Trainer Aircraft Upgrades and Modifications

Overview and New Approach

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Outline

- Operational Needs of Air Forces
- Installation and Integration of Aircraft Systems
- Aircraft Upgrades: The PC-9M as a Case Study
  - Advanced Avionics
  - Navigation Systems
  - Cockpit Arrangement
  - Stores Adaptation and Management Systems
- Flight Tests
- The Future of Upgrades

Operational Needs of Air Forces

- Air To Air Capability
- Ground Support Capability
- Operation In Dense Threats Environment
- Low Level Penetration Capability

Platform Requirements

- Simulate Modern Fighter Aircraft Characteristics
- Simulate Modern Advanced Fighter Cockpit :

  - **Environment**
  - **Avionics**
  - **Communication**
  - **Armament**
  - **Sensors**
  - **Workload**

To Enable Transfer of Skills
From the Training Environment to the
Front Line Aircraft

- Low Cost Affordable Platform

The Solution

OPERATIONAL REQ. + **PLATFORM REQ.** =

Fully Aerobatic Aircraft
With Armament Training and Stores Management Capabilities
With Advanced Avionics, Navigation and Communication Systems
With Self Defense System
With Advanced Cockpit Arrangement

For

Less Handling Skills and more Systems and Weapon Operations
All Incorporated on Low Cost Turboprop Aircraft
for both Preliminary and Advanced Training

Installation and Integration of

Aircraft Systems

Installation and Integration of Aircraft Systems

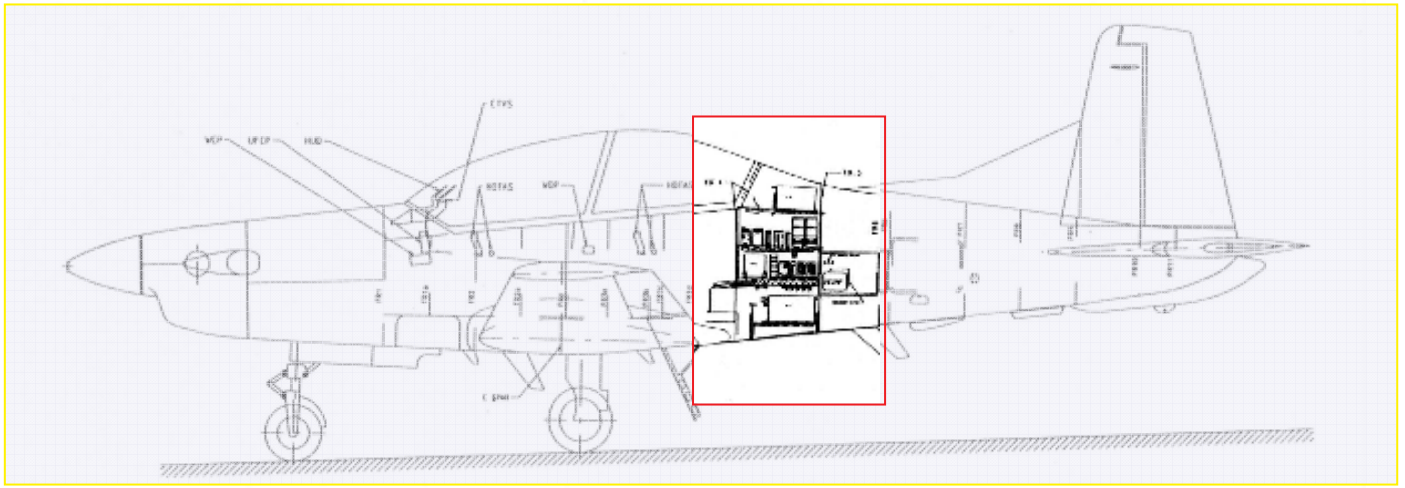
Involves :

- Airframe Modification
- Structure Analysis & Tests
- Environmental Analysis &Tests
- Systems Installation & Integration
- Stores Adaptation
- Certification

Airframe Modification

AVIONIC BAY ARRANGMENT

- A.I.U. - ARMAMENT INTERFACE UNIT
- MFD - ELECTRONIC UNIT (OPTIONAL)
- RA - RADER ALTIMETER KRA-405B
- VHF/UHF - XCVER, BOFORS 345-3 MODE 1
- VHF2 - CCVER KTR 908-02
- TACAN - KTU 709
- DIGITAL/DIGITAL CONV. - KDA689
- EFIS SYMBOL GENER. - SG 465 (TWO UNITS)
- INS/GPS - LN 100 LITTON
- XPNDR - MST67A
- AIR DATA COMP. (ADC) - KDC 481T
- ADF - KDF 806M
- NAV1 - KNR 634-10
- NAV2 - KNR 634-10
- MISSON COMPUTER - FV2000E (FV)

