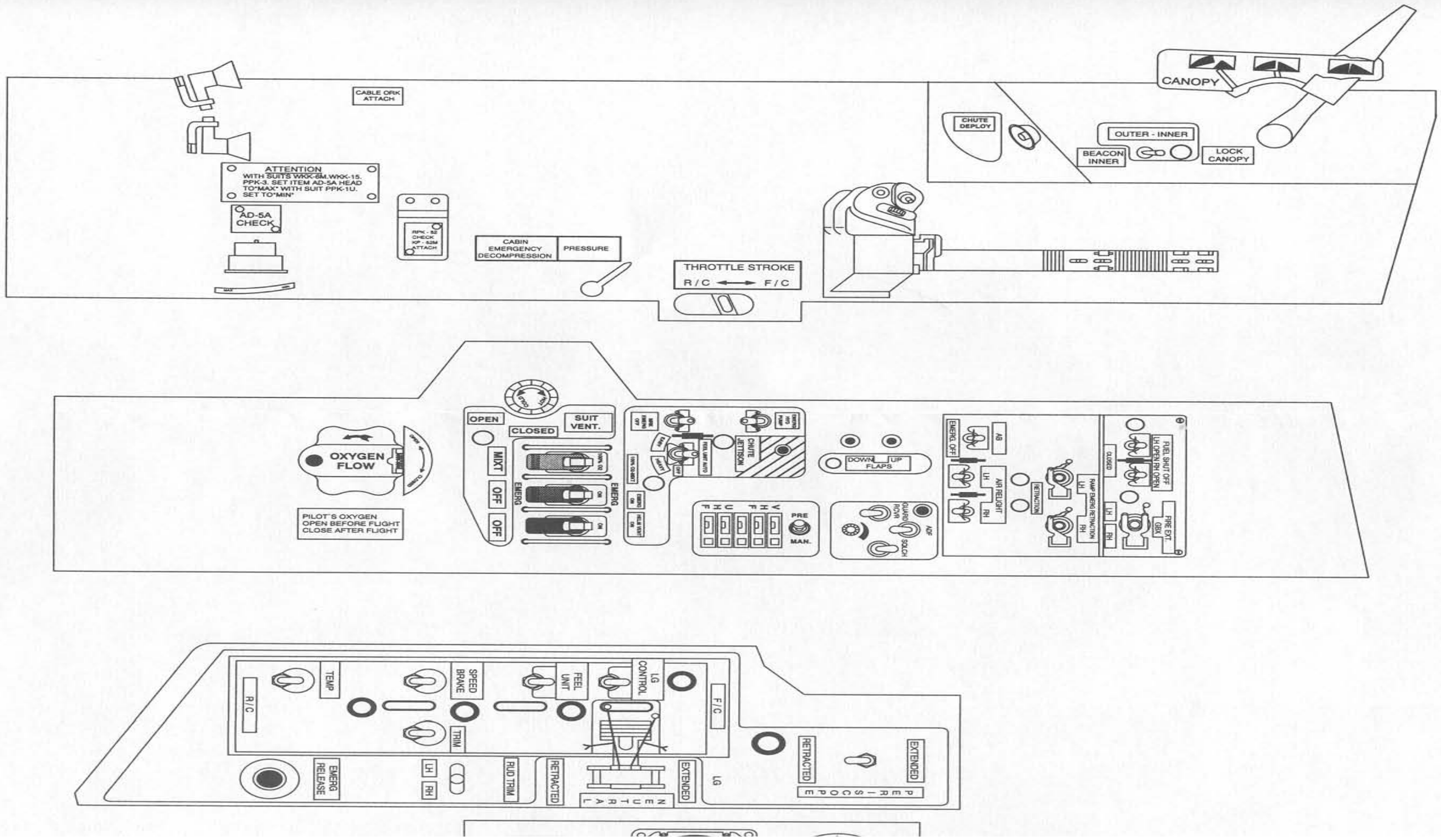


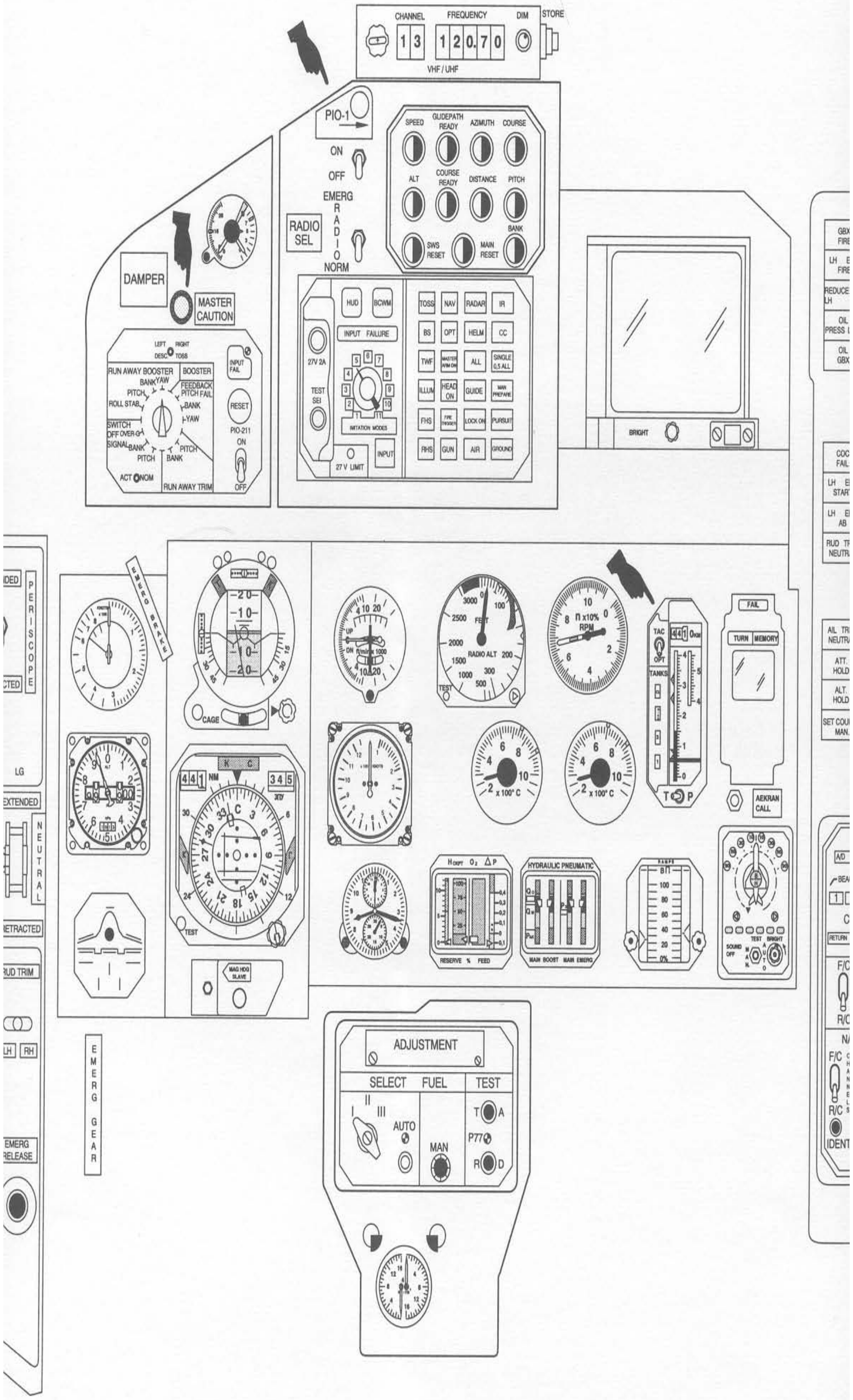
Figure FO-2



1. FWD LIGHTING CONTROL PANEL
2. CANOPY CLOSED CONTROL PIN
3. INTERNAL CANOPY EMERGENCY JETTISON HANDLE
4. AFT LIGHTING CONTROL PANEL
5. CONTROL AND TEST PANEL
6. TACAN CONTROL PANEL
7. ADF CONTROL PANEL
8. VOICE WARNING CHECK BUTTONS
9. INTERCOM CONTROL
10. ADF/TACAN/RSBN CAPTIONS
11. NAVIGATION CONTROL PANEL
12. TELELIGHT PANEL (TLP)
13. HDD
14. AEKRAN
15. RHAW DISPLAY PANEL
16. RAMPS POSITION INDICATOR
17. FUEL INDICATOR
18. COMBINED PRESSURE INDICATOR
19. COMBINED OXYGEN INDICATOR
20. EGT INDICATOR
21. EGT INDICATOR
22. ENGINE RPM INDICATOR
23. RADAR ALTIMETER
24. CLOCK
25. TAS INDICATOR
26. VERTICAL VELOCITY INDICATOR
27. NAVIGATION FAILURE SIMULATION PANEL
28. RADAR SIMULATION PANEL
29. VHF/UHF INDICATOR CONTROL PANEL
30. V/UHF SEL SWITCHES
31. COMBINED AOA/G-METER
32. MASTER CAUTION LIGHT
33. AFCS FAILURE SIMULATION PANEL
34. EMERGENCY BRAKE HANDLE
35. ATTITUDE DIRECTOR INDICATOR (ADI)
36. IAS INDICATOR
37. ALTIMETER
38. HORIZONTAL SITUATION INDICATOR (HSI)
39. LANDING SYSTEM SIGNAL PANEL
40. MAG HDG SLAVE BUTTON
41. REFUELING PANEL
42. BRAKE PRESSURE INDICATOR
43. LH VERTICAL CONSOLE
44. ENGINE EMERGENCY PANEL
45. VHF/UHF RADIO PANEL
46. FLAP OPERATION CONTROL PANEL
47. VHF/UHF FREQUENCY CONTROL PANEL
48. CONTROL PANEL
49. OXYGEN CONTROL PANEL
50. OXYGEN FLOW VALVE
51. PRESSURE REGULATOR
52. CABIN EMERG DECOMP LEVER
53. THROTTLE STROKE
54. THROTTLE
55. CHUTE DEPLOY BUTTON
56. OUTER/INNER SWITCH
57. INTERNAL CANOPY OPERATING HANDLE

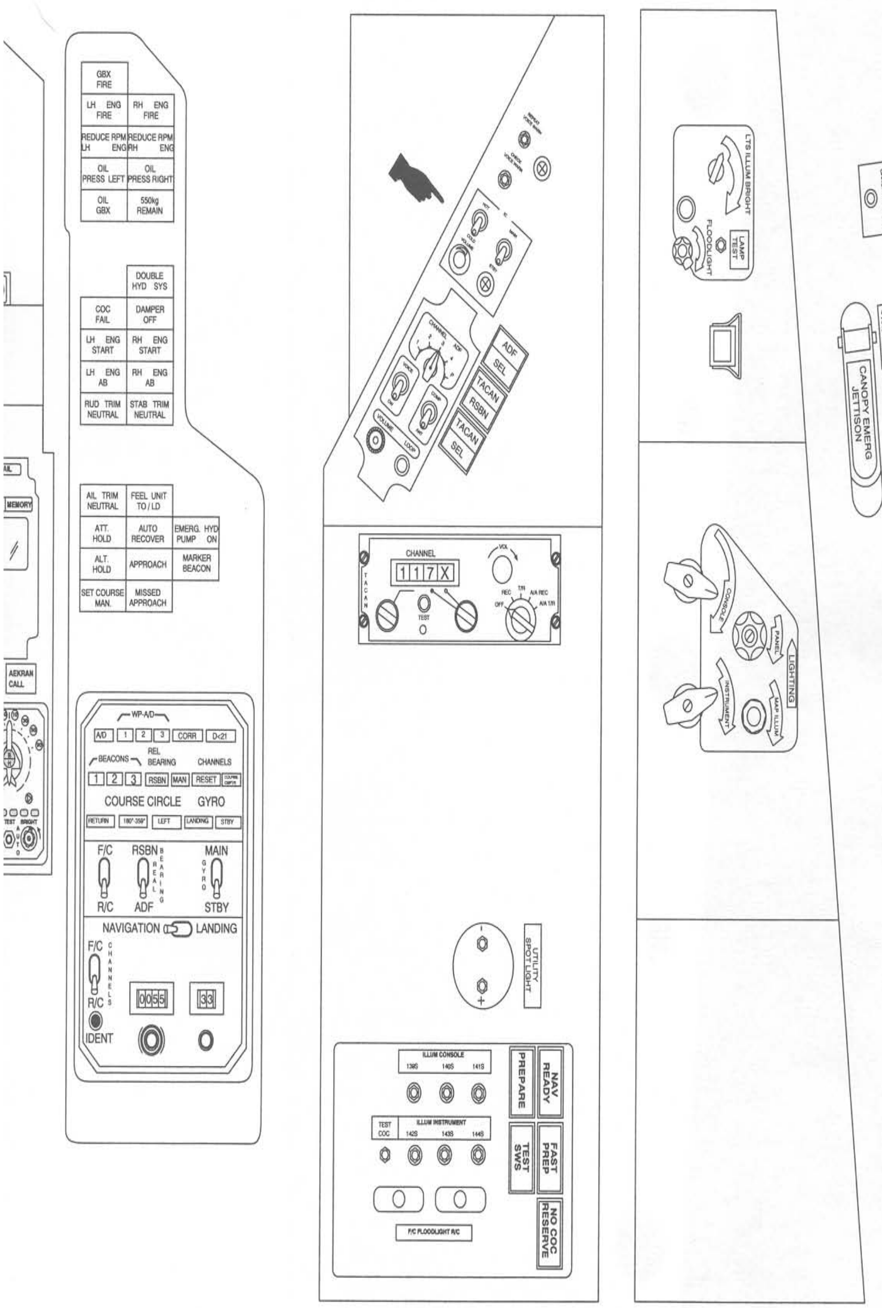


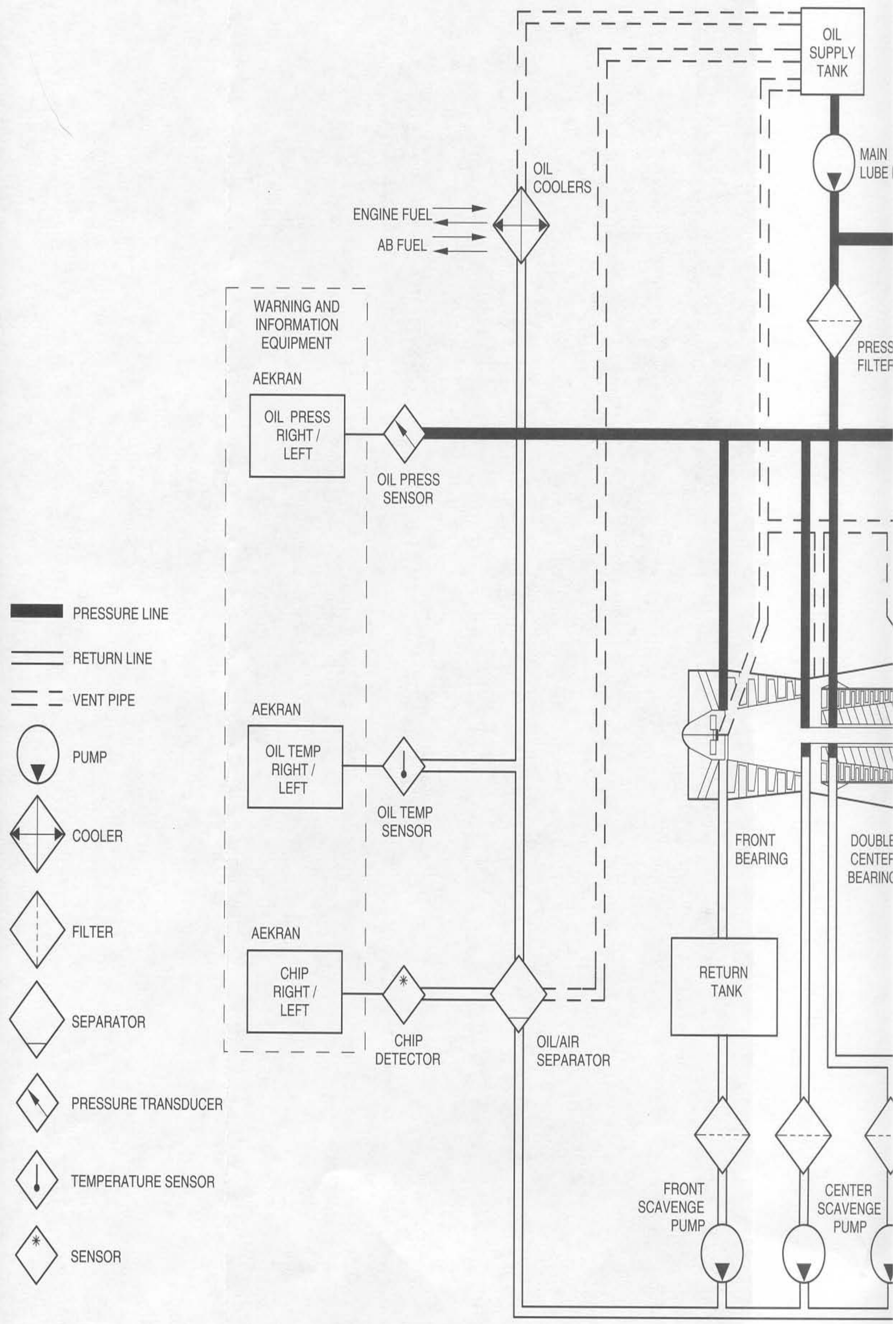
CABLE ORK ATTACH
ATTENTION
WITH SUITS WKK-6M, WKK-15, PPK-3. SET ITEM AD-5A HEAD TO"MAX" WITH SUIT PPK-1U. SET TO"MIN"
AD-5A CHECK
CABIN EMERGENCY DECOMPRESSION
PRESSURE
THROTTLE STROKE
R/C F/C
CHUTE DEPLOY
OUTER - INNER
BEACON INNER
LOCK CANOPY
CANOPY
OXYGEN FLOW
PILOT'S OXYGEN OPEN BEFORE FLIGHT CLOSE AFTER FLIGHT
OPEN
CLOSED
SUIT VENT.
MIXT
OFF
OFF
EMERG
CHUTE JETTISON
DOWN
UP
FLAPS
PRE
MAN.
V H F
U H F
ADF
SQLCH
AB
EMERG. OFF
AIR RELIGHT
LH
RH
RETRACTION
RAMP EMERG RETRACTION
LH
RH
CLOSED
FUEL SHUT OFF
LH OPEN RH OPEN
FIRE EXT.
GBX
LH
RH
R/C
TEMP
SPEED BRAKE
FEEL UNIT
LG CONTROL
F/C
TRIM
EMERG RELEASE
LH
RH
RUD TRIM
RETRACTED
NEUTRAL
EXTENDED
LG
RETRACTED
EXTENDED
PERISCOPE



