JOINT PRIMARY AIRCRAFT TRAINING SYSTEM
(JPATS)

T-6B SYSTEMS 1
STUDENT GUIDE

January 2015

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## LIST OF EFFECTIVE PAGES

Insert latest change page, dispose of superseded pages. Date(s) of issue for original and change pages are listed below.

<table>
<thead>
<tr>
<th>Rev’n</th>
<th>Date</th>
<th>Reason for Revision</th>
</tr>
</thead>
<tbody>
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</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Page #</th>
<th>Rev. #</th>
<th>Page #</th>
<th>Rev. #</th>
<th>Page #</th>
<th>Rev. #</th>
</tr>
</thead>
<tbody>
<tr>
<td>i to vi</td>
<td>0.1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-1 to 15-22</td>
<td>0.1</td>
<td>90-1 to 90-2</td>
<td>0.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A-1 to A-10</td>
<td>0.1</td>
<td>7-3 to 14-3</td>
<td>0.2</td>
<td>Appendix A</td>
<td>0.3</td>
</tr>
<tr>
<td>Appendix A</td>
<td>0.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
# TABLE OF CONTENTS

LIST OF EFFECTIVE PAGES ........................................................................................................ ii

TABLE OF CONTENTS .................................................................................................................. iii

PURPOSE ....................................................................................................................................... iv

UNIT CONTENTS ............................................................................................................................. Error! Bookmark not defined.

UNIT MAP ...................................................................................................................................... Error! Bookmark not defined.

SY0101 – INTRODUCTION TO T-6 SYSTEMS .............................................................................. 1-1

SY0102 – AIRCRAFT SYSTEMS TOUR ......................................................................................... 2-1

SY0103 – FLIGHT CONTROLS ...................................................................................................... 3-1

SY0104 – HYDRAULIC SYSTEM 1 ................................................................................................. 4-1

SY0105 – HYDRAULIC SYSTEM 2 ................................................................................................. 5-1

SY0106 – SYSTEMS REVIEW 1 .................................................................................................... 6-1

SY0107 – UP FRONT CONTROL PANEL ..................................................................................... 7-1

SY0108 – FLIGHT INSTRUMENTS 1 ............................................................................................. 8-1

SY0109 – FLIGHT INSTRUMENTS 2 ............................................................................................. 9-1

SY0110 – HEAD UP DISPLAY ...................................................................................................... 10-1

SY0111 – COMMUNICATION SYSTEMS ..................................................................................... 11-1

SY0112 – NAVIGATION SYSTEMS ............................................................................................ 12-1

SY0114 – GLOBAL POSITIONING SYSTEM ............................................................................... 14-1

SY0115 – SYSTEMS REVIEW 2 .................................................................................................. 12-1

SY0190 – SY1 EXAMINATION AND CRITIQUE ........................................................................ 90-1

APPENDIX A – ANSWER KEY ................................................................................................... A-1
PURPOSE