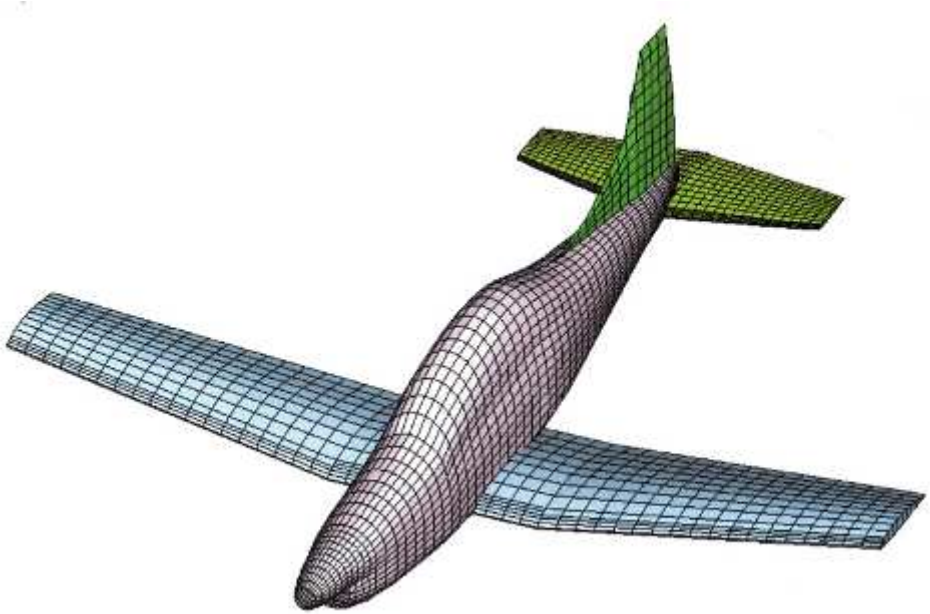


Environmental Analysis & Tests

- **ALL THE EQUIPMENT TESTED FOR ENVIRONMENTAL CONDITIONS**
  - **VIBRATIONS**
  - **MECHANICAL SHOCK**
  - **ACCELERATION LOADS**
  - **TEMPERATURE CONDITIONS**
  - **HUMIDITY**
  - **EMI / RFI**
- **TO COMPLY WITH MIL-STD-810E REQUIREMENTS.**

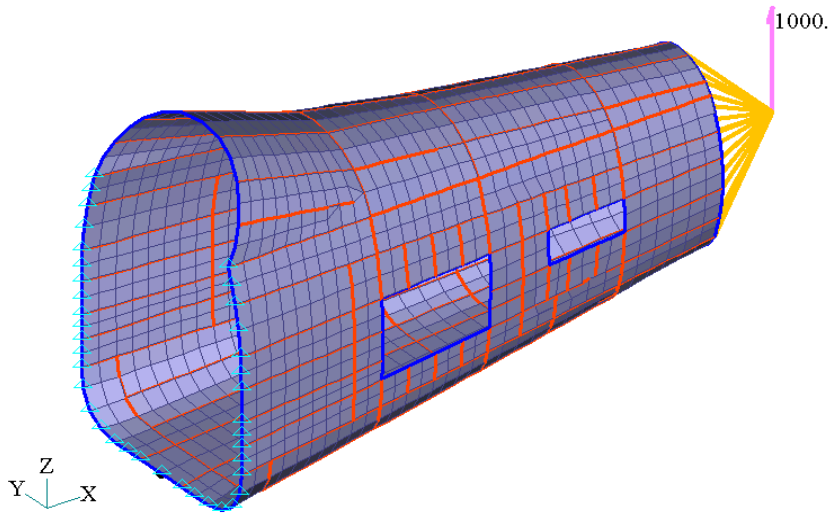
Structural Analysis

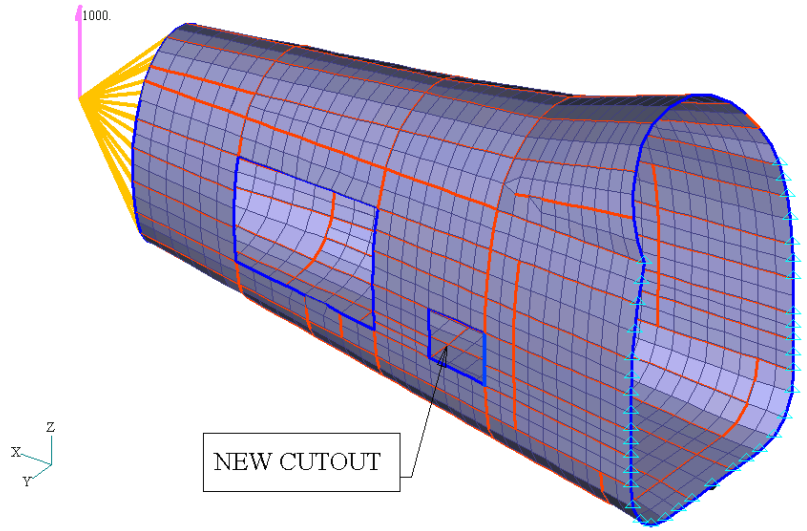
- **FINITE ELEMETS MODEL FOR COMPLETE AIRCRAFT**
- **FINITE ELEMENTS ANALYSIS OF ALL CRITICAL ELEMENTS, SUCH AS:**
  - **'INS/GPS' INSTALLATIOI**
  - **CHAFF AND FLARE INST**
  - **TRAINING MISSILE INST**



Stress Analysis.

AFT FUSELAGE – AVIONICS BAY
FINITE ELEMENT MODEL PRESENTATION.