CHANNEL
FREQUENCY
DIM
STORE
VHF / UHF
PIO-1
ON
OFF
EMERG
RADIO
NORM
RADIO SEL
SPEED
GLIDEPATH READY
AZIMUTH
COURSE
ALT
COURSE READY
DISTANCE
PITCH
BANK
SWS RESET
MAIN RESET
DAMPER
MASTER CAUTION
HUD
BCWM
INPUT FAILURE
27V 2A
TEST SEI
IMITATION MODES
27 V LIMIT
INPUT
TOSS
NAV
RADAR
IR
BS
OPT
HELM
CC
TWF
ALL
ILLUM
GUIDE
FHS
LOCK ON
PURSUIT
RHS
GUN
AIR
GROUND
RUN AWAY BOOSTER
BOOSTER
FEEDBACK PITCH FAIL
ROLL STAB
SWITCH OFF
SIGNAL
INPUT FAIL
RESET
PIO-211
ACT
NORM
RUN AWAY TRIM
BRIGHT
EMERG BRAKE
CAGE
PERISCOPE
LG
EXTENDED
RETRACTED
NEUTRAL
RUD TRIM
LH
RH
EMERG RELEASE
EMERG GEAR
RADIO ALT
FEET
TEST
RPM
TAC
TANKS
FAIL
TURN
MEMORY
AEKRAN CALL
MAG HDG SLAVE
x 100° C
RESERVE % FEED
HYDRAULIC PNEUMATIC
MAIN BOOST MAIN EMERG
SOUND OFF
ADJUSTMENT
SELECT
FUEL
TEST
AUTO
MAN
P77
ATT. HOLD
ALT. HOLD
F/C
R/C
IDENT

REAR COCKPIT LAYOUT MIG-29GT





OIL SUPPLY TANK
MAIN LUBE
OIL COOLERS
ENGINE FUEL
AB FUEL
WARNING AND INFORMATION EQUIPMENT
AEKRAN
OIL PRESS RIGHT / LEFT
OIL PRESS SENSOR
PRESS FILTER
AEKRAN
OIL TEMP RIGHT / LEFT
OIL TEMP SENSOR
AEKRAN
CHIP RIGHT / LEFT
CHIP DETECTOR
OIL/AIR SEPARATOR
FRONT BEARING
DOUBLE CENTER BEARING
RETURN TANK
FRONT SCAVENGE PUMP
CENTER SCAVENGE PUMP
PRESSURE LINE
RETURN LINE
VENT PIPE
PUMP
COOLER
FILTER
SEPARATOR
PRESSURE TRANSDUCER
TEMPERATURE SENSOR
SENSOR

ENGINE OIL SYSTEM

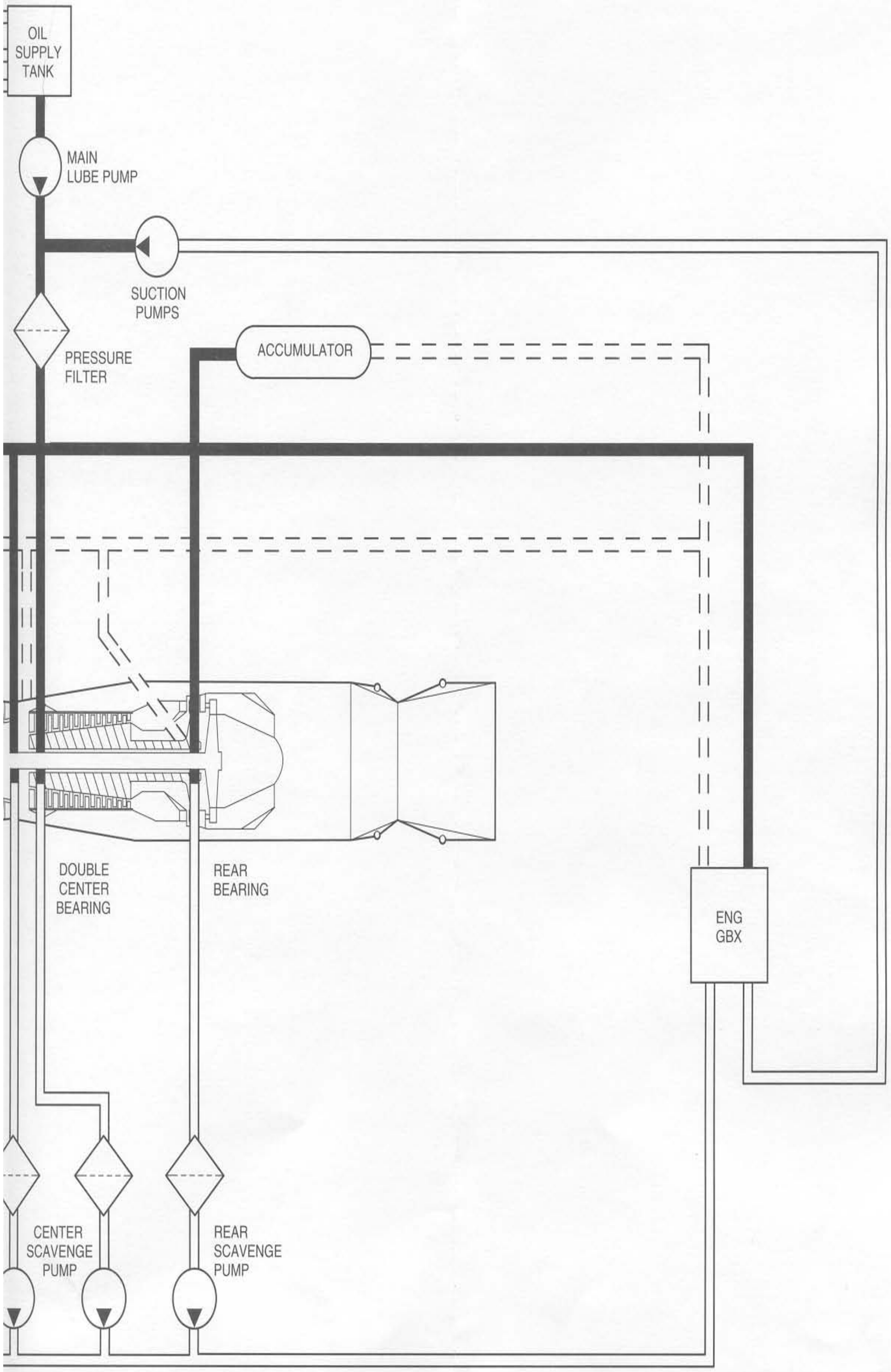
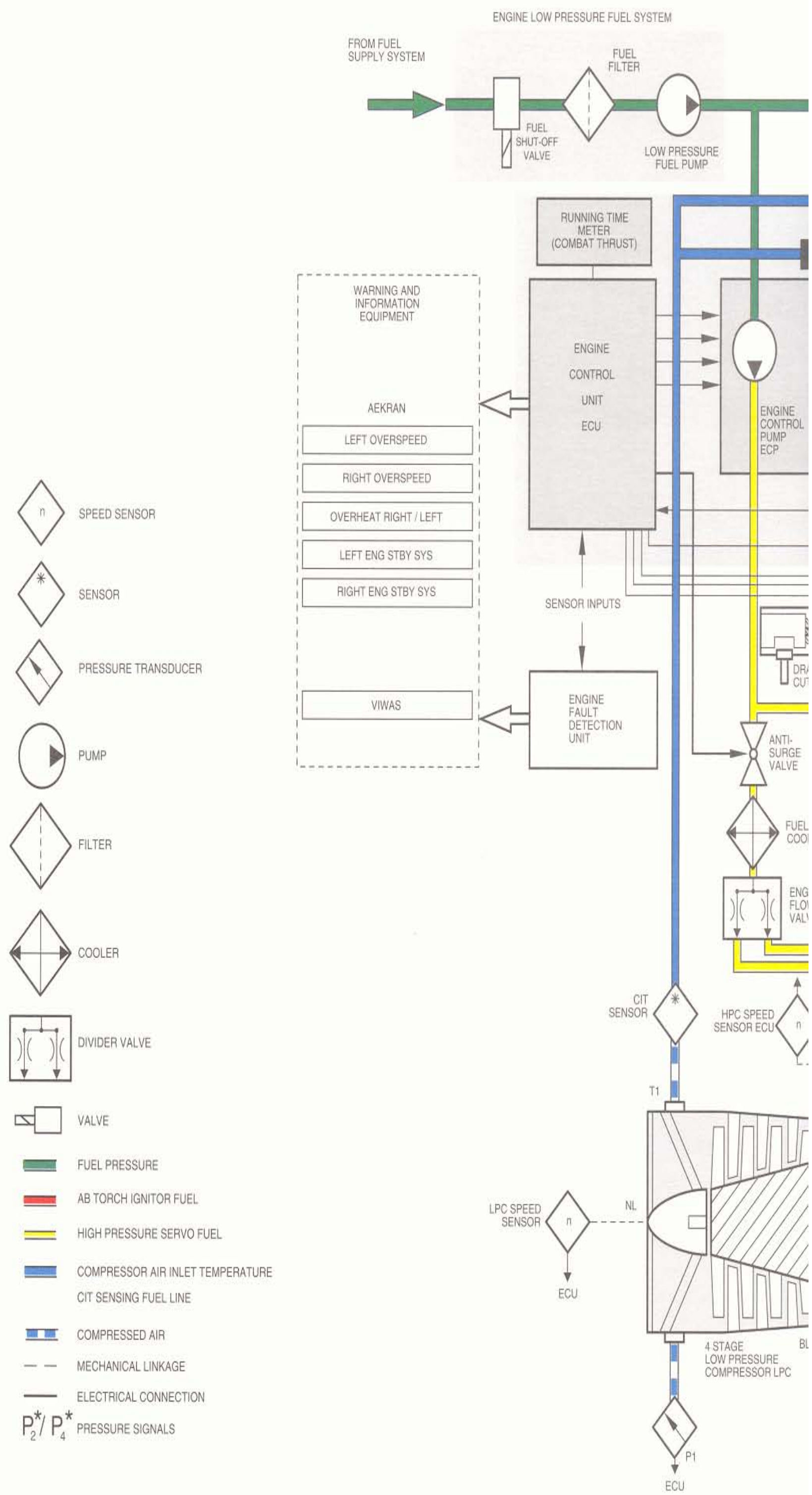


Figure FO-4



ENGINE LOW PRESSURE FUEL SYSTEM
FROM FUEL SUPPLY SYSTEM
FUEL FILTER
FUEL SHUT-OFF VALVE
LOW PRESSURE FUEL PUMP
RUNNING TIME METER (COMBAT THRUST)
WARNING AND INFORMATION EQUIPMENT
ENGINE CONTROL UNIT ECU
ENGINE CONTROL PUMP ECP
AEKRAN
LEFT OVERSPEED
RIGHT OVERSPEED
OVERHEAT RIGHT / LEFT
LEFT ENG STBY SYS
RIGHT ENG STBY SYS
SENSOR INPUTS
VIWAS
ENGINE FAULT DETECTION UNIT
ANTI-SURGE VALVE
CIT SENSOR
HPC SPEED SENSOR ECU
T1
LPC SPEED SENSOR
NL
ECU
4 STAGE LOW PRESSURE COMPRESSOR LPC
P1
ECU
SPEED SENSOR
SENSOR
PRESSURE TRANSDUCER
PUMP
FILTER
COOLER
DIVIDER VALVE
VALVE
FUEL PRESSURE
AB TORCH IGNITOR FUEL
HIGH PRESSURE SERVO FUEL
COMPRESSOR AIR INLET TEMPERATURE
CIT SENSING FUEL LINE
COMPRESSED AIR
MECHANICAL LINKAGE
ELECTRICAL CONNECTION
P_2^*/P_4^* PRESSURE SIGNALS

ENGINE FUEL SYSTEM

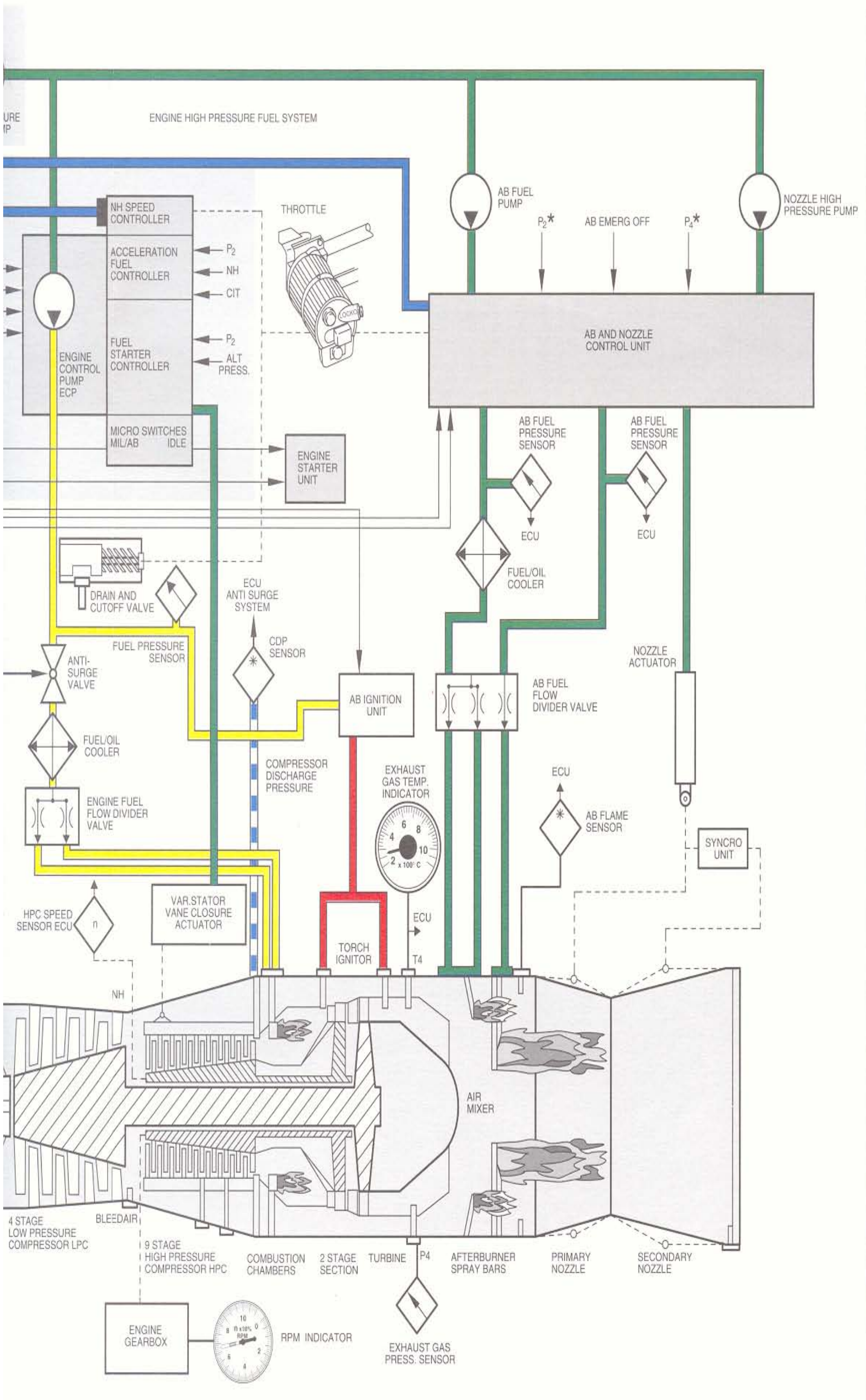
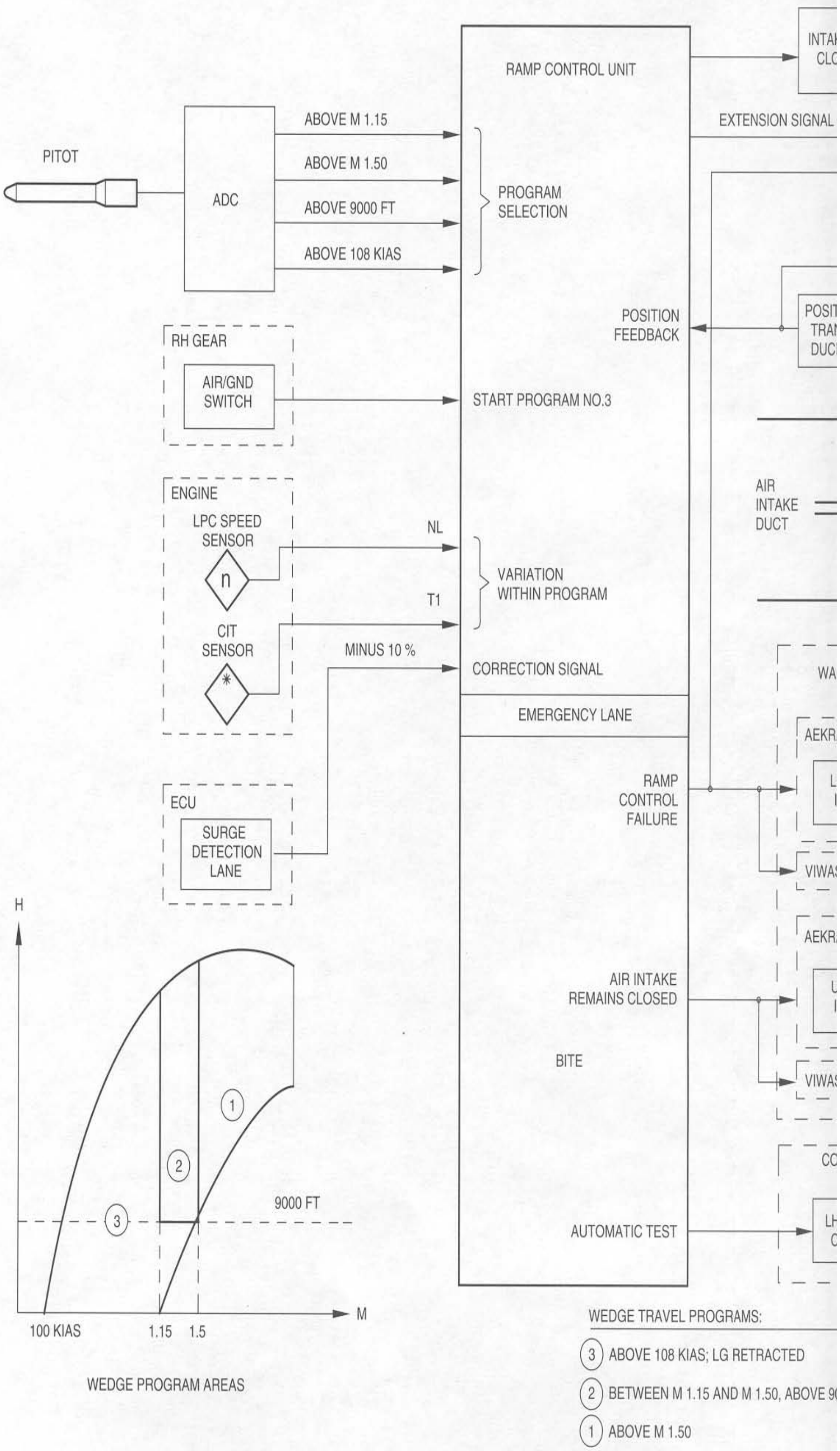