This student guide is designed to complement computer-aided instruction (CAI), mediated interactive lecture (MIL), and basic information found in the T-6B Flight Manual. It contains course objectives, references, assignments, graphics, and practice exercises. Before beginning each lesson, study the objectives. These tell you what you are expected to learn. The reading assignments preview the block of instruction and should be accomplished prior to CAI and MIL instruction. Graphics are intended to give you a personal, condensed version of the lesson with space provided for your notes. The practice questions are designed to give you an indication of how well you know the material and also provide an excellent review for the course test.
## TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>TABLE OF CONTENTS</td>
<td>1-1</td>
</tr>
<tr>
<td>LIST OF FIGURES</td>
<td>1-2</td>
</tr>
<tr>
<td>OVERVIEW</td>
<td>1-3</td>
</tr>
<tr>
<td>REFERENCES</td>
<td>1-3</td>
</tr>
<tr>
<td>STUDENT ASSIGNMENTS</td>
<td>1-3</td>
</tr>
<tr>
<td>LESSON OUTLINE</td>
<td>1-3</td>
</tr>
<tr>
<td>INTRODUCTION</td>
<td>1-4</td>
</tr>
<tr>
<td>INTRODUCTION TO T-6 SYSTEMS</td>
<td>1-4</td>
</tr>
<tr>
<td>T-6B SYSTEMS</td>
<td>1-4</td>
</tr>
<tr>
<td>LESSON QUESTIONS</td>
<td>1-17</td>
</tr>
</tbody>
</table>
# LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>SY101-1</td>
<td>Primary Flight Controls</td>
<td>1-4</td>
</tr>
<tr>
<td>SY101-2</td>
<td>Secondary Flight Controls</td>
<td>1-5</td>
</tr>
<tr>
<td>SY101-3</td>
<td>Propulsion System</td>
<td>1-5</td>
</tr>
<tr>
<td>SY101-4</td>
<td>Landing Gear and Gear Doors</td>
<td>1-6</td>
</tr>
<tr>
<td>SY101-5</td>
<td>Flaps</td>
<td>1-6</td>
</tr>
<tr>
<td>SY101-6</td>
<td>Speed Brake</td>
<td>1-6</td>
</tr>
<tr>
<td>SY101-7</td>
<td>Nose Wheel Steering</td>
<td>1-7</td>
</tr>
<tr>
<td>SY101-8</td>
<td>Electrical System</td>
<td>1-7</td>
</tr>
<tr>
<td>SY101-9</td>
<td>Fuel System</td>
<td>1-8</td>
</tr>
<tr>
<td>SY101-10</td>
<td>Environmental System</td>
<td>1-8</td>
</tr>
<tr>
<td>SY101-11</td>
<td>Communications Systems</td>
<td>1-9</td>
</tr>
<tr>
<td>SY101-12</td>
<td>Intercom</td>
<td>1-9</td>
</tr>
<tr>
<td>SY101-13</td>
<td>ELT</td>
<td>1-10</td>
</tr>
<tr>
<td>SY101-14</td>
<td>Navigation Systems</td>
<td>1-10</td>
</tr>
<tr>
<td>SY101-15</td>
<td>DME</td>
<td>1-11</td>
</tr>
<tr>
<td>SY101-15</td>
<td>GPS</td>
<td>1-11</td>
</tr>
<tr>
<td>SY101-16</td>
<td>TCAS</td>
<td>1-12</td>
</tr>
<tr>
<td>SY101-17</td>
<td>Primary Flight Instruments</td>
<td>1-12</td>
</tr>
<tr>
<td>SY101-18</td>
<td>Backup Flight Instrument</td>
<td>1-13</td>
</tr>
<tr>
<td>SY101-19</td>
<td>Canopy</td>
<td>1-13</td>
</tr>
<tr>
<td>SY101-20</td>
<td>Canopy Seals</td>
<td>1-14</td>
</tr>
<tr>
<td>SY101-21</td>
<td>Canopy Fracturing</td>
<td>1-14</td>
</tr>
<tr>
<td>SY101-22</td>
<td>Canopy Birdstrike Protection</td>
<td>1-14</td>
</tr>
<tr>
<td>SY101-23</td>
<td>Ejection</td>
<td>1-15</td>
</tr>
<tr>
<td>SY101-24</td>
<td>Martin-Baker Ejection Seat</td>
<td>1-15</td>
</tr>
<tr>
<td>SY101-25</td>
<td>Seat Ejection</td>
<td>1-16</td>
</tr>
<tr>
<td>SY101-26</td>
<td>Rocket Motor Firing</td>
<td>1-16</td>
</tr>
</tbody>
</table>
OVERVIEW
This introductory Systems lesson provides an overview of the function of the various T-6 systems you will be studying in the Systems block of instruction.

REFERENCES
Personnel: None
Media Facilities: MIL Equipped Classroom
Support Resources: T-6B Flight Manual; T-6B Systems 1 Student Guide

STUDENT ASSIGNMENTS
Read applicable portions of T-6B Flight Manual, Section I.
Complete the practice questions provided.

LESSON OUTLINE
The Introduction to T-6 Systems MIL lesson provides you with an introduction to T-6 systems functions.
Introduction

Introduction To T-6 Systems

T-6 Systems

<table>
<thead>
<tr>
<th>Version</th>
<th>Description</th>
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<td>Identify function of the propulsion system</td>
</tr>
<tr>
<td>1.18.0.0.2</td>
<td>Identify function of the hydraulic system</td>
</tr>
<tr>
<td>1.19.0.0.2</td>
<td>Identify function of the electrical system</td>
</tr>
<tr>
<td>1.20.0.0.2</td>
<td>Identify function of the fuel system</td>
</tr>
<tr>
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<td>Identify function of the environmental system</td>
</tr>
<tr>
<td>1.22.0.0.2</td>
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</tr>
<tr>
<td>1.23.0.0.2</td>
<td>Identify function of the canopy/ejection system</td>
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</tbody>
</table>

Primary Flight Controls

Control aircraft movement around lateral, longitudinal, and vertical (pitch, roll, and yaw) axes