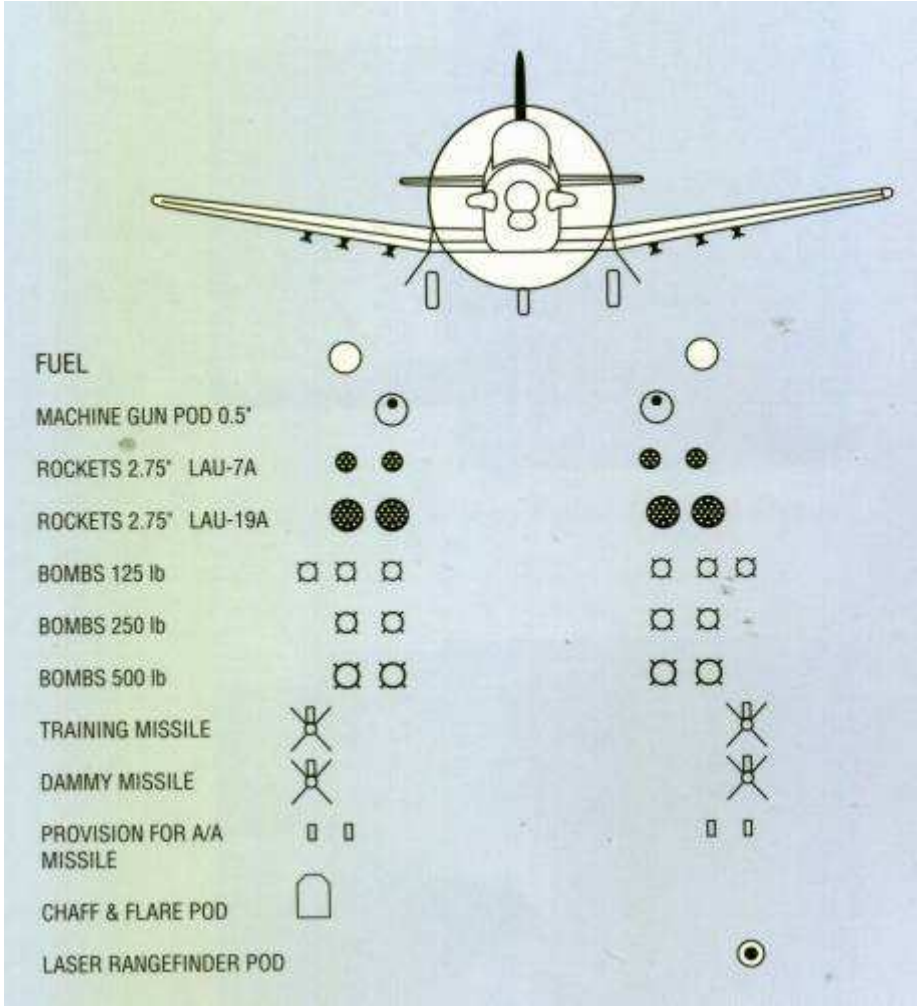




F.E.MODEL : BEFORE MODIFICATION.

F.E.MODEL : MODEFIED STRUCTURE .

Stores Adaptation



Aircraft Upgrades: The PC-9M

as a Case Study

Advanced Avionics

- Head Up Display (HUD)
- Up Front Control Panel (UFCP)
- Electronic Engine Display
- Air Data Computer
- Mission & Display Computer
- Hands on Throttle and Stick (HOTAS)
- Flight Data Recorder (FDR)
- Video Tape Recorder (VCR)
- INS / GPS Navigation System
- VOR / ILS / DME
- Stores Management System (SMS)
- UHF / VHF Communication System
- Radar Altimeter
- Intercom

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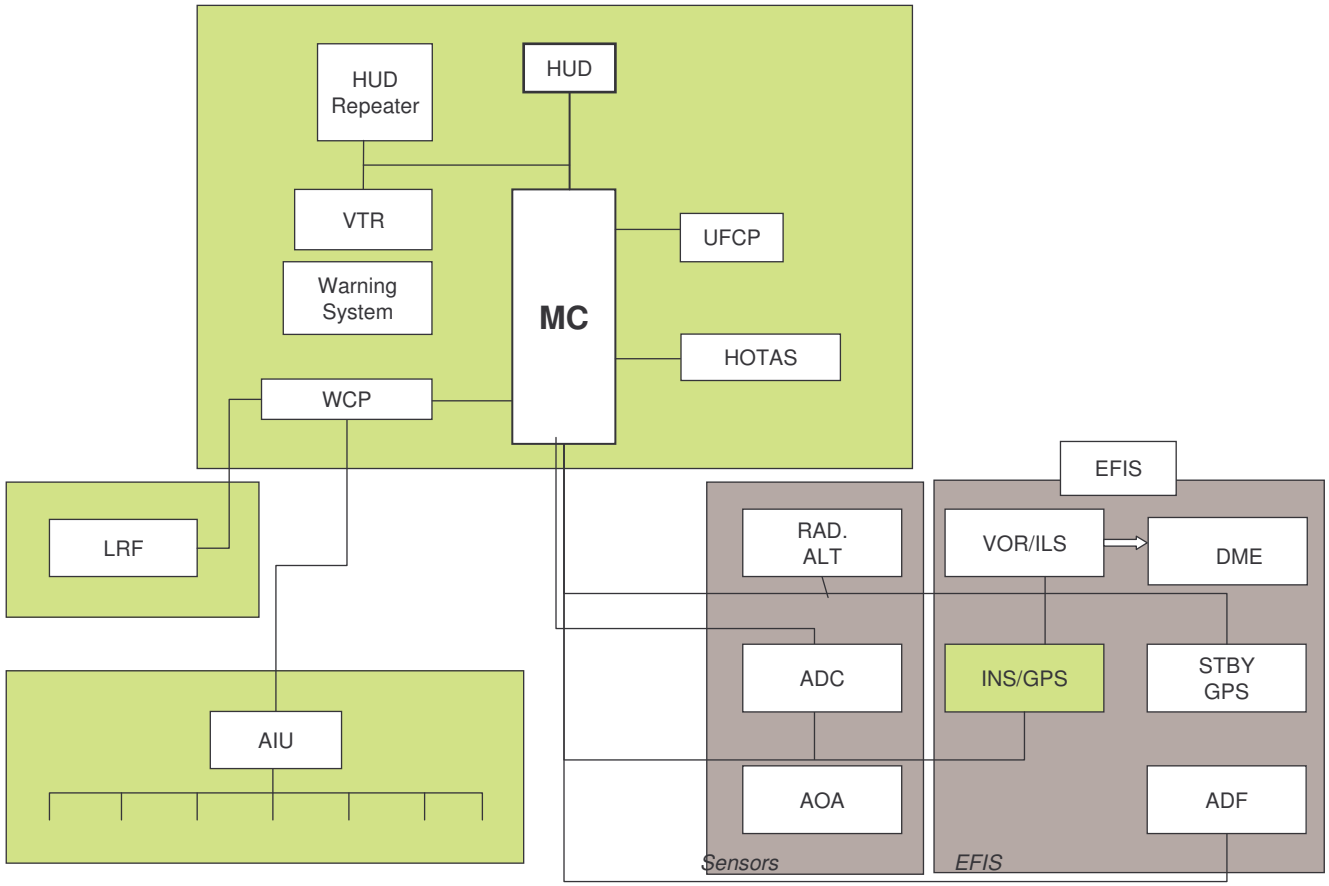
HUD