Figure FO-5


RAMP CONTROL UNIT
EXTENSION SIGNAL
PITOT
ADC
ABOVE M 1.15
ABOVE M 1.50
ABOVE 9000 FT
ABOVE 108 KIAS
PROGRAM SELECTION
POSITION FEEDBACK
RH GEAR
AIR/GND SWITCH
START PROGRAM NO.3
AIR INTAKE DUCT
ENGINE
LPC SPEED SENSOR
n
NL
VARIATION WITHIN PROGRAM
T1
CIT SENSOR
MINUS 10 %
CORRECTION SIGNAL
EMERGENCY LANE
ECU
SURGE DETECTION LANE
RAMP CONTROL FAILURE
AIR INTAKE REMAINS CLOSED
BITE
AUTOMATIC TEST
H
M
9000 FT
100 KIAS
1.15
1.5
1
2
3
WEDGE PROGRAM AREAS
WEDGE TRAVEL PROGRAMS:
3 ABOVE 108 KIAS; LG RETRACTED
2 BETWEEN M 1.15 AND M 1.50, ABOVE
1 ABOVE M 1.50

ENGINE AIR INTAKE SYSTEM

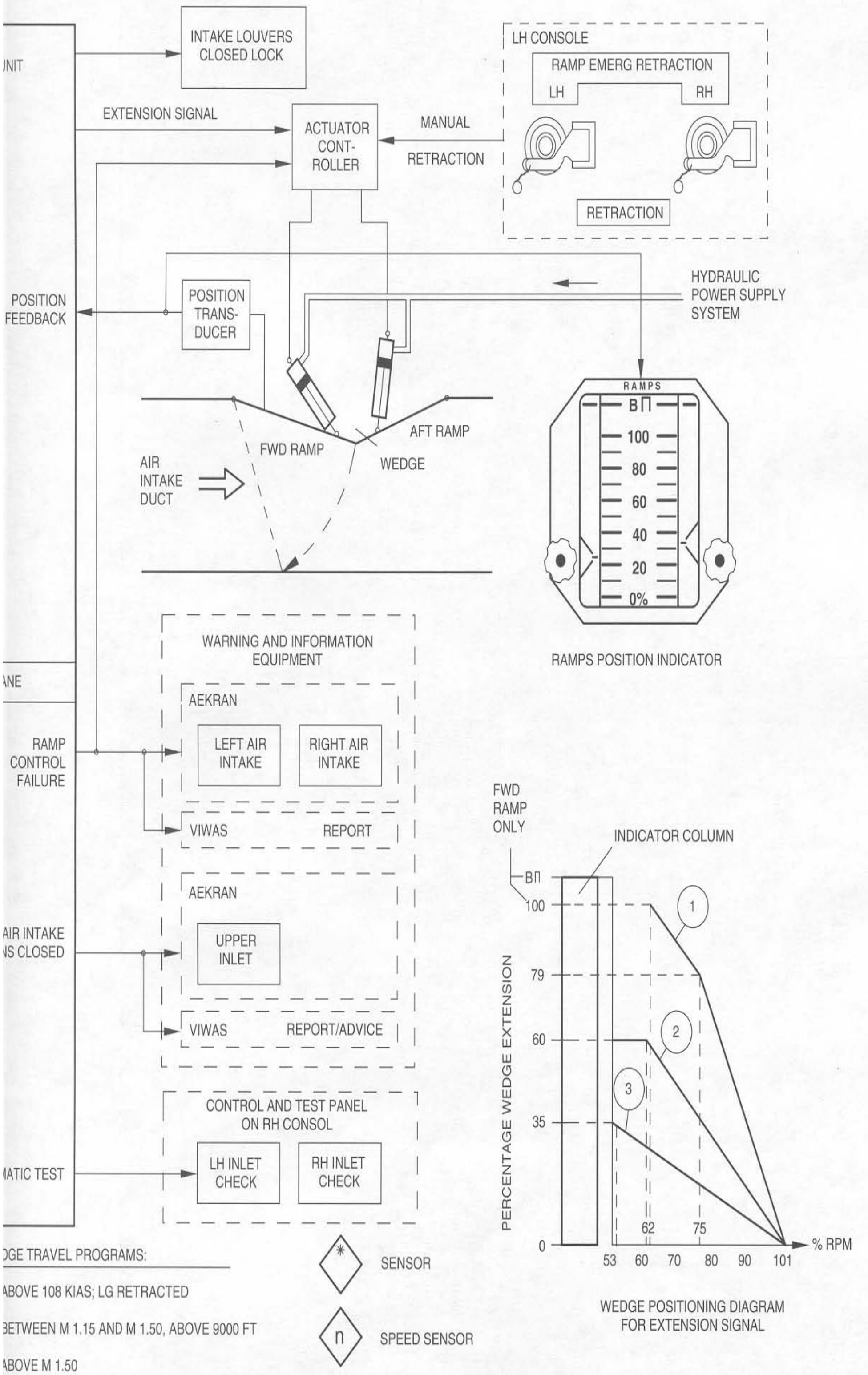
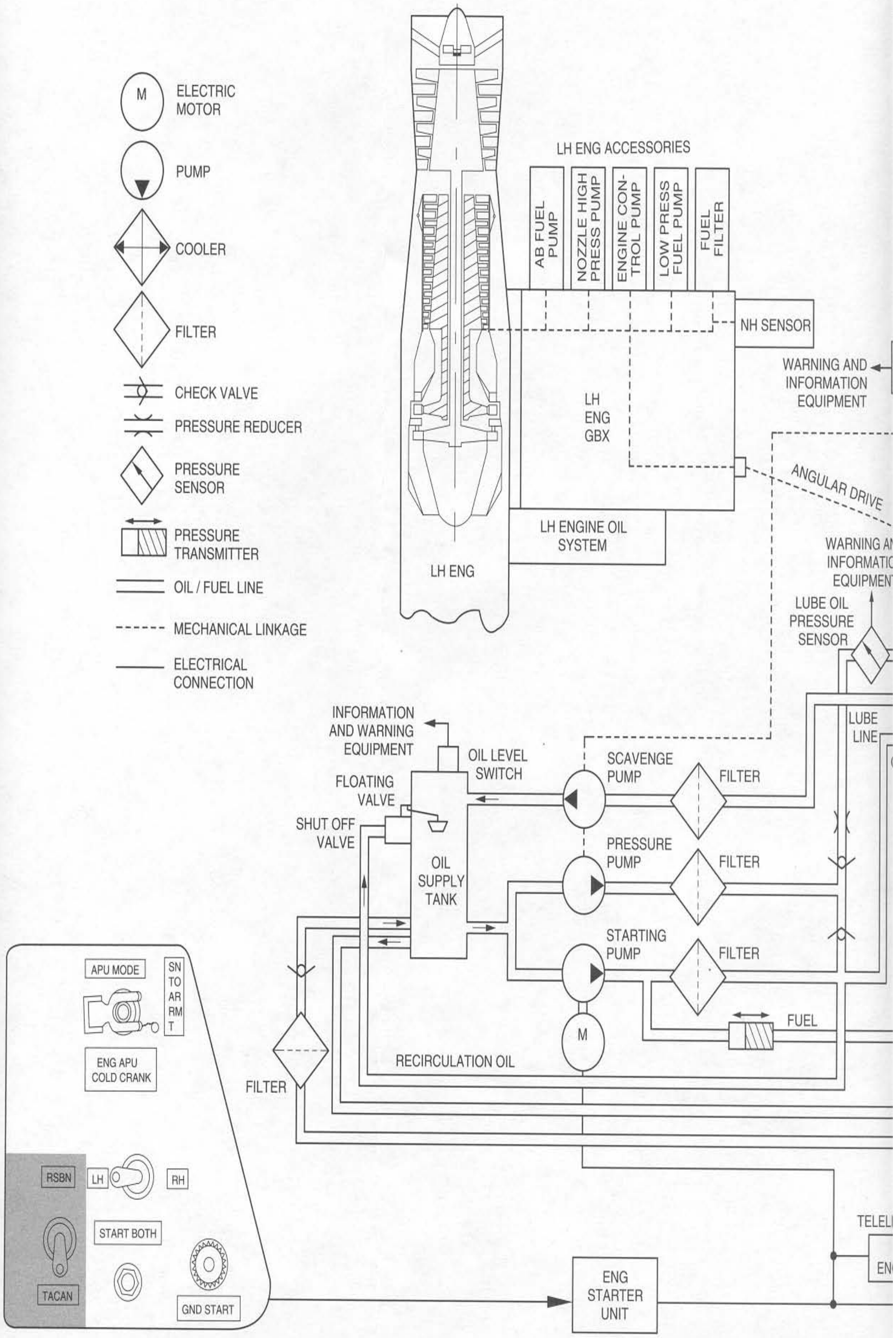


Figure FO-6


M
ELECTRIC MOTOR
PUMP
COOLER
FILTER
CHECK VALVE
PRESSURE REDUCER
PRESSURE SENSOR
PRESSURE TRANSMITTER
OIL / FUEL LINE
MECHANICAL LINKAGE
ELECTRICAL CONNECTION
LH ENG ACCESSORIES
AB FUEL PUMP
NOZZLE HIGH PRESS PUMP
ENGINE CON-TROL PUMP
LOW PRESS FUEL PUMP
FUEL FILTER
NH SENSOR
WARNING AND INFORMATION EQUIPMENT
LH ENG GBX
ANGULAR DRIVE
LH ENGINE OIL SYSTEM
LH ENG
LUBE OIL PRESSURE SENSOR
LUBE LINE
INFORMATION AND WARNING EQUIPMENT
OIL LEVEL SWITCH
FLOATING VALVE
SHUT OFF VALVE
OIL SUPPLY TANK
SCAVENGE PUMP
PRESSURE PUMP
STARTING PUMP
FILTER
FUEL
RECIRCULATION OIL
APU MODE
ENG APU COLD CRANK
RSBN
LH
RH
START BOTH
TACAN
GND START
ENG STARTER UNIT

AUXILIARY POWER SYSTEM

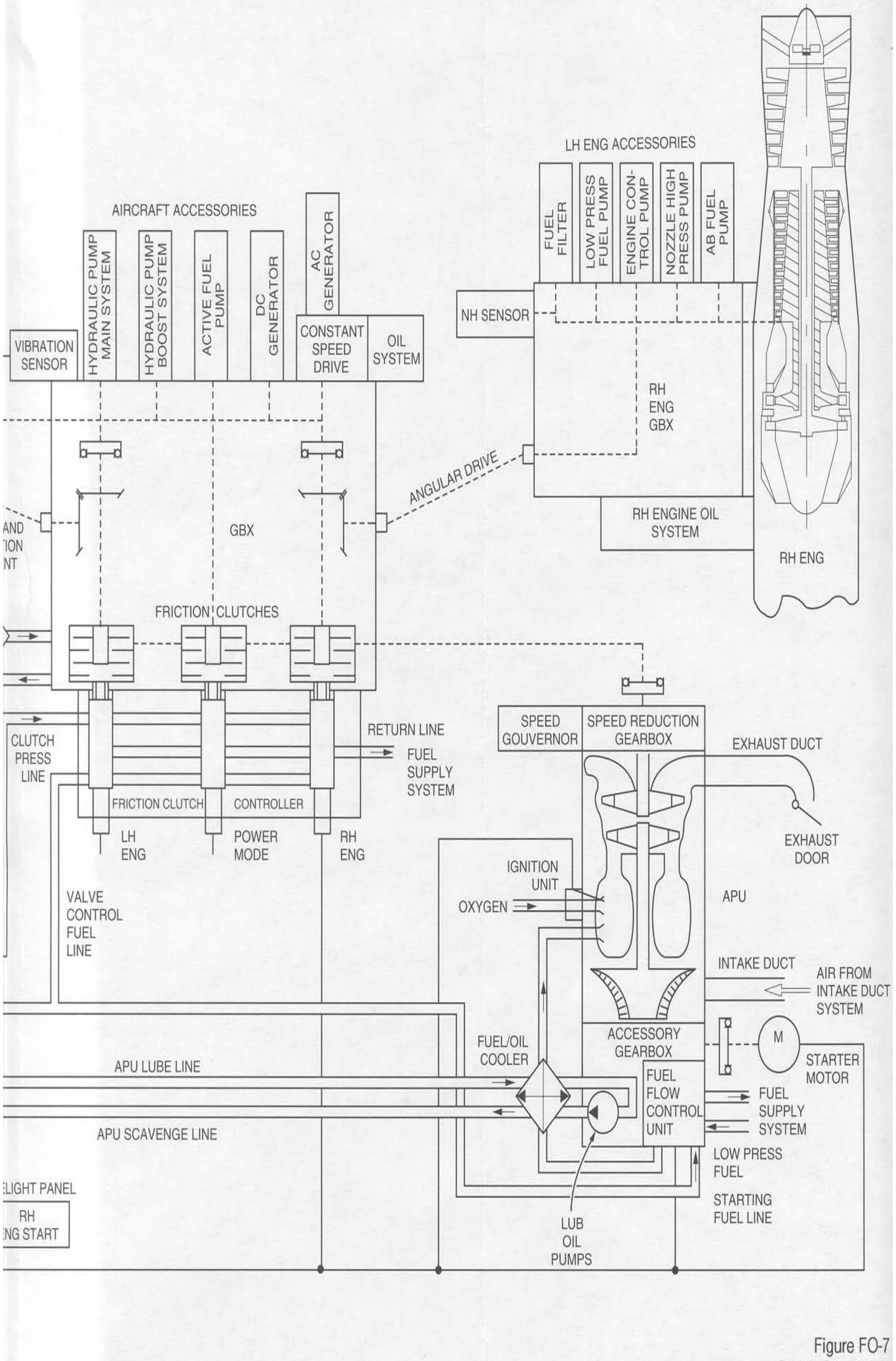
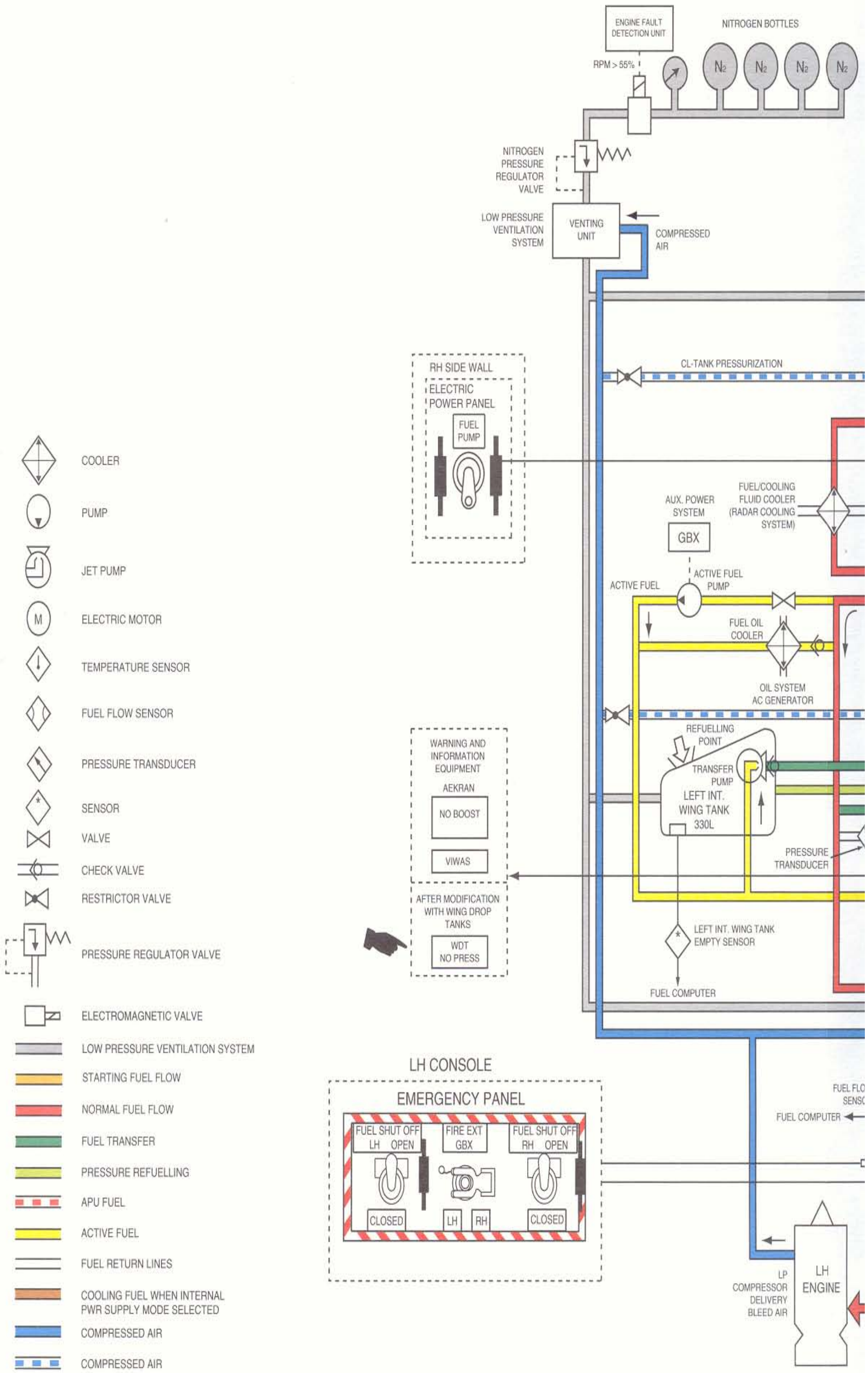