Elevator - Controls movement around the lateral (pitch) axis

Ailerons - Control movement around the longitudinal (roll) axis

Rudder - Controls movement around the vertical (yaw) axis

Gust lock - Locks controls to prevent wind damage

Figure SY101-1 – Primary Flight Controls
Secondary Flight Controls

Lessen control forces required to maintain normal flight attitudes

Elevator trim

Aileron trim

Rudder trim

Trim Aid Device (TAD)

Gives more “jet-like” aircraft performance to ease transition to follow-on aircraft

Propulsion System

Provides power (thrust) for aircraft

Provides power for aircraft systems such as electrical, hydraulics, and fuel pumps
Hydraulic System

Operates:

- Landing gear
- Main gear doors

Flaps

Speed brake

Figure SY101-4 – Landing Gear and Gear Doors

Figure SY101-5 – Flaps

Figure SY101-6 – Speed Brake
Nose wheel steering

Electrical System

Provides electrical power for aircraft systems

Primary power from starter/generator

Secondary power from battery

Backup power from auxiliary battery

External power through fuselage receptacle

Figure SY101-7 – Nose Wheel Steering

Figure SY101-8 – Electrical System
Fuel System

Provides fuel storage

Provides fuel feed to engine

Automatically maintains balance between tanks

Environmental System

Acceptable cockpit environment

Automatic temperature and pressurization control
Communications Systems

Up Front Control Panel (UFCP)

- VHF transceiver
- UHF transceiver
- Transponder

Intercom system

---

**Figure SY101-11 – Communications Systems**

**Figure SY101-12 – Intercom**
Emergency locator transmitter (ELT)

Navigation Systems

VHF navigation system

Figure SY101-13 – ELT

Figure SY101-14 – Navigation Systems
Distance Measuring Equipment (DME) system

Dual Global Positioning System (GPS) consisting of Inertial Reference Unit (IRU) and Flight Management System (FMS)

Figure SY101-15 – DME

Figure SY101-16 – GPS
Traffic Collision Avoidance System (TCAS)

Figure SY101-17 – TCAS

Primary Flight Instruments

Attitude Director Indicator (ADI)

Horizontal Situation Indicator (HSI)

Airspeed indicator

Altimeter

Vertical Speed Indicator (VSI)

Figure SY101-18 – Primary Flight Instruments
Backup Flight Instrument

- Airspeed indicator
- Attitude indicator
- Altimeter

Canopy

- Side opening

Figure SY101-19 – Backup Flight Instrument

Figure SY101-20 – Canopy
Provides pressure and weather seal

Fracturing system for ejection and emergency ground egress

Protects pilots from birdstrike

Figure SY101-21 – Canopy Seals

Figure SY101-22 – Canopy Fracturing

Figure SY101-23 – Canopy Birdstrike Protection
Ejection System

Provides means of safe escape for student and instructor

Martin-Baker ejection seats

Figure SY101-24 – Ejection

Figure SY101-25 – Martin-Baker Ejection Seat
Seats ejected from cockpit by gas cartridges

Altitude provided by rocket motor fired at top of seat rails

Figure SY101-26 – Seat Ejection

Figure SY101-27 – Rocket Motor Firing
LESSON QUESTIONS

EMBEDDED QUESTIONS (Ref: Topic/Question)
1. Which control surface controls aircraft movement around the pitch axis? (B/1/1)
2. The Trim Aid Device (TAD) assists trimming for which control surface during airspeed and power changes? (B/1/2)
3. True or false? Engine exhaust augments the thrust of the propeller. (B/1/3)
4. Primary aircraft electrical power is provided by which component of the electrical system? (B/1/4)
5. Tuning for each of the communications and navigation radios and the transponder is provided by which component? (B/1/5)
6. True or false? The VHF navigation system provides VOR, ILS, localizer and GPS capability. (B/1/6)
7. Primary navigation display is provided by which component of the Primary Flight Display (PFD)? (B/1/7)
8. If the battery bus fails, which flight instrument is powered by this auxiliary battery? (B/1/8)
9. True or false? The entire canopy structure is engineered to be protected from birdstrikes. (B/1/9)