Mission & Display Computer

UFCP

AAP

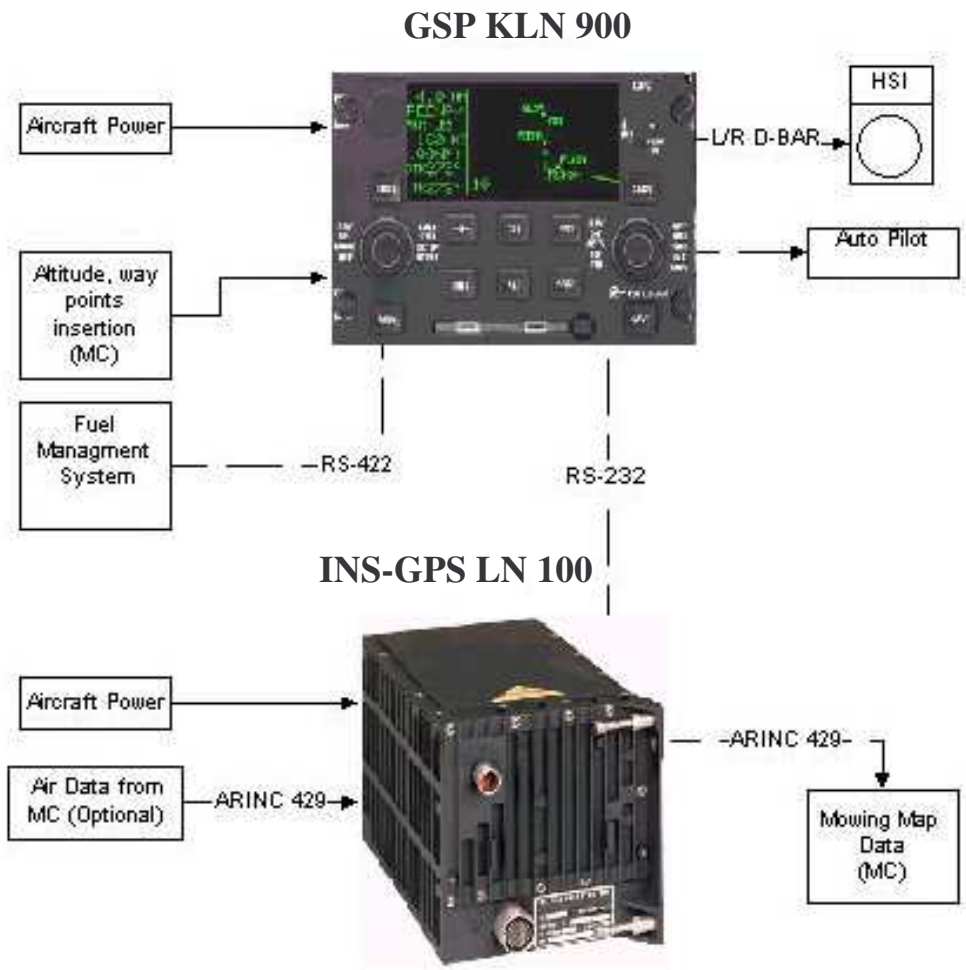
System Architecture



Navigation Systems

- **INS / GPS Navigation System**
- **VOR / ILS / DME / TACAN**
- **Back -Up GPS**

Navigation System



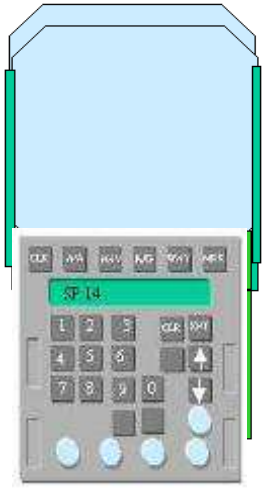
Cockpit Arrangement

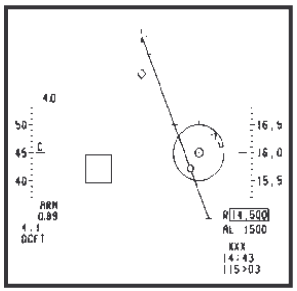
Before Upgrading

After Upgrading

Integrated Cockpit Management

- A Single Button Operation
- HOTAS Control
- Weapons and Display pre-sets
- RADAR/RWR Simulation (OPTIONAL)

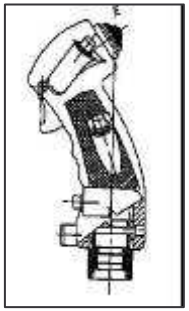


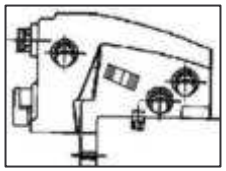


AA Mode

A/G Mode

NAV Mode

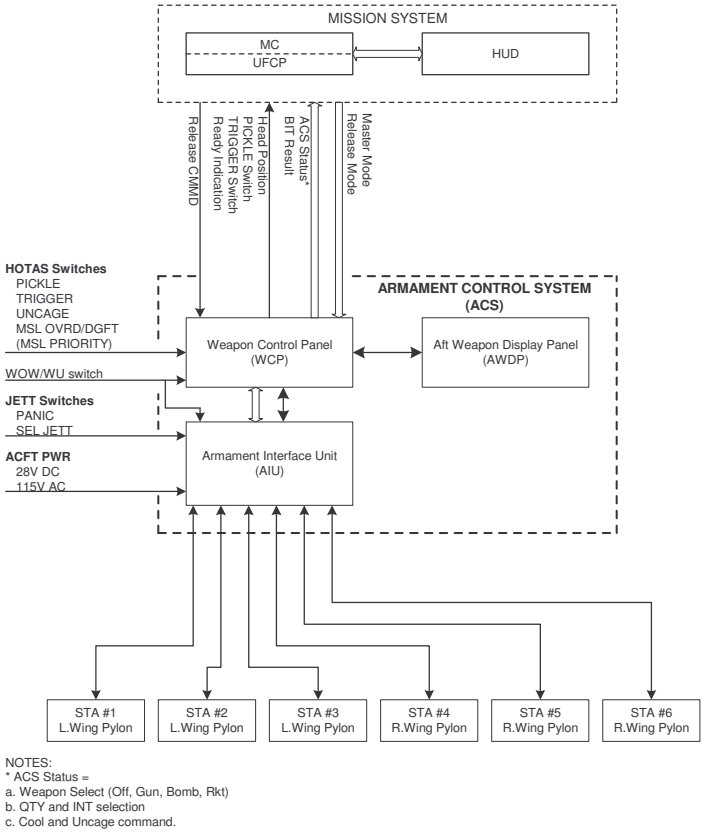




Stores Adaptation and Management Systems

Stores Management System – Main Components

BLOCK DIAGRAM



NOTES:
* ACS Status =
a. Weapon Select (Off, Gun, Bomb, Rkt)
b. QTY and INT selection
c. Cool and Uncage command.