Figure FO-7


ENGINE FAULT DETECTION UNIT
NITROGEN BOTTLES
RPM > 55%
N2
NITROGEN PRESSURE REGULATOR VALVE
LOW PRESSURE VENTILATION SYSTEM
VENTING UNIT
COMPRESSED AIR
RH SIDE WALL
ELECTRIC POWER PANEL
FUEL PUMP
CL-TANK PRESSURIZATION
AUX. POWER SYSTEM
GBX
FUEL/COOLING FLUID COOLER (RADAR COOLING SYSTEM)
ACTIVE FUEL
ACTIVE FUEL PUMP
FUEL OIL COOLER
OIL SYSTEM AC GENERATOR
WARNING AND INFORMATION EQUIPMENT
AEKRAN
NO BOOST
VIWAS
REFUELLING POINT
TRANSFER PUMP
LEFT INT. WING TANK 330L
PRESSURE TRANSDUCER
AFTER MODIFICATION WITH WING DROP TANKS
WDT NO PRESS
LEFT INT. WING TANK EMPTY SENSOR
FUEL COMPUTER
COOLER
PUMP
JET PUMP
ELECTRIC MOTOR
TEMPERATURE SENSOR
FUEL FLOW SENSOR
PRESSURE TRANSDUCER
SENSOR
VALVE
CHECK VALVE
RESTRICTOR VALVE
PRESSURE REGULATOR VALVE
ELECTROMAGNETIC VALVE
LOW PRESSURE VENTILATION SYSTEM
STARTING FUEL FLOW
NORMAL FUEL FLOW
FUEL TRANSFER
PRESSURE REFUELLING
APU FUEL
ACTIVE FUEL
FUEL RETURN LINES
COOLING FUEL WHEN INTERNAL PWR SUPPLY MODE SELECTED
COMPRESSED AIR
COMPRESSED AIR
LH CONSOLE
EMERGENCY PANEL
FUEL SHUT OFF LH OPEN
FIRE EXT GBX
FUEL SHUT OFF RH OPEN
CLOSED
LH
RH
CLOSED
FUEL COMPUTER
LP COMPRESSOR DELIVERY BLEED AIR
LH ENGINE

FUEL SUPPLY SYSTEM

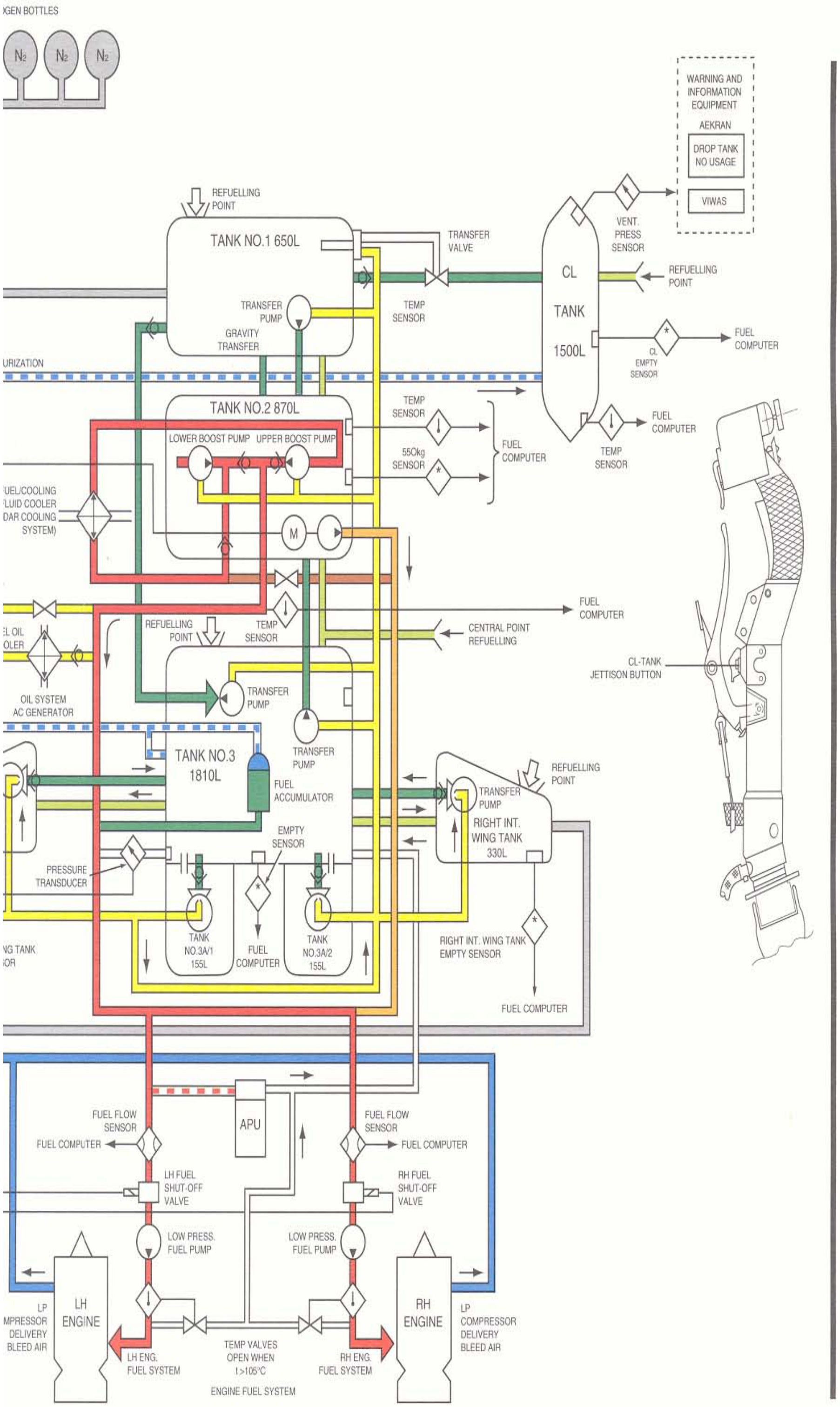
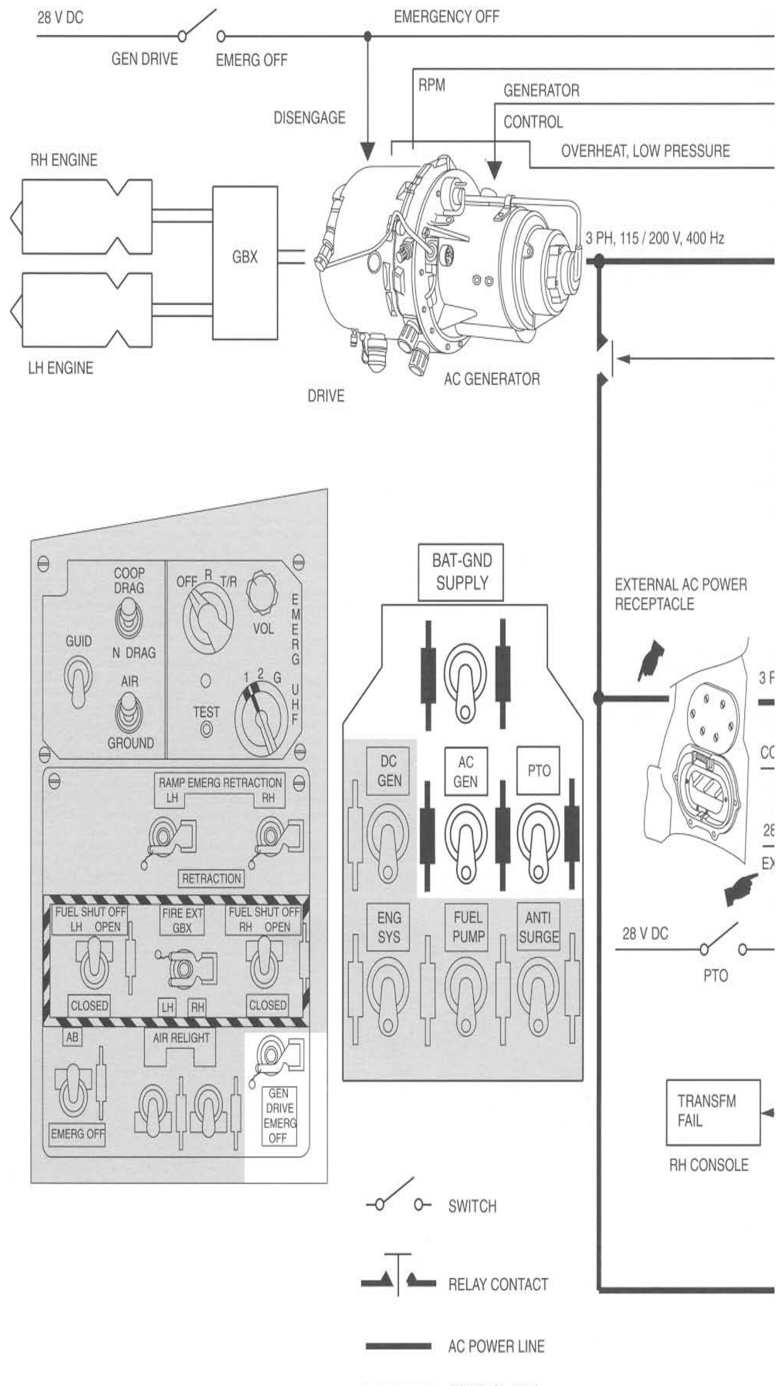


Figure FO-8


28 V DC
GEN DRIVE
EMERG OFF
EMERGENCY OFF
RPM
GENERATOR
CONTROL
DISENGAGE
OVERHEAT, LOW PRESSURE
RH ENGINE
GBX
3 PH, 115 / 200 V, 400 Hz
LH ENGINE
DRIVE
AC GENERATOR
COOP DRAG
N DRAG
GUID
AIR
GROUND
OFF R T/R
VOL
EMERG
TEST
1 2 G
UHF
RAMP EMERG RETRACTION
LH RH
RETRACTION
FUEL SHUT OFF LH OPEN
FIRE EXT GBX
FUEL SHUT OFF RH OPEN
CLOSED
LH RH
CLOSED
AB
AIR RELIGHT
EMERG OFF
GEN DRIVE EMERG OFF
BAT-GND SUPPLY
DC GEN
AC GEN
PTO
ENG SYS
FUEL PUMP
ANTI SURGE
EXTERNAL AC POWER RECEPTACLE
28 V DC
PTO
TRANSFM FAIL
RH CONSOLE
SWITCH
RELAY CONTACT
AC POWER LINE
CONTROL LINE

AC POWER SYSTEM

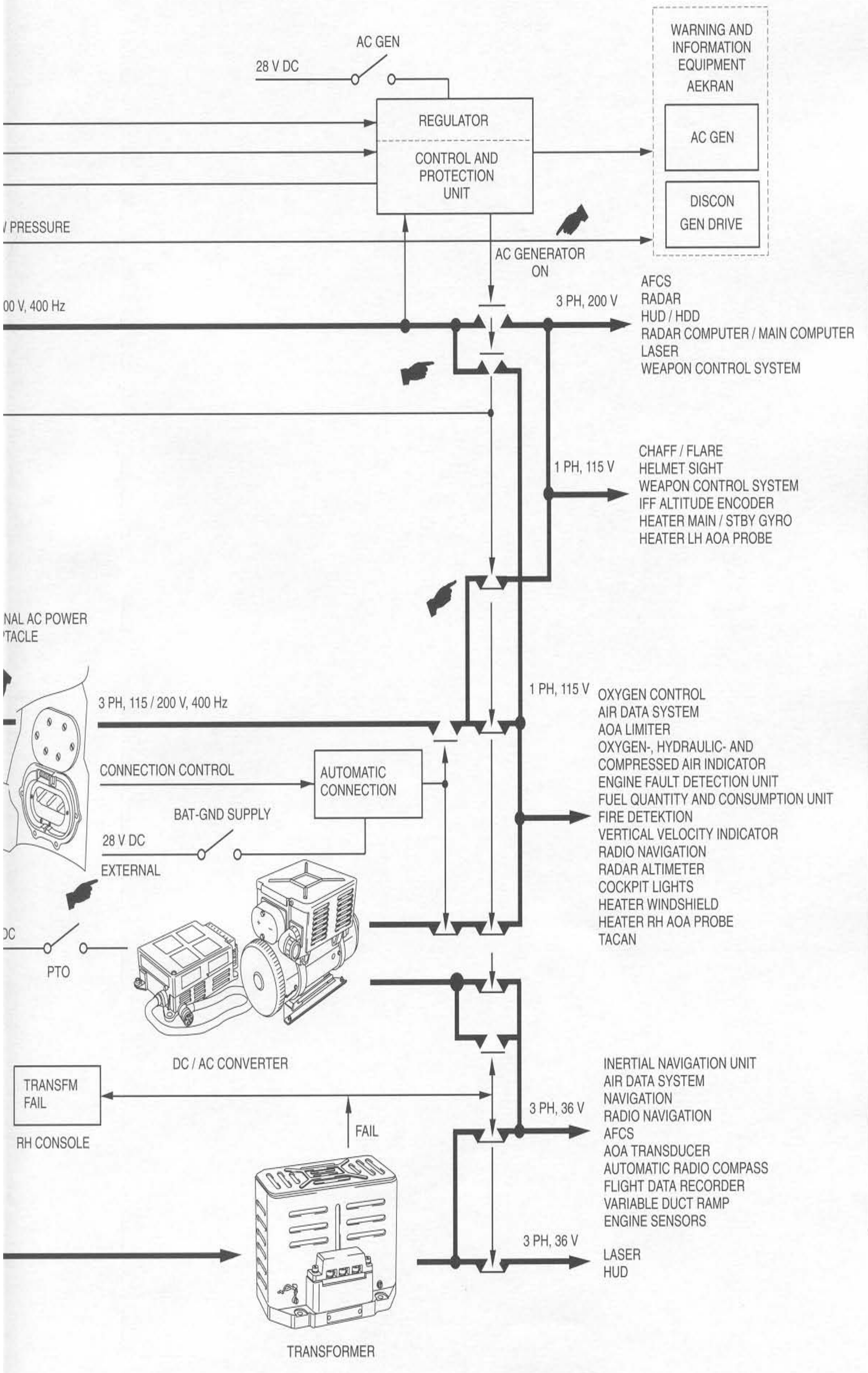
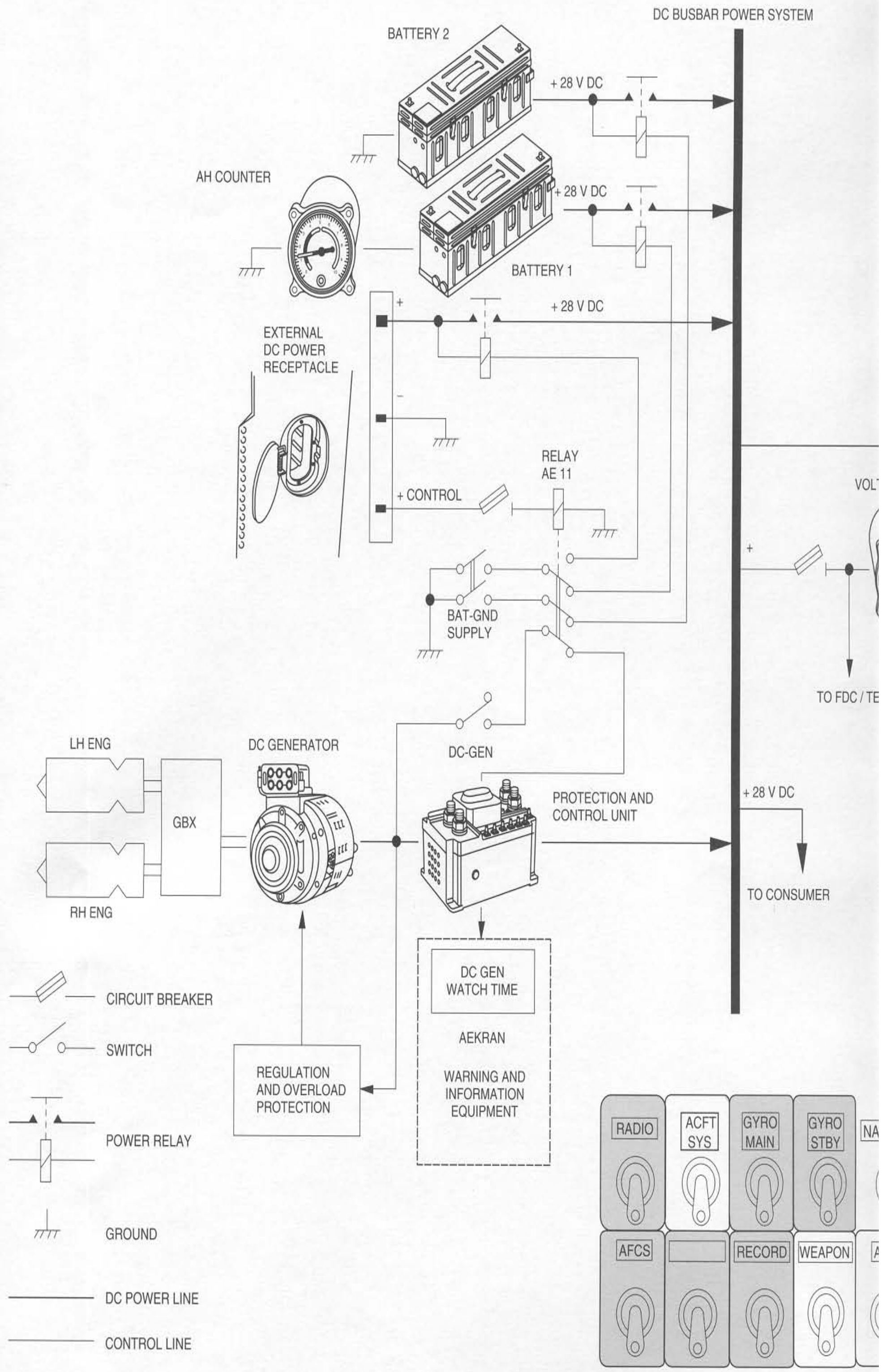


Figure FO-9


DC BUSBAR POWER SYSTEM
BATTERY 2
+ 28 V DC
AH COUNTER
+ 28 V DC
BATTERY 1
+ 28 V DC
EXTERNAL
DC POWER
RECEPTACLE
+
-
+ CONTROL
RELAY
AE 11
BAT-GND
SUPPLY
+
TO FDC / TE
DC-GEN
LH ENG
DC GENERATOR
GBX
RH ENG
PROTECTION AND
CONTROL UNIT
+ 28 V DC
TO CONSUMER
DC GEN
WATCH TIME
AEKRAN
WARNING AND
INFORMATION
EQUIPMENT
REGULATION
AND OVERLOAD
PROTECTION
CIRCUIT BREAKER
SWITCH
POWER RELAY
GROUND
DC POWER LINE
CONTROL LINE
RADIO
ACFT
SYS
GYRO
MAIN
GYRO
STBY
AFCS
RECORD
WEAPON