LESSON REVIEW QUESTIONS
1. Landing gear extension and retraction is operated by which aircraft system?
2. Movement around the roll axis is controlled by which primary control surface(s)?
3. What component of the ejection seat provides sufficient altitude for parachute deployment?
4. True or false? In an emergency situation the auxiliary battery will power the Backup Flight Instrument (BFI) for approximately of 15 minutes.
5. Secondary aircraft electrical power is provided by what component?
6. Which aircraft system provides automatic temperature and pressurization control?
7. Control of the transponder is provided by which component?
8. True or false? The canopy is hinged at the rear and opens up.
9. Which primary instrument provides primary attitude display?
10. In the event of inadvertent aircraft contact with the ground, which component will be activated and generate a radio signal?
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>TABLE OF CONTENTS</td>
<td>3-1</td>
</tr>
<tr>
<td>LIST OF FIGURES</td>
<td>3-2</td>
</tr>
<tr>
<td>OVERVIEW</td>
<td>3-4</td>
</tr>
<tr>
<td>REFERENCES</td>
<td>3-4</td>
</tr>
<tr>
<td>STUDENT ASSIGNMENTS</td>
<td>3-4</td>
</tr>
<tr>
<td>LESSON OUTLINE</td>
<td>3-4</td>
</tr>
<tr>
<td>INTRODUCTION</td>
<td>3-5</td>
</tr>
<tr>
<td>AIRCRAFT FLIGHT CONTROLS</td>
<td>3-5</td>
</tr>
<tr>
<td>FLIGHT CONTROLS</td>
<td>3-5</td>
</tr>
<tr>
<td>AILERON SYSTEM</td>
<td>3-7</td>
</tr>
<tr>
<td>ELEVATOR SYSTEM</td>
<td>3-10</td>
</tr>
<tr>
<td>RUDDER SYSTEM</td>
<td>3-13</td>
</tr>
<tr>
<td>ELECTROMECHANICAL TRIM SYSTEMS</td>
<td>3-16</td>
</tr>
<tr>
<td>TRIM AID DEVICE (TAD)</td>
<td>3-22</td>
</tr>
<tr>
<td>GUST LOCK</td>
<td>3-27</td>
</tr>
<tr>
<td>LESSON QUESTIONS</td>
<td>3-30</td>
</tr>
</tbody>
</table>

Version 0.3/JAN 15
# LIST OF FIGURES

| Figure SY0103-1 – Flight Control Axes | 3-5 |
| Figure SY0103-2 – Primary Flight Controls | 3-6 |
| Figure SY0103-3 – Secondary Flight Controls | 3-6 |
| Figure SY0103-4 – Aileron System Components | 3-7 |
| Figure SY0103-5 – Aileron Purpose | 3-8 |
| Figure SY0103-6 – Aileron Control Characteristics | 3-8 |
| Figure SY0103-7 – Aileron Limits | 3-9 |
| Figure SY0103-8 – Ground Adjustable Trim Tabs | 3-9 |
| Figure SY0103-9 – Aileron Balancing | 3-10 |
| Figure SY0103-10 – Elevator Components | 3-10 |
| Figure SY0103-11 – Elevator Bobweight | 3-11 |
| Figure SY0103-12 – Elevator Purpose | 3-12 |
| Figure SY0103-13 – Elevator Control Characteristics | 3-12 |
| Figure SY0103-14 – Elevator Limits | 3-12 |
| Figure SY0103-15 – Elevator Balancing | 3-13 |
| Figure SY0103-16 – Rudder Components | 3-13 |
| Figure SY0103-17 – Rudder Hand Crank | 3-14 |
| Figure SY0103-18 – Rudder Purpose | 3-15 |
| Figure SY0103-19 – Rudder Control Characteristics | 3-15 |
| Figure SY0103-20 – Rudder Limits | 3-16 |
| Figure SY0103-21 – Rudder Balancing | 3-16 |
| Figure SY0103-22 – Electromechanical Trim Systems | 3-17 |
| Figure SY0103-23 – Roll and Pitch Trim Controls | 3-17 |
| Figure SY0103-24 – Rudder Trim Control | 3-18 |
| Figure SY0103-25 – Trim Interrupt Button | 3-18 |
| Figure SY0103-26 – Front Trim Control Panel | 3-19 |
| Figure SY0103-27 – Rear Trim Control Panel | 3-19 |
| Figure SY0103-28 – Trim Disconnect | 3-20 |
| Figure SY0103-29 – Trim Circuit Breakers | 3-21 |
| Figure SY0103-30 – Aileron Trim Characteristics | 3-21 |
| Figure SY0103-31 – Elevator Trim Characteristics | 3-21 |
| Figure SY0103-32 – Rudder Trim Characteristics | 3-22 |
| Figure SY0103-33 – Trim Position Indicators | 3-22 |
| Figure SY0103-34 – Trim Components | 3-23 |
| Figure SY0103-35 – TAD Operations | 3-24 |
| Figure SY0103-36 – TAD Note | 3-25 |
Figure SY103-37 – TAD Control Switch ........................................................................ 3-25
Figure SY103-38 – TAD Off Indications ..................................................................... 3-26
Figure SY103-39 – Trim Interrupt Impact on TAD ...................................................... 3-27
Figure SY103-40 – Gust Lock ...................................................................................... 3-27
Figure SY103-41 – Gust Lock Engaged ....................................................................... 3-28
Figure SY103-42 – Gust Lock Disengaged .................................................................. 3-29
OVERVIEW
This lesson will provide you with the basic knowledge of the T-6B flight control systems. You will learn the proper identification and location of flight control components, indicators, and controls as well as their functions and normal operating characteristics.