- Weapon Control Panel (WCP).
- Aft Weapon Display Panel (AWDP).
- Armament Interface Unit (AIU).

WCP

SMS MAIN TASKS

- Weapon Delivery.
- Weapon select: armament station select, weapon type select, quantity of stores to release etc.
- Air to Air missile control: power supply, cool and uncage command.
- Gun control: fire signal, automatic and manual recocking, burst limit etc.
- Display and indication: presence of stores, station READY, guns' remaining rounds etc.

•Armament safety provisions:

W.O.W. and W.U, M/A switches, SAFE mode etc.

•Emergency jettison of loaded weapon on stores.

Weapon System Training

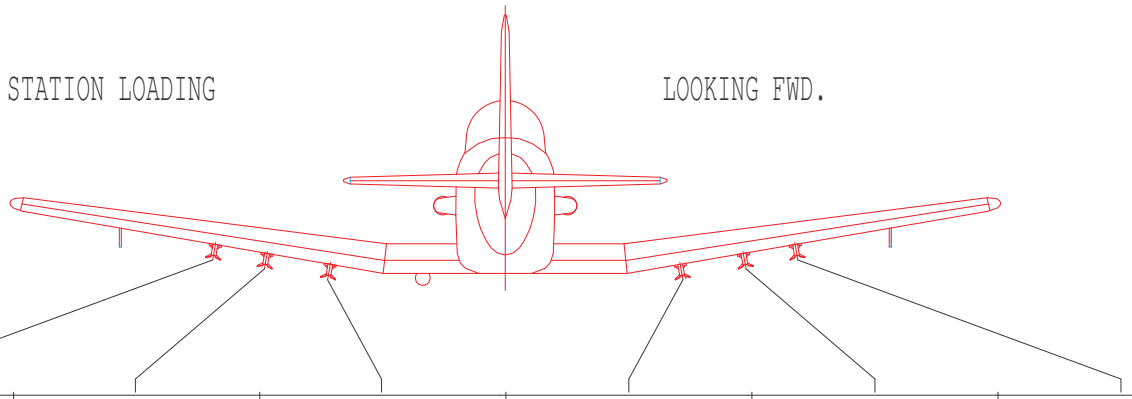
- Emulated and actual weapon delivery capabilities
- Six wing stores allowing large variety of carriage and delivery capabilities:
  - –Single and triple stores carriage on wing stations
  - –All bombs delivery modes: CCIP, delayed CCIP, CCRP, DTOS
  - –Guns and rockets carriage and delivery modes
  - –Pods carriage (LRF, CFD, emulated A/A missile)
- Store Management System (SMS) allowing stores recognition and handling

EXTERNAL STORES
TRAINING CONFIGURATION

DESCRIPTION	SYMBOLS	WEIGHT [KG]
BOMB RACK TYPE P65 (INCLUDING 3 BL-5 BOMBS)		190
0.5" GUN POD		116
ROCKET LAUNCHERS LAU-7A		91.1
LASER RANGEFINDER		50
TRAINING MISSILE / DUMMY MISSILE		50
FUEL (160 LITTERT)		153

NOTE: STATION LOADING 1 & 6 CAN CARRY TRAINING MISSILE (TM) OR DUMMY MISSILE (DM)
OR LASER RANGEFINDER (LF) WITH ALL CONFIGURATION.

TRAINING CONFIGURATION



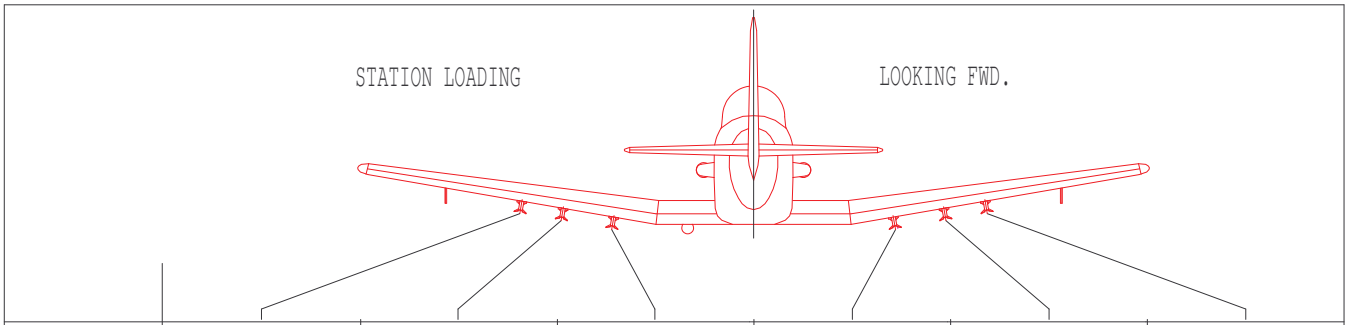
CONF.	1	2	3	4	5	6
1	TM	—	—	—	—	LF
2	TM	—			—	LF
3	TM	—			—	LF
4	TM	—			—	LF
5	TM	F160	—	—	F160	LF
6	TM					LF
7	TM					LF

EXTERNAL STORES
ADVANCED TRAINING/COMBAT CONFIGURATION

DESCRIPTION	SYMBOLS	WEIGHT [KG]
ROCKET LAUNCHERS LAU-19A		238.7
CLUSTER BOMBS ATAP-300		230
BOMBS MK 82 (250 Kg)		250
BOMBS MK 81 (125 KG)		125
LASER RANGEFINDER		50
TRAINING MISSILE / DUMMY MISSILE		50
FUEL (160 LITTERT)		153

NOTE: STATION LOADING 1 & 6 CAN CARRY TRAINING MISSILE (TM) OR DUMMY MISSILE (DM)
OR LASER RANGEFINDER (LF) WITH ALL CONFIGURATION.