DC POWER SYSTEM

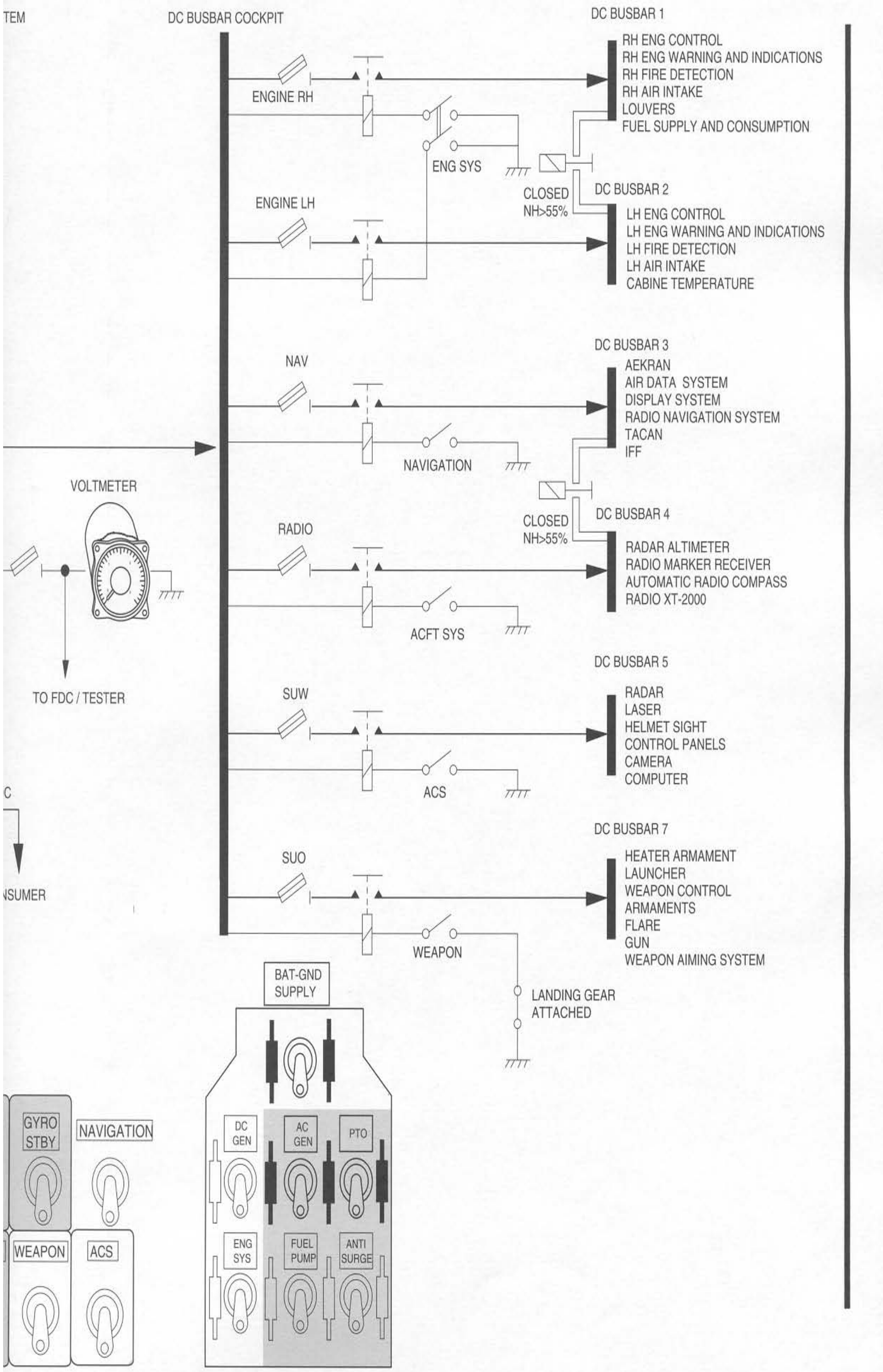
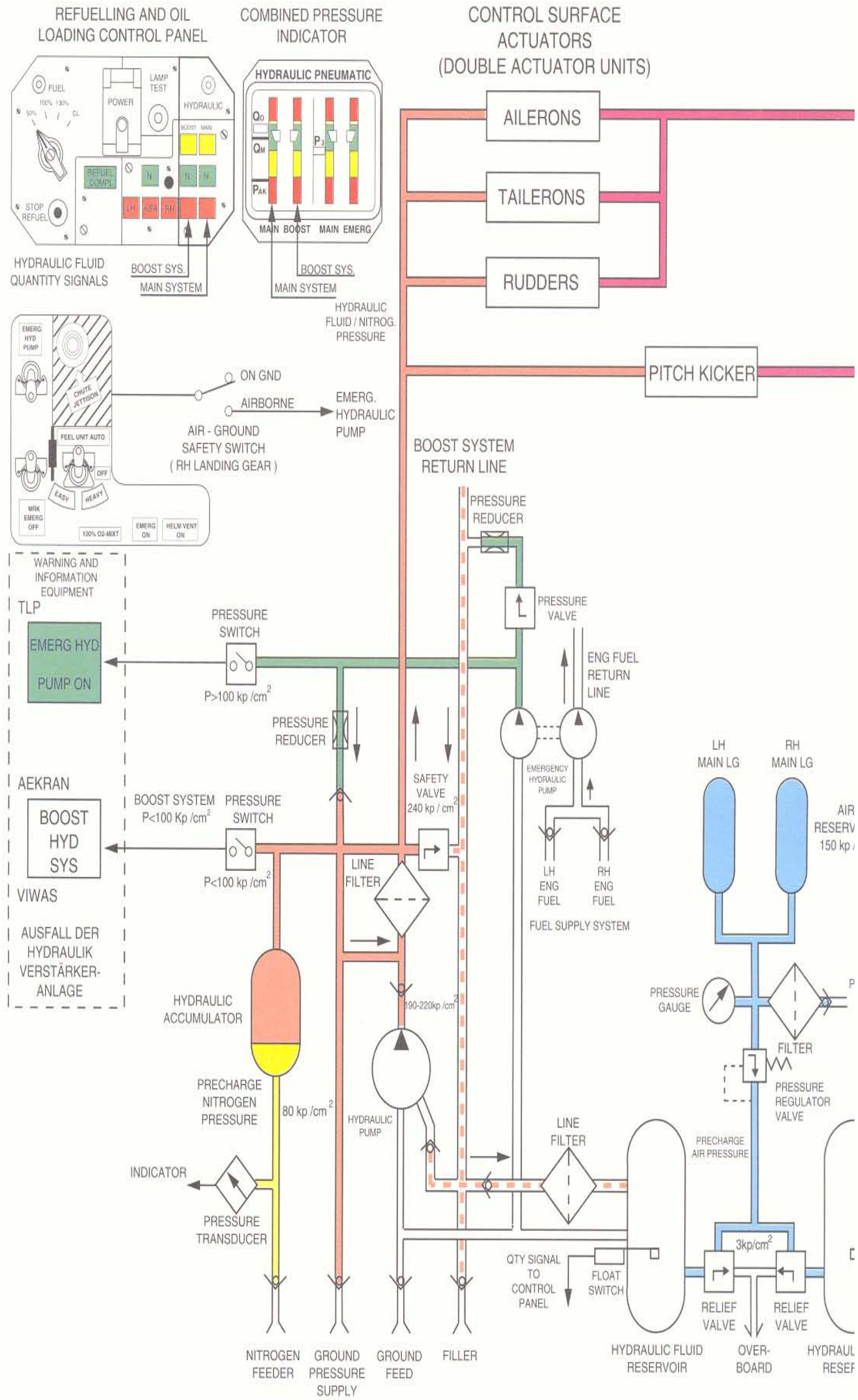


Figure FO-10



HYDRAULIC BOOST SYSTEM

HYDRAULIC POWER SYSTEM

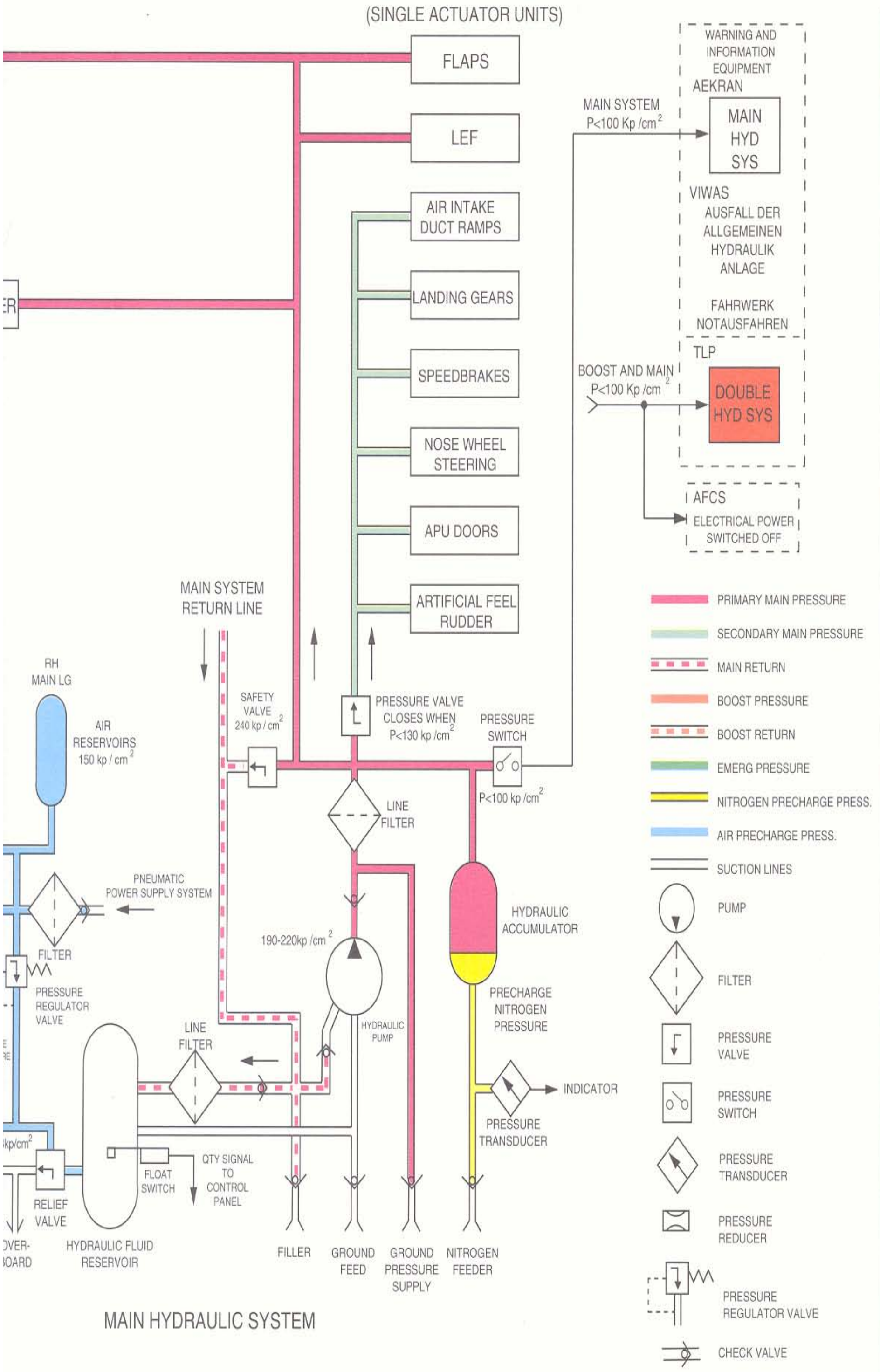
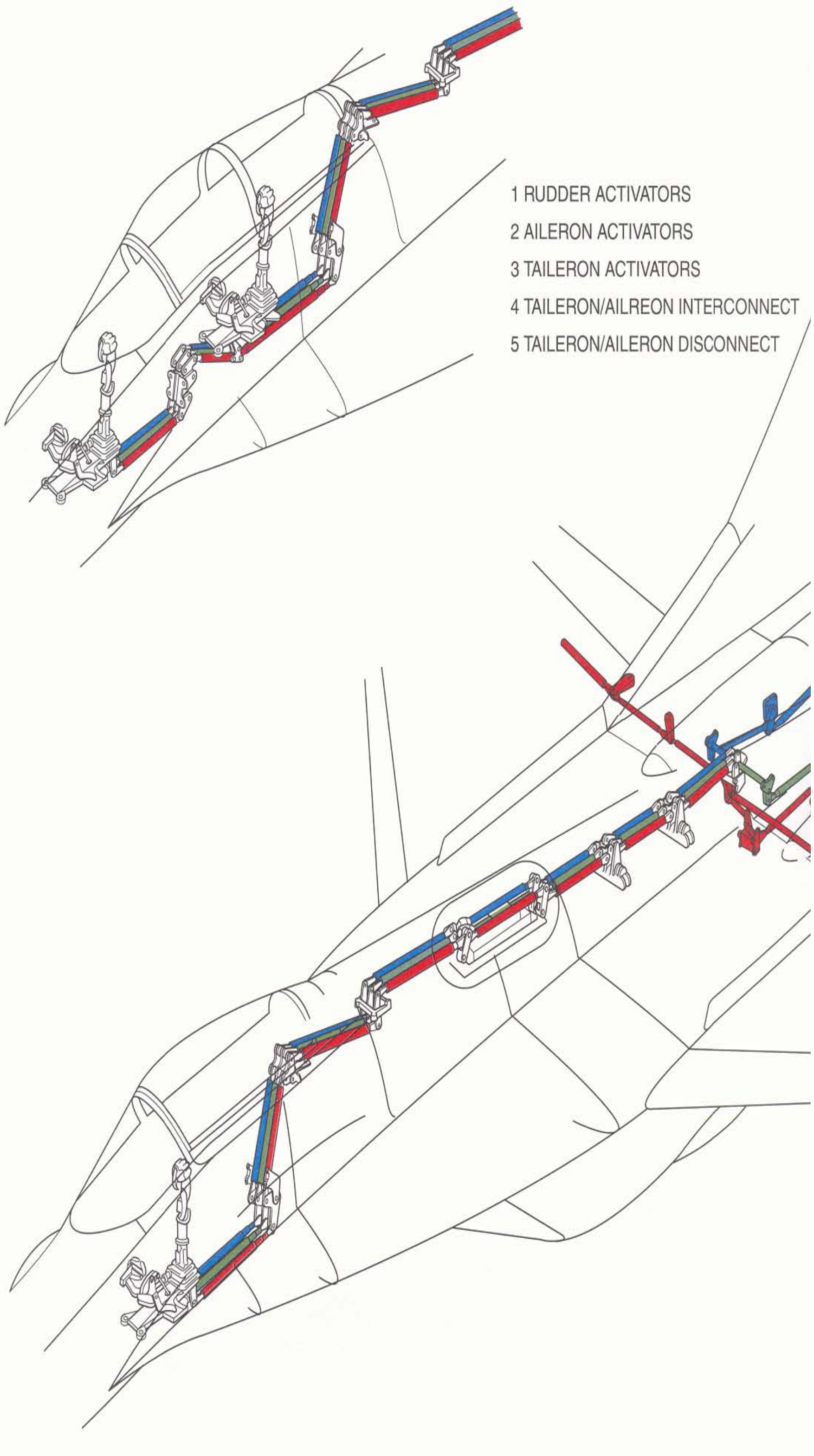


Figure FO-11


1 RUDDER ACTIVATORS
2 AILERON ACTIVATORS
3 TAILERON ACTIVATORS
4 TAILERON/AILREON INTERCONNECT
5 TAILERON/AILERON DISCONNECT