REFERENCES
Personnel: None.
Media Facilities: Student CAI Workstation.
Support Resources: T-6B Flight Manual Section 1, T-6B Systems 1 Student Guide.

STUDENT ASSIGNMENTS
Read applicable portions of T-6B Flight Manual, Section 1.
Complete CAI lesson SY103, following along with this student guide.
Complete the practice questions provided.

LESSON OUTLINE
Topics in this lesson must be taken in sequential order. All topics must be completed prior to attempting the end of lesson quiz. The estimated time required to complete this lesson is 1.2 hours.
Introduction

Aircraft Flight Controls

Primary and Secondary Flight Controls

| 1.16.0.0.1 | Define terminology and concepts related to the flight controls system |
| 1.16.0.0.3 | Identify major components of the flight controls system |

Flight Controls Overview

To maneuver an airplane, the pilot must have some way to redirect the forces acting on the aircraft’s wings and tail assembly.

Flight controls are the means by which this is accomplished. Using flight control surfaces, the pilot can create independent or combined motion in three separate axes of flight: longitudinal (roll), vertical (yaw), and lateral (pitch).

Flight Controls Basic Concepts

Aircraft can employ a wide variety of flight control components and configurations. However, in every aircraft, the various components can be divided into two major categories:

Figure SY103-1 – Flight Control Axes
Primary Flight Controls

In the T-6B, the primary flight controls consist of the:

- Ailerons
- Elevator
- Rudder

The T-6B’s primary flight controls are all manually operated using mechanical linkages.

Secondary Flight Controls

The T-6B also has secondary flight controls. These are the:

- Aileron trim surfaces (roll)
- Elevator trim tab (pitch)
- Rudder trim tab (yaw)
- Trim Aid Device (TAD)

All of the secondary flight controls are electromechanically operated and controlled.
The elevator, rudder, and TAD all utilize trim tabs, while aileron trim is accomplished through positioning of the actual aileron control surfaces. Inputs from both the rudder trim system and the TAD are sent to the rudder trim tab.

### Aileron System

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<thead>
<tr>
<th>ID</th>
<th>Description</th>
</tr>
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<tbody>
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<td>Identify characteristics of normal operations for aileron system</td>
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#### Aileron System Components

The following components make up the aileron control system:

- Left and right aileron
- Two control sticks
- Interconnect tube
- Push-pull rods
- Bellcranks

Push-pull rods and bellcranks are used to transmit the pilot’s lateral stick deflection to the ailerons. An interconnect tube also connects the control sticks.

*Figure SY103-4 – Aileron System Components*
Aileron Purpose

The purpose of the aileron system is to facilitate pilot control of the aircraft around the longitudinal or roll axis.

Notice how the ailerons must be deflected to effect a change in the aircraft’s roll angle.

Aileron Control Characteristics

When the pilot makes a control input to the ailerons, both aileron control surfaces are deflected but in opposite directions.

Notice how the right aileron trailing edge moves down while the left aileron trailing edge moves up.

As you can see, the aileron deflections are reversed.

Figure SY103-5 – Aileron Purpose

Figure SY103-6 – Aileron Control Characteristics
Aileron Deflection Limits

It’s not critical you memorize the exact deflection limits for each flight control and trim system. You’ll need an idea of their normal travel range however, so that you can detect possible problems during preflight.

For the aileron system, aileron trailing edge travel is limited to:

- 20° up
- 11° down

Aileron Ground Adjusted Trim Tabs

Each aileron also has a ground adjustable trim tab located on its trailing edge.

These are used by maintenance personnel only to adjust for a stick neutral trim input to the controls. They should not be tampered with by the aircrew.