COMBAT CONFIGURATION



CONF.	1	2	3	4	5	6
1	TM	F160			F160	LF
2	TM	125	125	125	125	LF
3	TM	F160			F160	LF
4	TM	F160			F160	LF
5	TM	F160	250	125	F160	LF
6	TM	——	250	250	——	LF
7	TM	F160	250	250	F160	LF
8	TM	——			——	LF
9	TM	F160			F160	LF
10	TM	——			——	LF
11	TM	F160			F160	LF

RADOM

Laser Range Finder Pod

Chaff & Flare Pod

PC-9M
FLIGHT TEST
PROGRAM

Preceding Activities

- Avionics system functional testing
- Ground tests:
  - geometrical and mechanical compatibility
  - weight and balance
  - system functionality
  - electromagnetic compatibility

Flight Test Sequence

i. Flight envelope expansion of the PC-9M in a clean loading
ii. PC-9M existing systems functional integrity and accuracy
iii. PC-9M new system validation
iv. Flight envelope expansion of new loadings :
    iv.a. Captive envelope
    iv.b. Release envelope
    iv.c. Weapon delivery accuracy
v. Operational test and evaluation

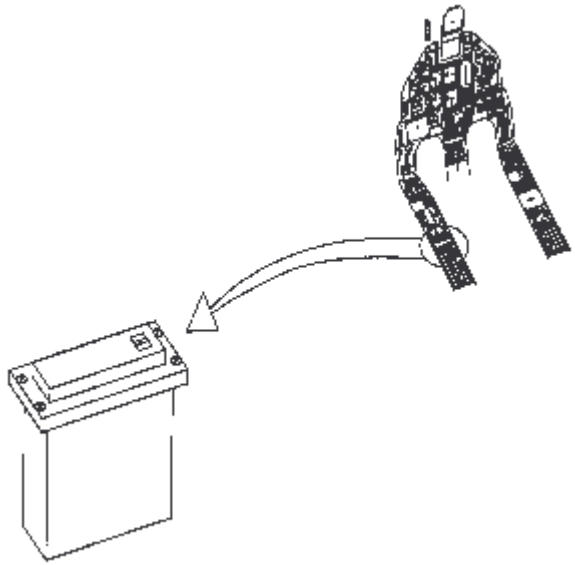
Tests Envelope

Parameter	Limit Value	
Weight	Clean	External stores
Altitude	0-25,000	0-25,000
Airspeed	0-320K	0-320K
Load Factor	-3 / +7	-2.5 / +4.5

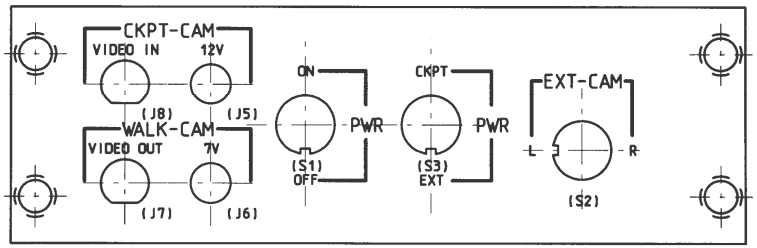
Instrumentation & Data Recording
FDR

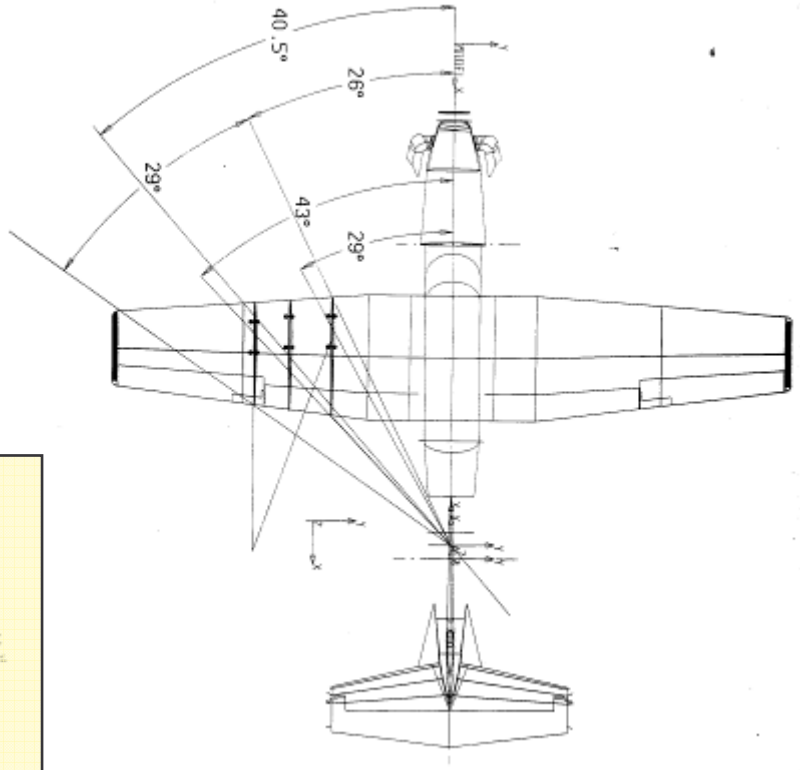
Continuous Recording on 1.6GB PCMCIA

- A/C GPS (3D position).
- A/C data (pitch, roll, yaw, engine, etc....)
- Engine data (Enabling HUMS)
- Student actions.
- Synchronized VCR and Flight data
- Enables future Digital Video Recording (DVR) and the need for a VCR in the cockpit
- Dedicated PCMCIA cassette recording BIT results and system faults for technician usage