MECHANICAL FLIGHT CONTROL SYSTEM

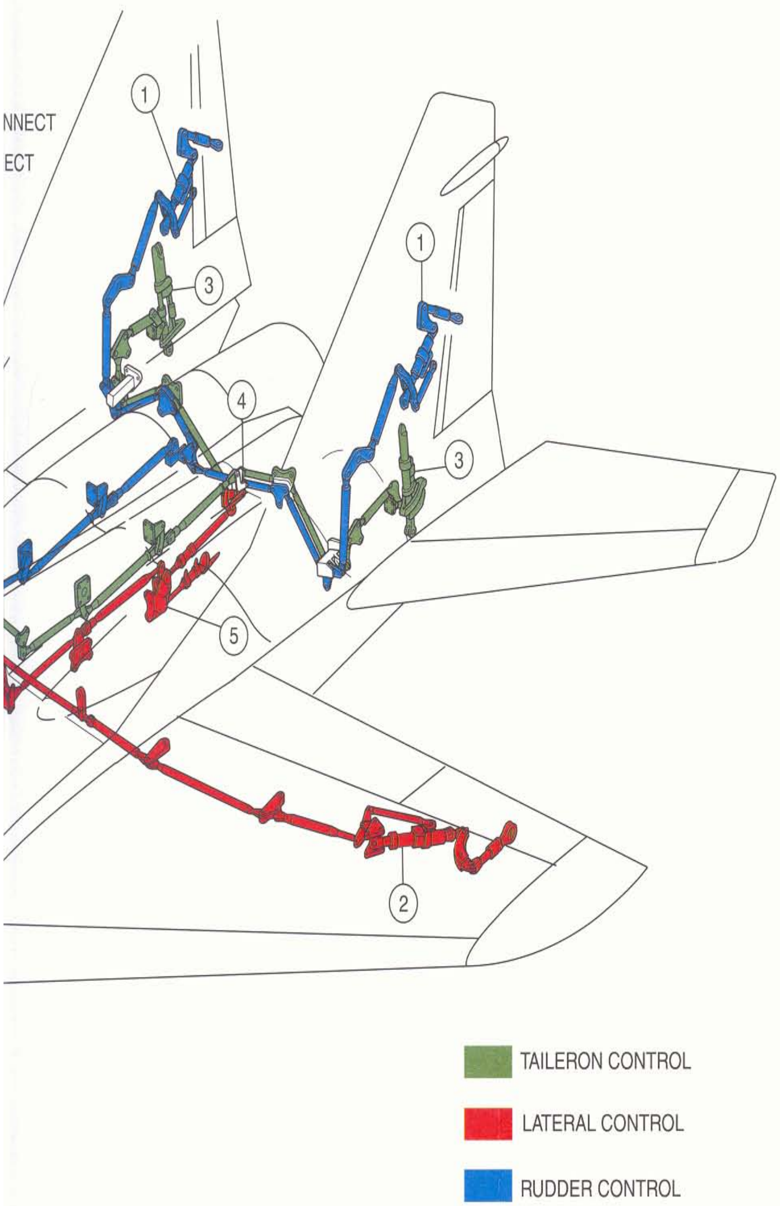
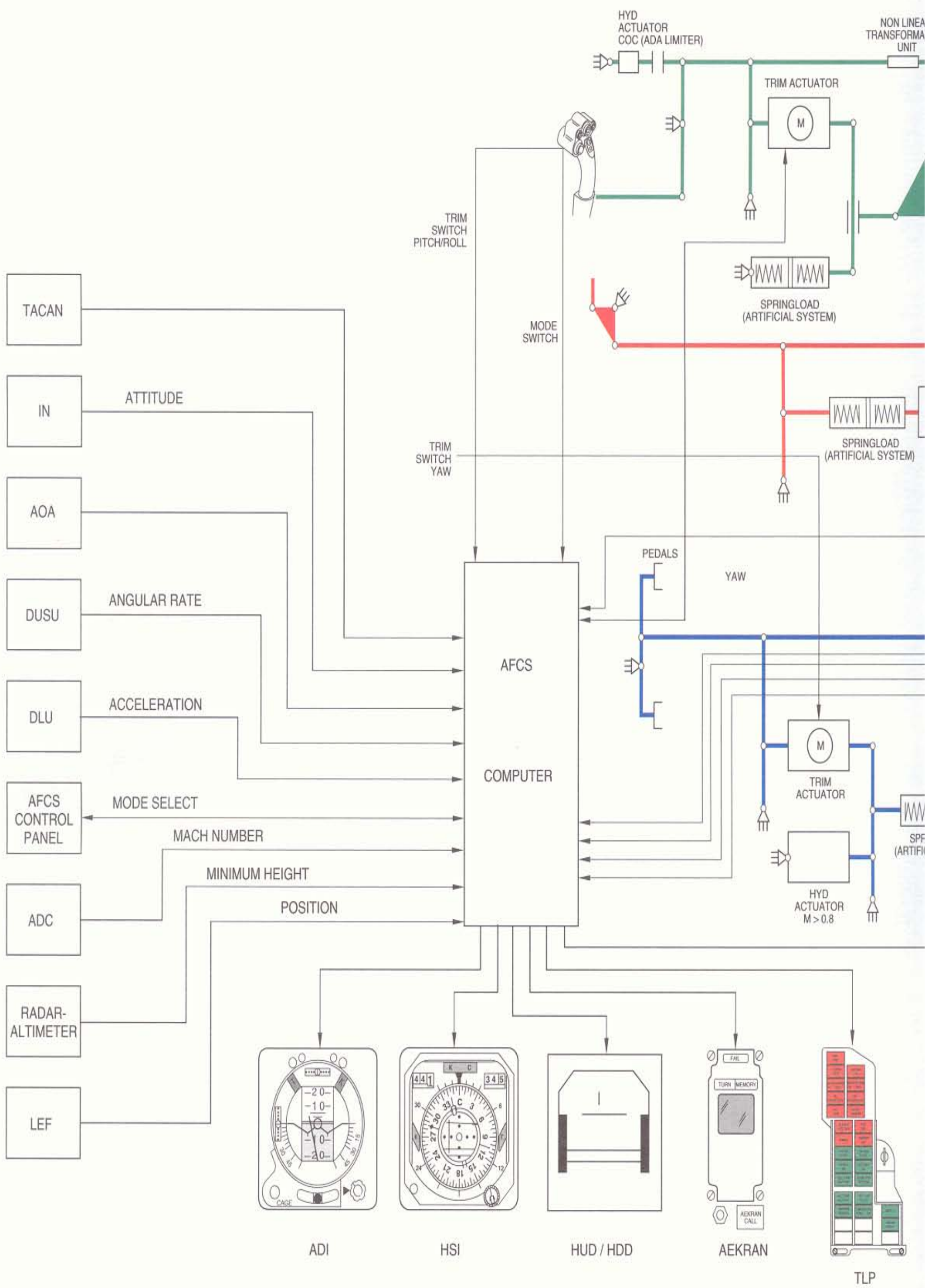
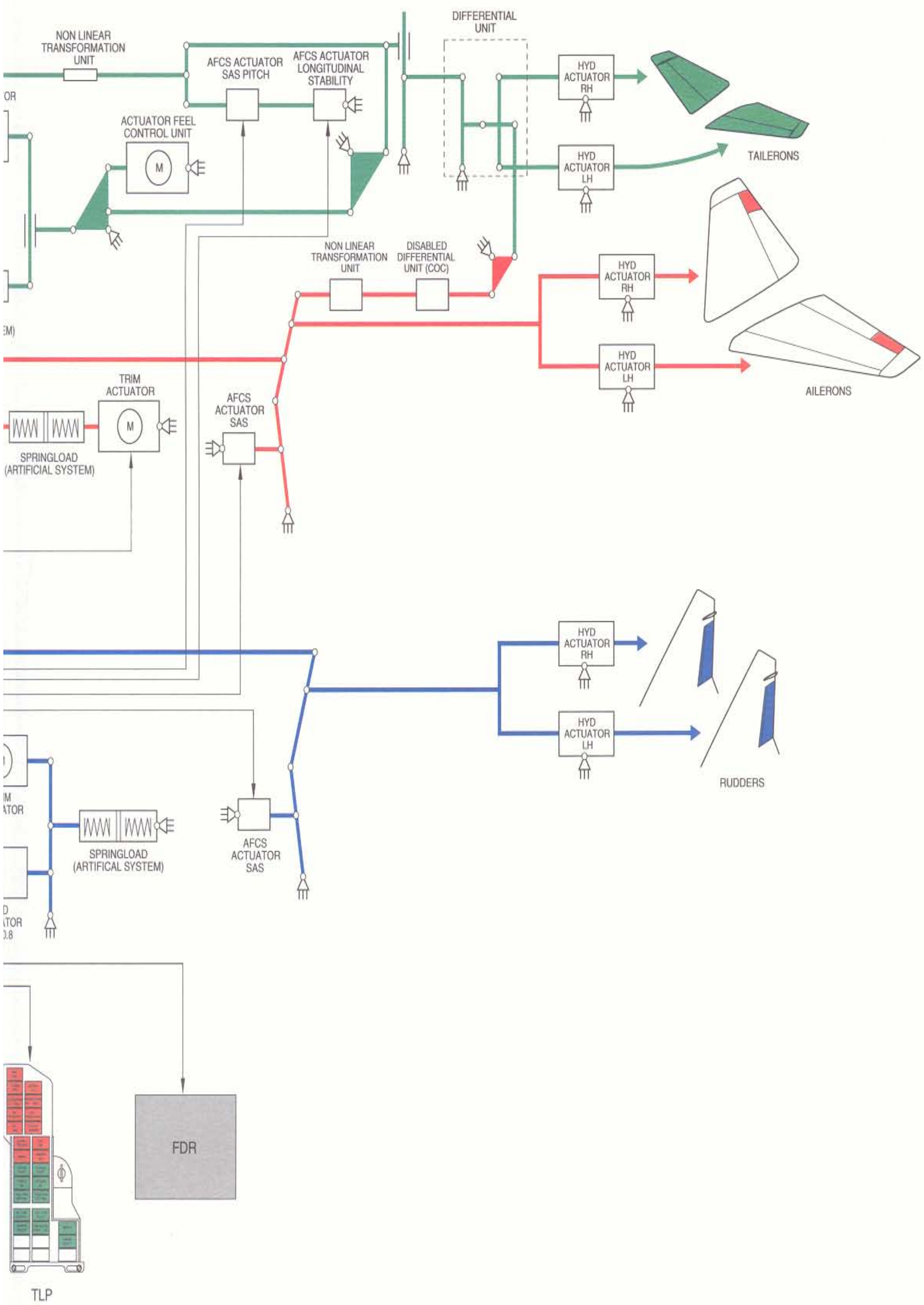


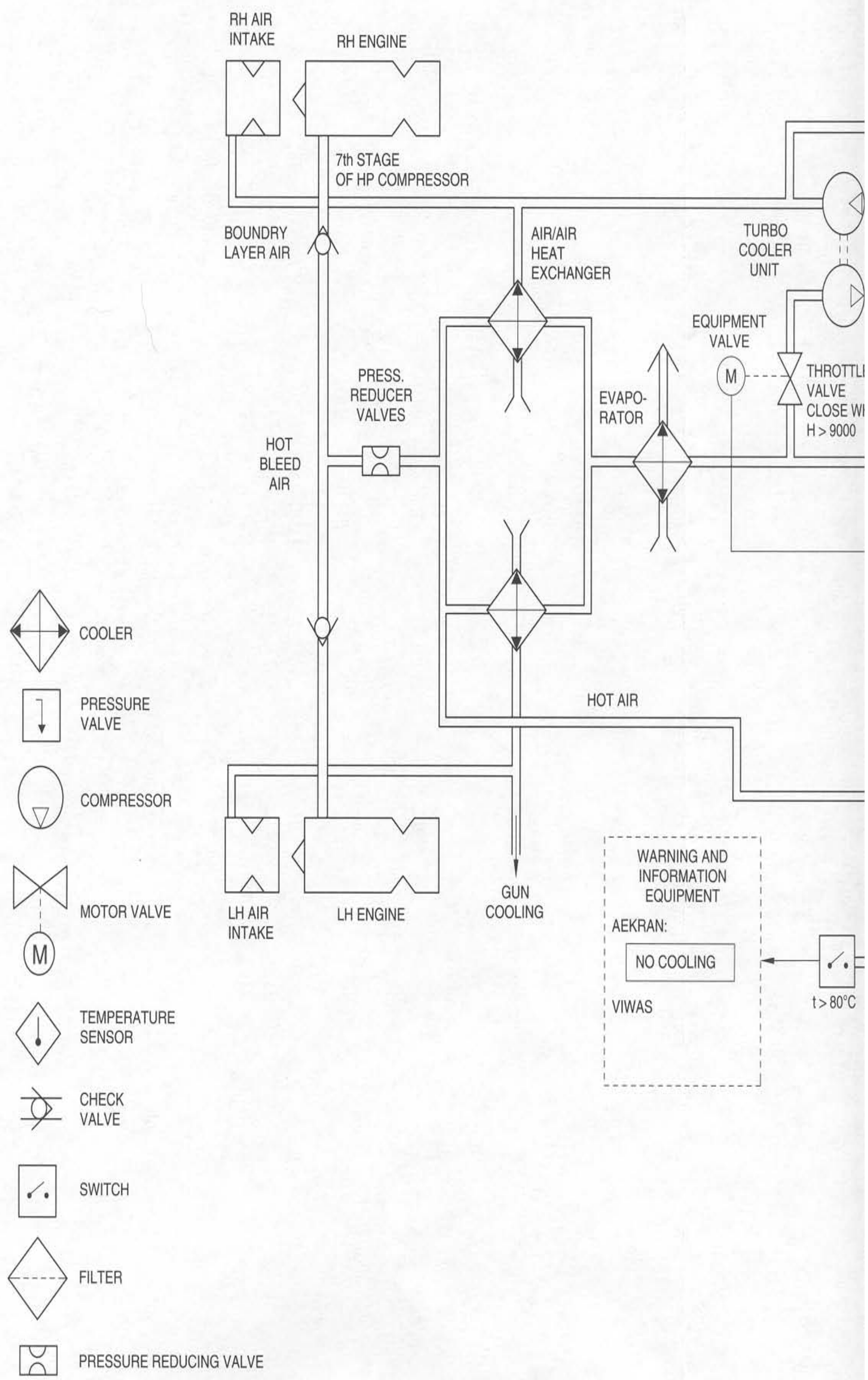
Figure FO-12

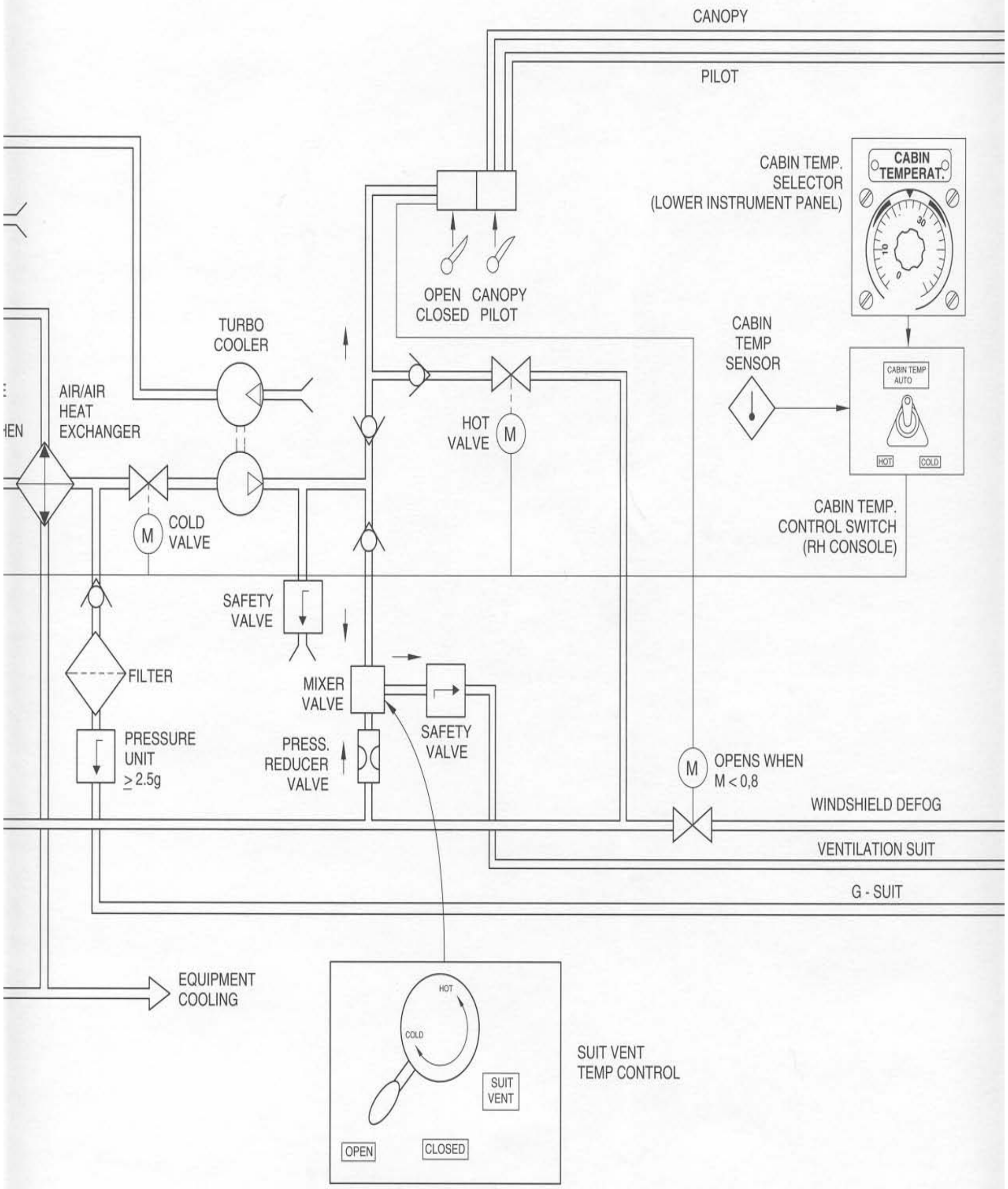


HYD
ACTUATOR
COC (ADA LIMITER)
UNIT
TRIM ACTUATOR
M
TRIM
SWITCH
PITCH/ROLL
SPRINGLOAD
(ARTIFICIAL SYSTEM)
MODE
SWITCH
TACAN
IN
ATTITUDE
AOA
SPRINGLOAD
(ARTIFICIAL SYSTEM)
TRIM
SWITCH
YAW
PEDALS
YAW
DUSU
ANGULAR RATE
DLU
ACCELERATION
AFCS
COMPUTER
TRIM
ACTUATOR
AFCS
CONTROL
PANEL
MODE SELECT
MACH NUMBER
MINIMUM HEIGHT
POSITION
ADC
HYD
ACTUATOR
M > 0.8
RADAR-
ALTIMETER
LEF
ADI
HSI
HUD / HDD
AEKRAN
TLP

AUTOMATIC FLIGHT CONTROL SYSTEM (AFCS)




RH AIR
INTAKE
RH ENGINE
7th STAGE
OF HP COMPRESSOR
BOUNDRY
LAYER AIR
AIR/AIR
HEAT
EXCHANGER
TURBO
COOLER
UNIT
EQUIPMENT
VALVE
M
THROTTL
VALVE
CLOSE W
H > 9000
PRESS.
REDUCER
VALVES
EVAPO-
RATOR
HOT
BLEED
AIR
HOT AIR
LH AIR
INTAKE
LH ENGINE
GUN
COOLING
WARNING AND
INFORMATION
EQUIPMENT
AEKRAN:
NO COOLING
VIWAS
t > 80°C
COOLER
PRESSURE
VALVE
COMPRESSOR
MOTOR VALVE
M
TEMPERATURE
SENSOR
CHECK
VALVE
SWITCH
FILTER
PRESSURE REDUCING VALVE


CANOPY
PILOT
CABIN TEMP.
SELECTOR
(LOWER INSTRUMENT PANEL)
CABIN
TEMPERAT.
TURBO
COOLER
OPEN
CLOSED
CANOPY
PILOT
CABIN
TEMP
SENSOR
CABIN TEMP
AUTO
HOT
COLD
AIR/AIR
HEAT
EXCHANGER
HOT
VALVE
COLD
VALVE
CABIN TEMP.
CONTROL SWITCH
(RH CONSOLE)
SAFETY
VALVE
FILTER
MIXER
VALVE
PRESSURE
UNIT
≥ 2.5g
PRESS.
REDUCER
VALVE
SAFETY
VALVE
OPENS WHEN
M < 0,8
WINDSHIELD DEFOG
VENTILATION SUIT
G - SUIT
EQUIPMENT
COOLING
SUIT VENT
TEMP CONTROL
HOT
COLD
SUIT
VENT
OPEN
CLOSED