Aileron Balance

Each primary flight control surface on the T-6B is “mass balanced”. This simply means that the center of gravity of each control surface falls along its pivot or hinge line.
Mass balancing is used to regulate control pressures, prevent control flutter, and improve control stability.

Since most of the aileron’s mass is behind the hinge line, small weights are installed along the leading edge to achieve a mass balanced condition.

**Elevator System**

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</table>

**Elevator System Components**

The T-6B elevator system consists of:

- The elevator
- Two control sticks
- Interconnect tube
- Bellcranks
- Elevator cables
- Downsprings
- Bobweight

**Figure SY103-9 – Aileron Balancing**

**Figure SY103-10 – Elevator Components**
Elevator System Component Functions

The push-pull rods, cables, and bellcranks function together to transmit fore and aft control stick deflection to the elevator. Two downsprings are attached to the aft elevator bellcrank and provide a balanced control feel and tendency to return the control stick to the neutral position.

Like the aileron system, an interconnect tube between the control sticks prevents conflicting inputs.

Elevator Bobweight

The bobweight is simply an assembly of metal plates attached to the base of the front control stick. This extra weight provides a heavier stick force whenever G-loading is increased. Heavier stick force helps enhance control feedback to help prevent overstressing of the airframe.

Figure SY103-11 – Elevator Bobweight
Elevator Purpose

The purpose of the elevator is to facilitate pilot control of the aircraft’s lateral or pitch axis.

As you watch the video, observe the relationship of the elevator’s position to the attitude of the aircraft.

Elevator Control Characteristics

To control aircraft pitch, the elevators respond to fore-aft movement of either control stick.

Notice that forward stick input will cause the elevator trailing edge to deflect downward. When airborne, this will create a nose down movement of the aircraft.

Now the elevator trailing edge is deflected up. When airborne, this will cause a pitch up of the aircraft’s nose.

Elevator Deflection Limits

Maximum travel of the elevator trailing edge is:

18° up
16° down
Elevator Balancing

Like the aileron system, the elevator needs to use balance weights to achieve mass balance. These weights are installed in both of the elevator horns just forward of the hinge line.

Figure SY103-15 – Elevator Balancing

Rudder System

1.16.3.0.1 Identify purpose of the rudder system
1.16.3.0.3 Identify rudder system components
1.16.3.0.4 Match rudder system components to functions
1.16.3.0.5 Identify characteristics of normal operations for rudder system

Rudder System Components

The T-6B rudder system consists of:

The rudder
Two sets of rudder pedals
Rudder cables
Pulleys
Bellcranks
Tie rods
Centering springs

Figure SY103-16 – Rudder Components
Rudder System Component Functions

Cables, pulleys, and bellcranks provide the connection between the rudder pedals and the rudder control surface. The front and rear rudder pedals are interconnected with tie rods. Centering springs are installed to provide a tendency for the rudder to return to the neutral position and to enhance control feedback.

Rudder Pedal Adjustment Hand Crank

A rudder pedal adjustment hand crank is located on the lower portion of each center console to allow you to set your rudder pedals to a comfortable position. Adjustment range is a total of seven inches from forward to aft.

Figure SY103-17 – Rudder Hand Crank
Rudder Purpose

The purpose of the rudder system is to provide the pilot a means of controlling the aircraft around the vertical or yaw axis of flight.

Rudder Control Characteristics

Pilots control yaw simply by stepping on the rudder pedals.

As you can see, left rudder pedal deflects the rudder to the left. When airborne, this will cause static pressure to increase on the left side of the vertical stabilizer, pushing the tail to the right and forcing the nose of the aircraft to yaw left.

Now the rudder is deflected to the right. In-flight, this will yaw the aircraft’s nose to the right.
Rudder Deflection Limits

Adjustable stops limit rudder travel to a maximum of 24° left and right.

Rudder Balancing

Like the ailerons and elevator, the T-6B’s rudder is mass balanced. Rudder balancing is achieved with a weight located in the rudder horn, just forward of the hinge line.

Electromechanical Trim Systems

<table>
<thead>
<tr>
<th>Id</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.16.6.0.1</td>
<td>Identify purpose of the trim system</td>
</tr>
<tr>
<td>1.16.6.0.3</td>
<td>Identify trim system components</td>
</tr>
<tr>
<td>1.16.6.0.4</td>
<td>Match trim system components to functions</td>
</tr>
<tr>
<td>1.16.6.0.5</td>
<td>Identify characteristics of normal operations for trim system</td>
</tr>
<tr>
<td>1.16.6.0.8</td>
<td>Specify function and operation of aircraft trim motors and surfaces</td>
</tr>
</tbody>
</table>
Purpose of Aircraft Trim Systems

Each primary flight control surface has an electromechanical trim system associated with it.