Video photography

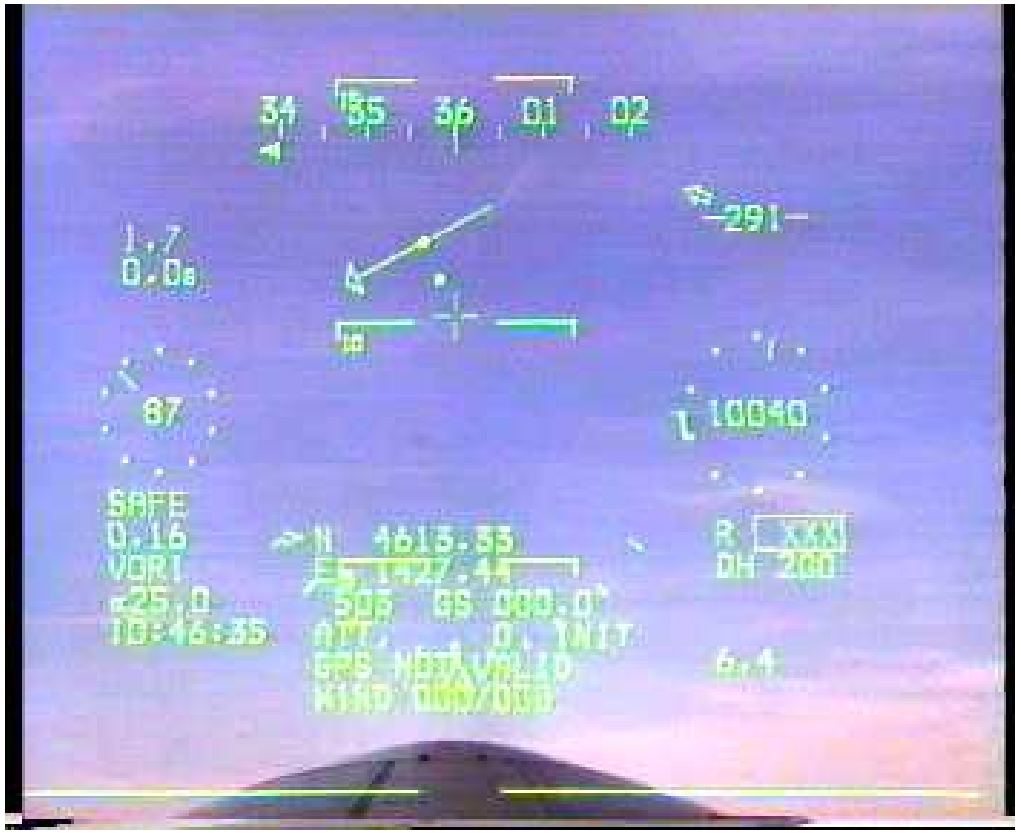




- HUD camera
- 2 External CCD Cameras
- 3VCRs (HUD, L-wing, R-wing)
- Portable Cam Walkman
- Playback between passes
- Video synchronized to Data

Flight Envelope Evaluation

Stall Speed Test



Methods of Test- Avionics System

- **INS/GPS LN-100G system testing**
  - static accuracy (ground)
  - ground taxi
  - in-flight accuracy tests
- **Navigation display and control functions**
  - En route
  - Landing
- **Air to Ground modes**
  - WCP function evaluation
  - designation and pointing accuracy
  - A/G modes and functions
- **Air to Air modes**
- **Laser Range Finder Testing**
- **Training missile tests**

Store Certification Test method

Pre-Flight engineering analysis

- Structure analysis
- Aerodynamic analysis
- Store drag effects
- Separation analysis

Captive carriage tests

- flying qualities tests
- performance and drag tests
- loads and structural integrity

Store Certification Test method

- **Employment tests**
  - bomb release tests
  - data reduction method
  - gun fire and rockets launch tests
  - jettison tests
- **Weapon delivery accuracy tests**