AIR CONDITIONING AND PRESSURIZATION SYSTEM

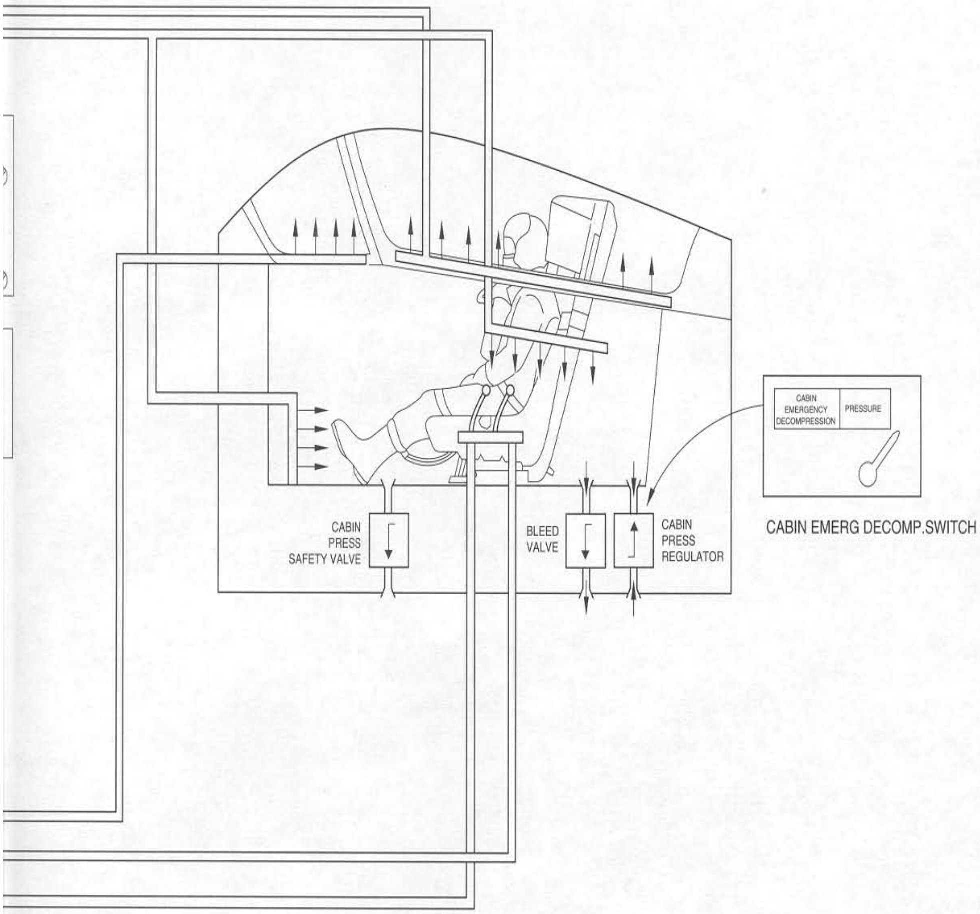
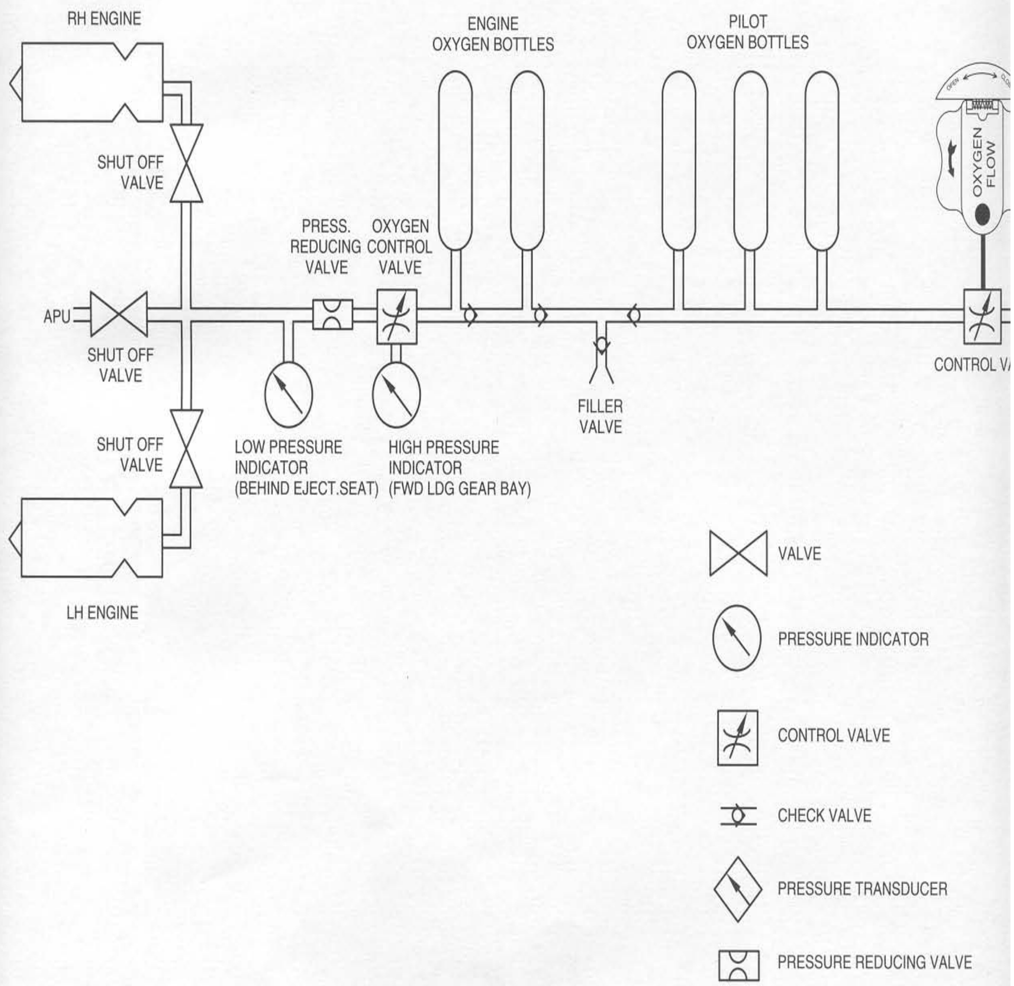


Figure FO-14


RH ENGINE
ENGINE
OXYGEN BOTTLES
PILOT
OXYGEN BOTTLES
OXYGEN
FLOW
SHUT OFF
VALVE
PRESS.
REDUCING
VALVE
OXYGEN
CONTROL
VALVE
APU
SHUT OFF
VALVE
CONTROL V
FILLER
VALVE
SHUT OFF
VALVE
LOW PRESSURE
INDICATOR
(BEHIND EJECT.SEAT)
HIGH PRESSURE
INDICATOR
(FWD LDG GEAR BAY)
LH ENGINE
VALVE
PRESSURE INDICATOR
CONTROL VALVE
CHECK VALVE
PRESSURE TRANSDUCER
PRESSURE REDUCING VALVE

OXYGEN SUPPLY SYSTEM

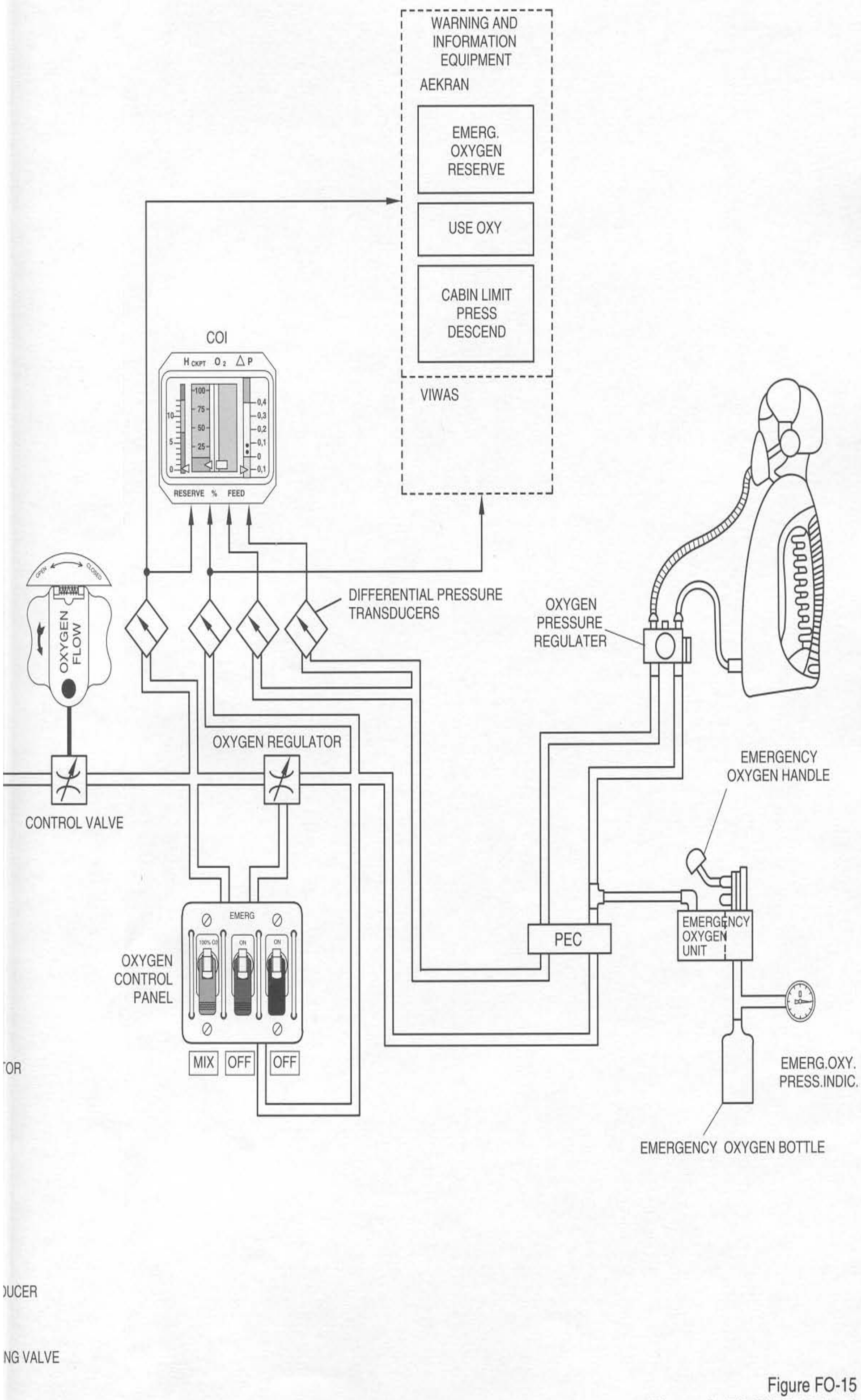
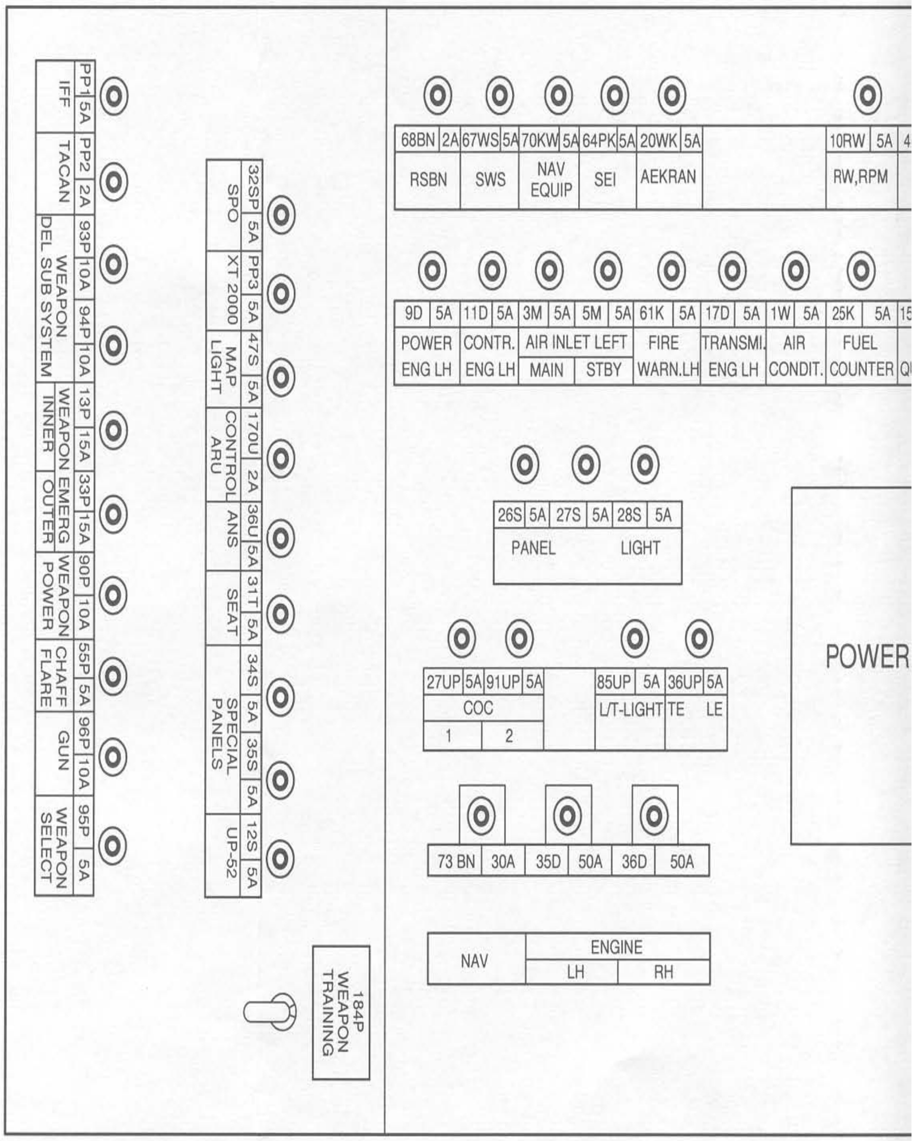
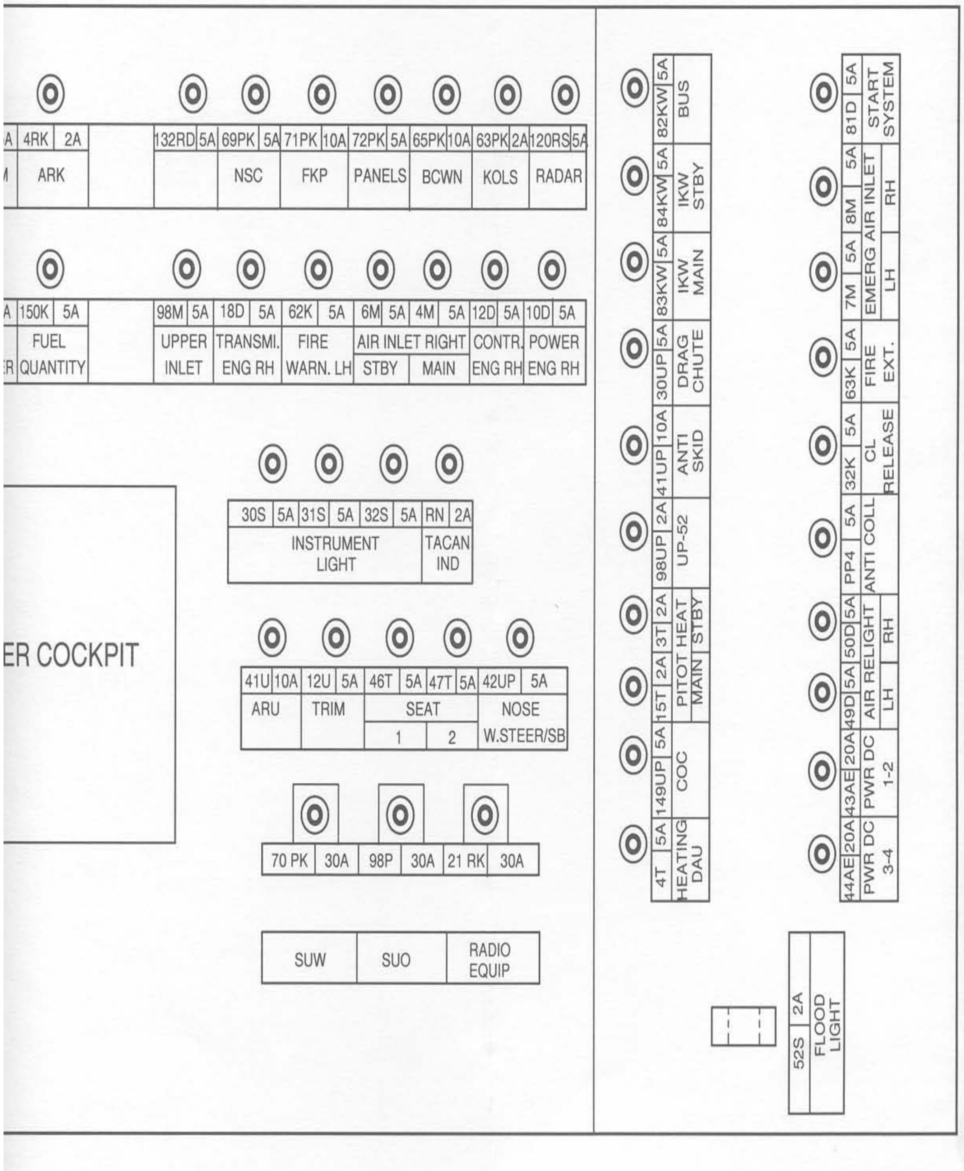
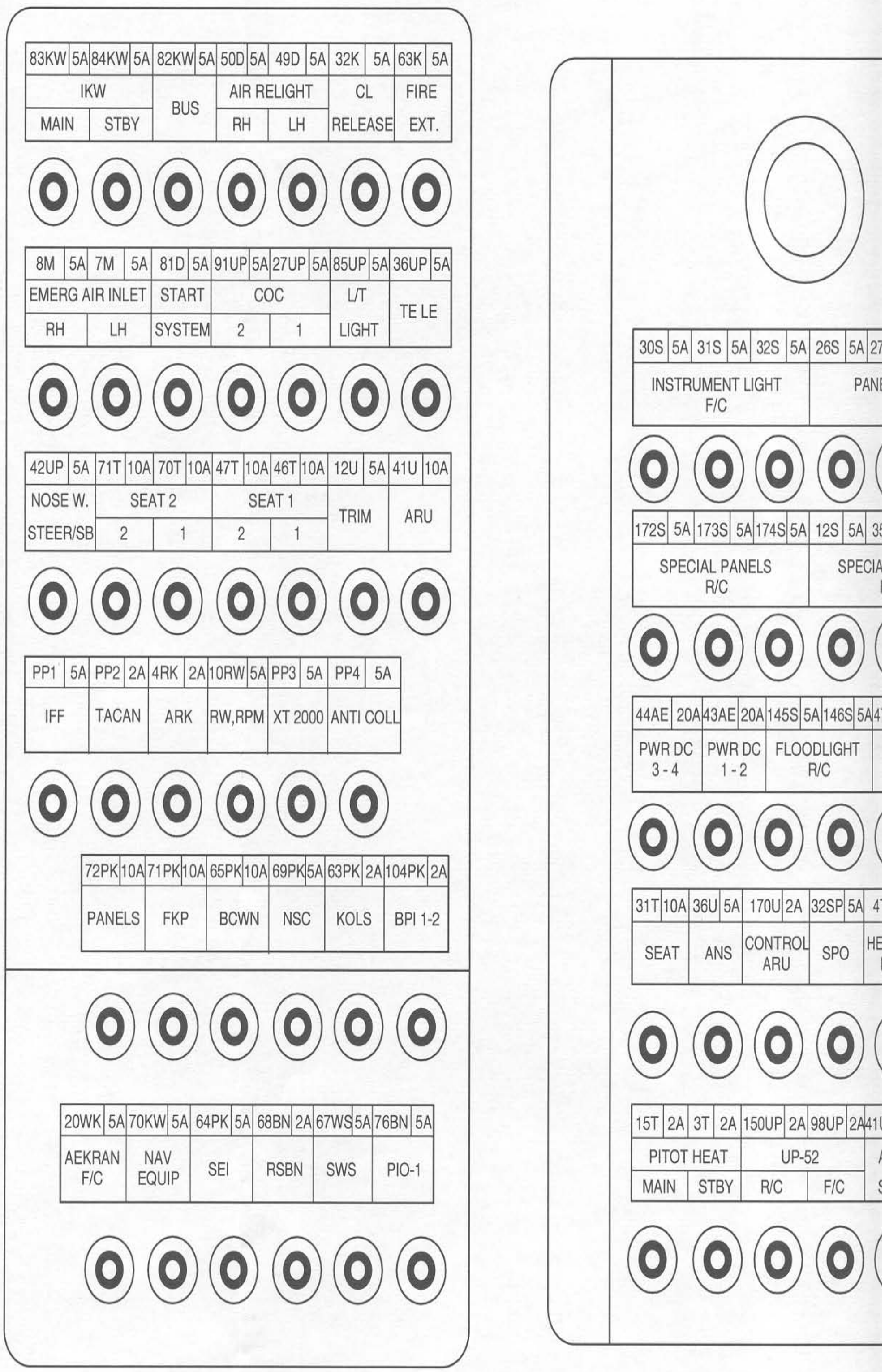