Trim allows a pilot to maintain rudder, aileron, or elevator position without applying constant control force.

A properly trimmed aircraft can greatly reduce pilot workload and fatigue. Having the airplane well trimmed is essential to prevent overcontrolling.

Aileron/Elevator Trim Control

Elevator and aileron trim actuators are controlled by a combined roll/pitch trim switch located on top of each control stick. Fore and aft movement of this switch will actuate the elevator trim while left and right movement controls aileron trim inputs.

The rear cockpit switch has priority in the event of conflicting inputs between the pilots.
Rudder Trim Control

Control of rudder trim position (left and right) is through a rocker switch installed on the front side of the Power Control Lever (PCL) in each cockpit. Again, rear cockpit inputs have priority in the event of conflicting inputs between the pilots.

Trim Interrupt

In the event of a trim system malfunction, a trim interrupt button is available for rapid disconnect of all trim systems. The button is located right of the roll/pitch trim switch on top of each control stick.

Pressing and holding the button in either cockpit will interrupt all power to the aileron, elevator, and rudder trim actuators, and the TRIM OFF advisory will be illuminated. When activated, the trim interrupt button also causes the Trim Aid Device (TAD) to disengage.

When the button is released power is restored to the trim actuators. However, the TAD will remain disengaged.
Trim Control

Activation of the trim system is controlled from the front and rear cockpit trim control panels. These panels are on the left control consoles, just forward of the power control levers.

Figure SY103-26 – Front Trim Control Panel

Figure SY103-27 – Rear Trim Control Panel
Trim Disconnect

On the bottom right side of the trim control panel is a switch labeled “NORM” and “TRIM DISCONNECT”. With the switch in “NORM”, the aileron, rudder, and elevator trim systems are all activated.

The trim system is now turned off and the “TRIM OFF” advisory illuminates. Notice the “TAD OFF” advisory also illuminates. You’ll see why that happens in the next topic.

Figure SY103-28 – Trim Disconnect

Trim Power Supply/Circuit Breakers

Each of the T-6B’s trim systems are electrically actuated and controlled. Two important circuit breakers associated with the trim system are located on the battery bus circuit breaker panel on the front cockpit’s left control console.

The AIL/EL TRIM circuit breaker controls power to the aileron and elevator systems.
The RUD TRIM circuit breaker controls the electrical supply to the rudder trim system.

Aileron Trim System/Characteristics

Pilot aileron trim inputs are transmitted to an actuator in the center of the wing. This actuator repositions the aileron center bellcrank to set and hold both ailerons in a trimmed position.

Maximum trim displacement of the ailerons is limited to one aileron at $6^\circ$ trailing edge up, with the opposite aileron at $6^\circ$ trailing edge down.

Elevator Trim System/Characteristics

The elevator trim system uses an electromechanical actuator to drive a small tab surface installed on the trailing edge of the right side of the elevator. Elevator trim tab movement is limited to $5.5^\circ$ up and $22^\circ$ down.

Figure SY103-29 – Trim Circuit Breakers

Figure SY103-30 – Aileron Trim Characteristics

Figure SY103-31 – Elevator Trim Characteristics
Rudder Trim
System/Characteristics

The rudder trim system uses an electromechanical actuator located in the vertical stabilizer. This actuator drives a small tab surface on the rudder’s trailing edge. With the rudder at neutral, maximum travel of the trim tab is 9° right and 9° left.

Trim Position Indicators

Aileron, rudder, and elevator trim positions are visually depicted on the aircraft’s trim position indicators. The green band markings are the takeoff trim setting positions. These indicators are located on the trim control panels in each cockpit.

Trim Aid Device (TAD)

<table>
<thead>
<tr>
<th>Task ID</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.16.7.0.1</td>
<td>Identify purpose of the TAD system</td>
</tr>
<tr>
<td>1.16.7.0.3</td>
<td>Identify TAD system components</td>
</tr>
<tr>
<td>1.16.7.0.4</td>
<td>Match TAD system components to functions</td>
</tr>
<tr>
<td>1.16.7.0.5</td>
<td>Identify characteristics of normal operations for TAD system</td>
</tr>
</tbody>
</table>
TAD Purpose

A rudder Trim Aid Device (TAD) is installed on the T-6B to assist the pilot in maintaining directional trim, reduce out-of-trim rudder forces, and maintain coordinated flight. The TAD does this by automatically adjusting rudder trim to compensate for airspeed and power changes.