Bomb Release Test

Mid Point

Bomb Release Test

Inner Point

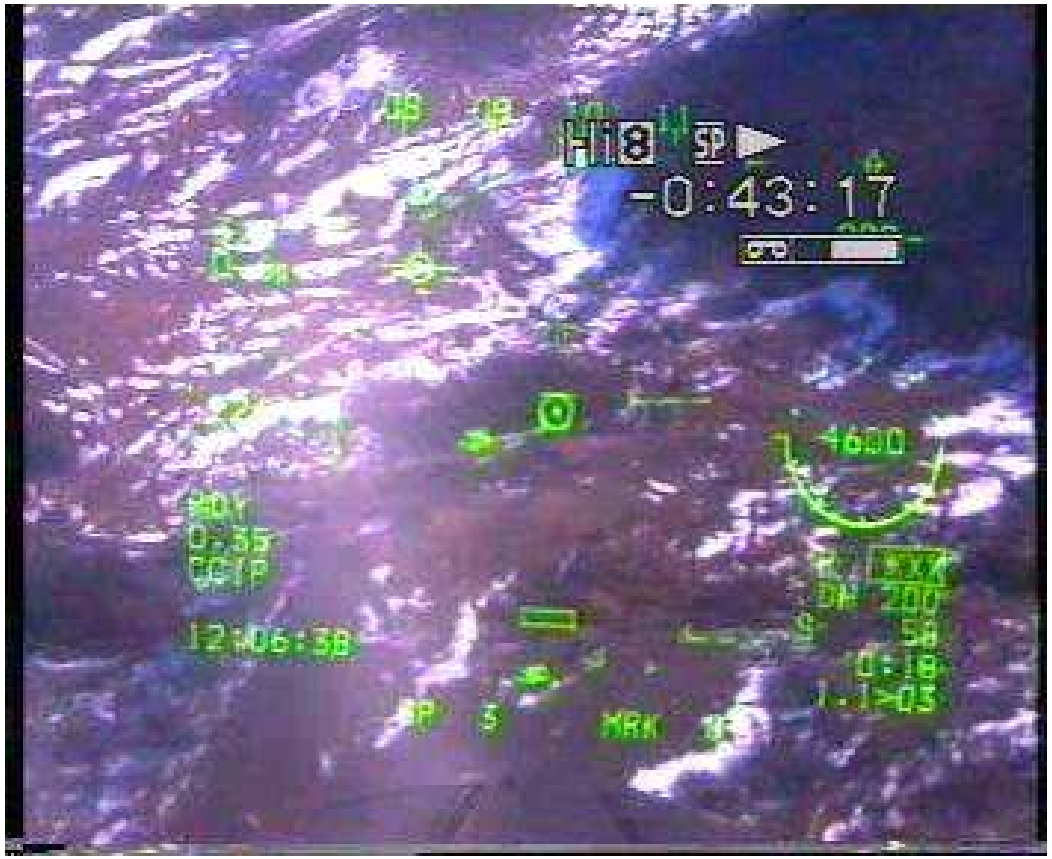
Gun Pod Fire Test

Gun Pod Fire Test

Gun Pod Fire Test

HUD Display

Rockets Fire Test



Chaff & Flares Fire Test

The Future of Upgrades

Existing Trainers Fleet

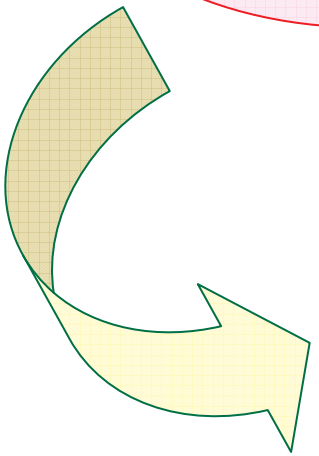
•Quantities and costs

Piston engine trainers - More then 15,000 existing aircraft, with Purchase cost around 100KUSD. Operating cost around 150 USD per Hour.

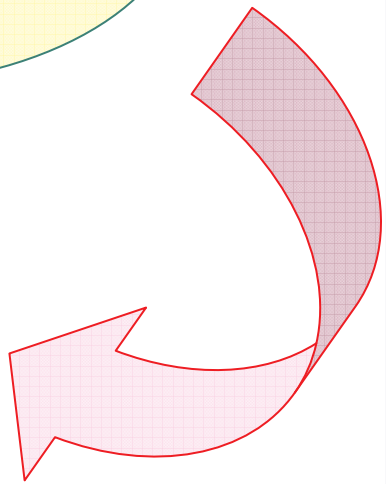
Turbo-prop trainers - More then 6,000 existing aircraft. Purchase cost between 2-5MUSD. Operating cost 400-1000 USD per Hour

Jet trainers - More then 4,000 existing aircraft. Purchase cost between 2-15MUSD. Operating cost 1000-4000 USD per Hour

Shrinking Budget + Extended Operational Requirements



More Opportunities For Trainer Aircraft Upgrades



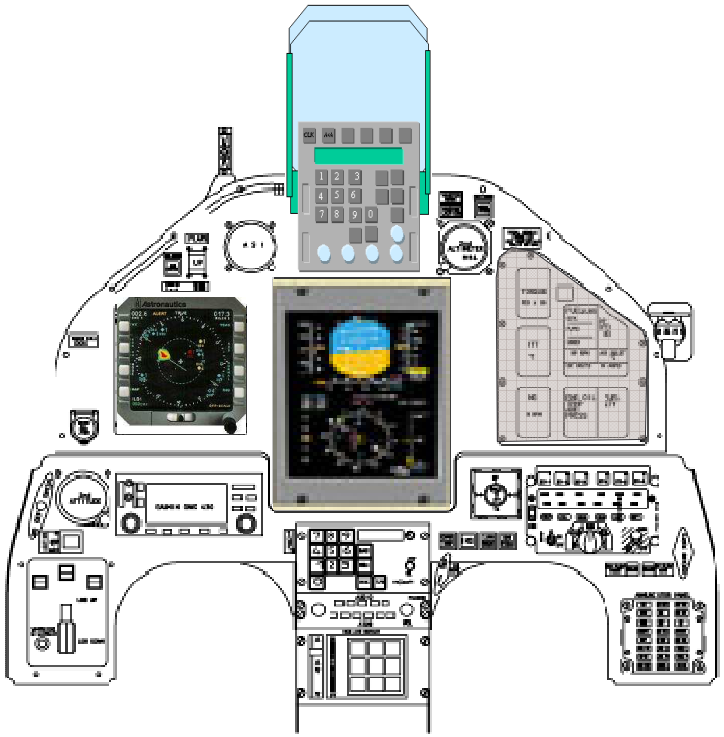
Enhanced Capabilities

- RADAR Emulation on MFD, HUD and HOTAS
- RWR Emulation on MFD
- Simulated A/A maneuvering targets (single, many, aggressive)
- Pre-set Scenarios controlled from the aft cockpit
- The limited flight envelop will be compensated by target speed.

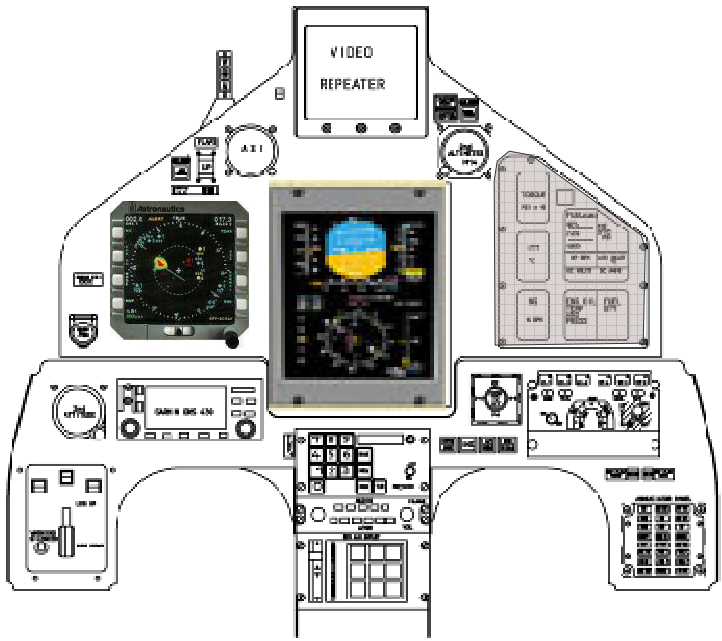
Enhanced Cockpit

FCR Displays
HOTAS controls
HUD realistic presentation
Simulated A/A missiles
RWR simulated warnings

Instructor's input:
- Simulated Targets
- Pre-defined maneuvers
- Target initial conditions
- RWR threats
- Simulated malfunctions



FWD INSTRUMENT PANEL



AFT INSTRUMENT PANEL

Just a Matter of Perspective:

The Dawn of The Era of Powered Flight
Wright Brothers Flyer – December 17 1903 At 10:35