Figure FO-15


PP1 5A IFF
PP2 2A TACAN
93P 10A 94P 10A WEAPON DEL SUB SYSTEM
13P 15A WEAPON INNER
33P 15A EMERG OUTER
90P 10A WEAPON POWER
55P 5A CHAFF FLARE
96P 10A GUN
95P 5A WEAPON SELECT
32SP 5A SPO
PP3 5A XT 2000
47S 5A MAP LIGHT
170U 2A CONTROL ARU
36U 5A ANS
31T 5A SEAT
34S 5A 35S 5A SPECIAL PANELS
12S 5A UP-52
184P WEAPON TRAINING
68BN 2A RSBN
67WS 5A SWS
70KW 5A NAV EQUIP
64PK 5A SEI
20WK 5A AEKRAN
10RW 5A RW,RPM
9D 5A POWER ENG LH
11D 5A CONTR. ENG LH
3M 5A 5M 5A AIR INLET LEFT MAIN STBY
61K 5A FIRE WARN.LH
17D 5A TRANSMI. ENG LH
1W 5A AIR CONDIT.
25K 5A FUEL COUNTER
26S 5A 27S 5A 28S 5A PANEL LIGHT
27UP 5A 91UP 5A COC 1 2
85UP 5A L/T-LIGHT
36UP 5A TE LE
73 BN 30A 35D 50A 36D 50A
NAV
ENGINE LH RH
POWER

POWER DISTRIBUTION PANEL MIG-29G





83KW 5A 84KW 5A 82KW 5A 50D 5A 49D 5A 32K 5A 63K 5A
IKW
MAIN
STBY
BUS
AIR RELIGHT
RH
LH
CL
RELEASE
FIRE
EXT.
8M 5A 7M 5A 81D 5A 91UP 5A 27UP 5A 85UP 5A 36UP 5A
EMERG AIR INLET
RH
LH
START
SYSTEM
COC
2
1
L/T
LIGHT
TE LE
42UP 5A 71T 10A 70T 10A 47T 10A 46T 10A 12U 5A 41U 10A
NOSE W.
STEER/SB
SEAT 2
2
1
SEAT 1
2
1
TRIM
ARU
PP1 5A PP2 2A 4RK 2A 10RW 5A PP3 5A PP4 5A
IFF
TACAN
ARK
RW,RPM
XT 2000
ANTI COLL
72PK 10A 71PK 10A 65PK 10A 69PK 5A 63PK 2A 104PK 2A
PANELS
FKP
BCWN
NSC
KOLS
BPI 1-2
20WK 5A 70KW 5A 64PK 5A 68BN 2A 67WS 5A 76BN 5A
AEKRAN
F/C
NAV
EQUIP
SEI
RSBN
SWS
PIO-1
30S 5A 31S 5A 32S 5A 26S 5A
INSTRUMENT LIGHT
F/C
172S 5A 173S 5A 174S 5A 12S 5A
SPECIAL PANELS
R/C
44AE 20A 43AE 20A 145S 5A 146S 5A
PWR DC
3 - 4
PWR DC
1 - 2
FLOODLIGHT
R/C
31T 10A 36U 5A 170U 2A 32SP 5A
SEAT
ANS
CONTROL
ARU
SPO
15T 2A 3T 2A 150UP 2A 98UP 2A
PITOT HEAT
MAIN
STBY
UP-52
R/C
F/C

POWER DISTRIBUTION PANEL MIG-29GT

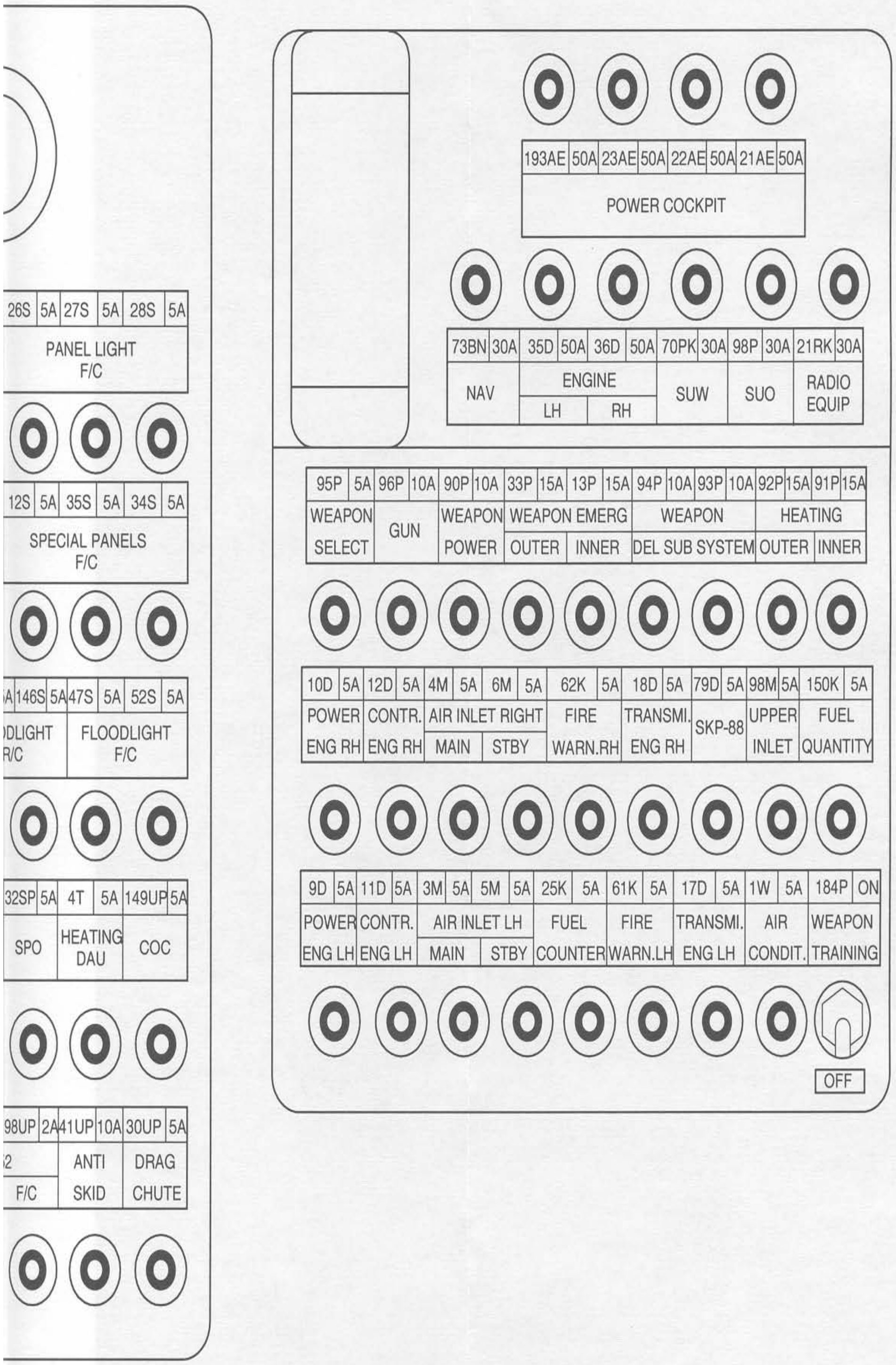
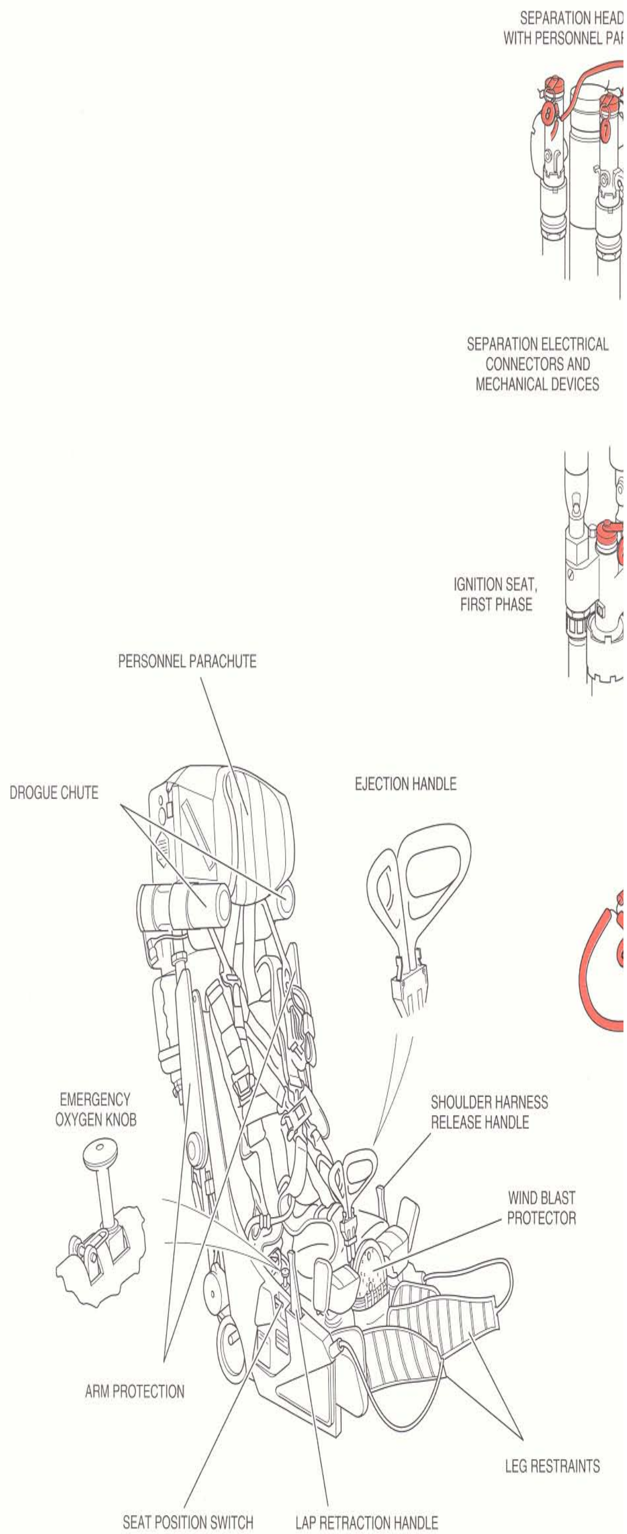
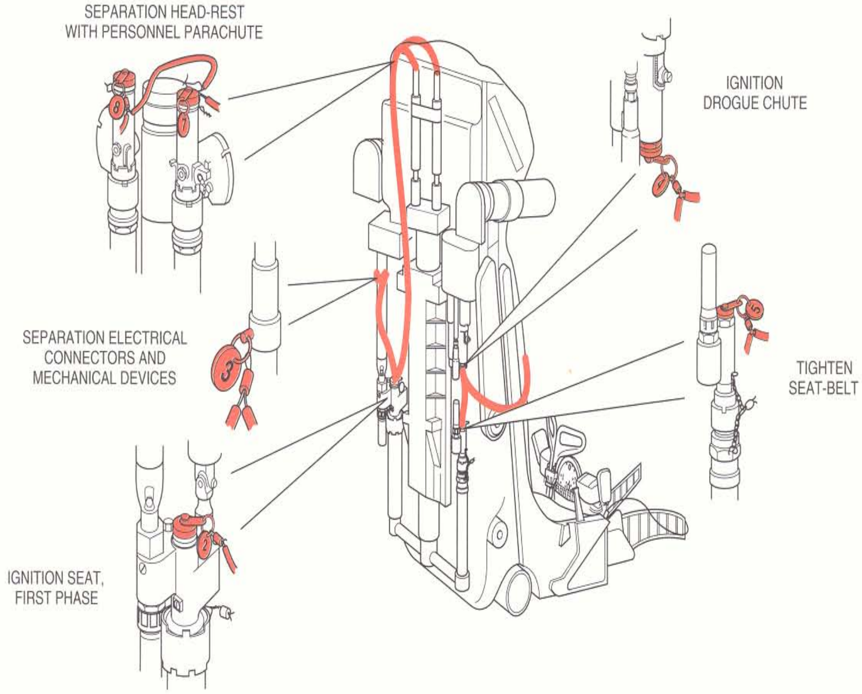
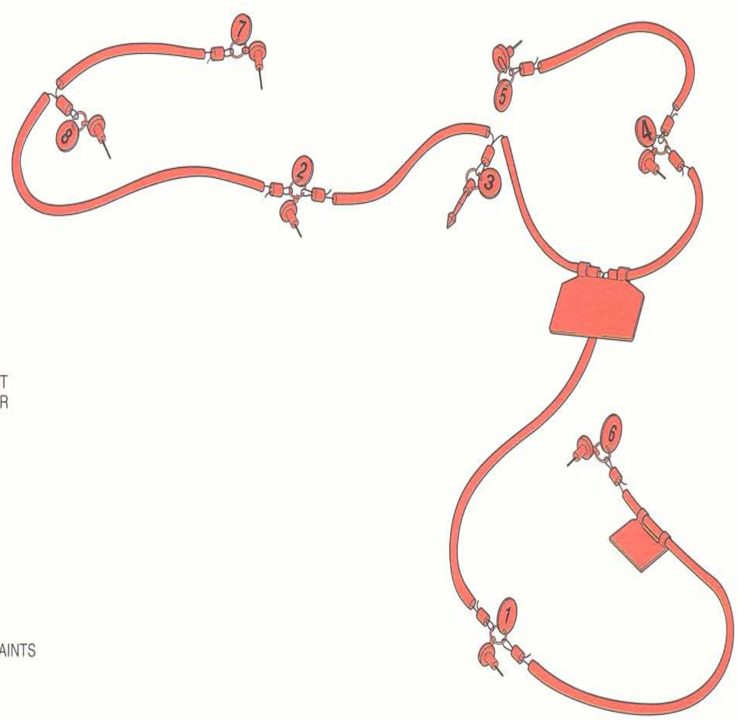


Figure FO-17


SEPARATION HEAD
WITH PERSONNEL
SEPARATION ELECTRICAL
CONNECTORS AND
MECHANICAL DEVICES
IGNITION SEAT,
FIRST PHASE
PERSONNEL PARACHUTE
DROGUE CHUTE
EJECTION HANDLE
EMERGENCY
OXYGEN KNOB
SHOULDER HARNESS
RELEASE HANDLE
WIND BLAST
PROTECTOR
ARM PROTECTION
LEG RESTRAINTS
SEAT POSITION SWITCH
LAP RETRACTION HANDLE


SEPARATION HEAD-REST
WITH PERSONNEL PARACHUTE
IGNITION
DROGUE CHUTE
SEPARATION ELECTRICAL
CONNECTORS AND
MECHANICAL DEVICES
TIGHTEN
SEAT-BELT
IGNITION SEAT,
FIRST PHASE


NDLE
SHOULDER HARNESS
RELEASE HANDLE
WIND BLAST
PROTECTOR
LEG RESTRAINTS
LE


7
8
2
3
5
4
6
1

EJECTION SEAT

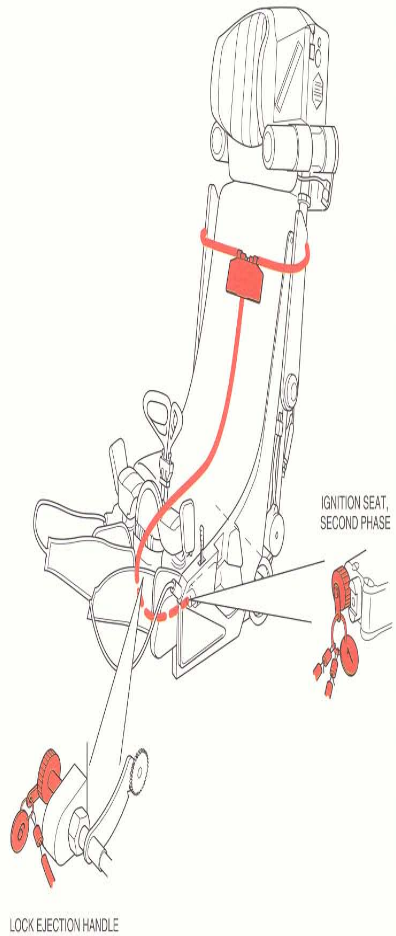


Figure FO-18