TAD Components 1

The Trim Aid Device (TAD) computer interfaces with the rudder trim system and controls TAD operation. The computer calculates inputs to the rudder trim based on:

- Pitch rate
- Altitude
- Airspeed
- Engine torque

TAD Components 2

Once the computer determines a setting, it relays a signal to the rudder trim tab actuator. The actuator then deflects the trim tab to match the computed setting.
TAD Operation 1

As this chart shows, the TAD inputs a precalculated takeoff setting to the rudder trim tab. No further inputs are made by the TAD until the aircraft reaches 80 KIAS and there is no weight on the wheels.

Once this point is reached, the TAD provides automatic rudder trim inputs to compensate for airspeed and power changes.

TAD Operation 2

Although the TAD system provides a great deal of directional stability, pilot trim inputs are also required to keep the aircraft properly trimmed. These inputs are additive to the TAD setting.

After a landing or during a touch and go, the TAD will set the rudder trim to takeoff position when the aircraft is on the ground (weight on wheels) and airspeed is less than 80 knots. No further inputs will be made until airspeed increases to greater than 80 knots. The rudder trim can still be adjusted by the pilot as desired.
TAD Note

The trim aid system will not completely trim the aircraft in yaw.

Figure SY103-36 – TAD Notes

TAD Controls

Operation of the TAD system is controlled by a switch labeled “TRIM AID” located on the trim control panel in the front cockpit. With the switch in the “TRIM AID” position, the TAD system is activated.

Figure SY103-37 – TAD Control Switch
When the system is turned off, the green “TAD OFF” advisory will illuminate.

Figure SY103-38 – TAD Off Indications

Trim Interrupt Button

The trim interrupt button on the control handle will also turn off the TAD.

When the trim interrupt button is pushed, the TRIM OFF advisory illuminates until the button is released and the trim aid switch moves to the OFF position causing the TAD OFF advisory to illuminate.
The trim aid switch is electromagnetic, meaning there must be power to the system for it to stay on. Because of this, whenever the TAD is turned off by the trim interrupt button, the switch will automatically move to “OFF”.

TAD Reset

TAD operation is restored simply by moving the trim aid switch back to “TRIM AID”.

Gust Lock

<table>
<thead>
<tr>
<th></th>
<th>1.16.8.0.1 Identify purpose of gust lock</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.16.8.0.2 Identify gust lock characteristics related to normal operations</td>
</tr>
<tr>
<td></td>
<td>1.16.8.0.3 Identify procedural steps to operate gust lock</td>
</tr>
</tbody>
</table>

Gust Lock Purpose

When the aircraft is parked, a gust lock is used to prevent excess wear and damage to the primary flight controls. The gust lock is located in the front cockpit.
Gust Lock Characteristics

When put in place, the gust lock holds the aileron and rudder surfaces in a neutral position. The elevator is also locked, but in a nose down configuration.

Gust Lock Operation 1

To engage the gust lock, the front cockpit pilot moves the control column aft, lifts the gust lock yoke from its stowed position, then lowers it onto the control column adapter.

With the yoke assembly engaged, the control column is locked in place preventing movement of the elevator and ailerons. The rudder latch assembly and barrel lock hold the rudder cable and prevent movement of the rudder control surface.

Figure SY103-41 – Gust Lock Engaged
Gust Lock Operation 2

The gust lock is disengaged by lifting the yoke, moving the control stick to the side and then aft, and lowering the yoke to the stowed position. When removing the gust lock, make sure you always check for complete disengagement from the control column.

Lesson Review Quiz

Figure SY103-42 – Gust Lock Disengaged
LENSON QUESTIONS

EMBEDDED QUESTIONS (Ref: Segment/Topic/Question)

1. The ailerons control movement of the aircraft in the ______ axis. (B/2/1)
   a. lateral or pitch
   b. vertical or yaw
   c. longitudinal or roll

2. Which of the following is NOT a part of the aileron control system? (B/2/2)
   a. Left and right aileron
   b. Bellcranks
   c. TAD
   d. Push-pull rods
   e. Front and rear control sticks

3. The elevator controls aircraft movement around the lateral or pitch axis. (B/3/1)
   a. True
   b. False

4. What is the purpose of the bobweight located on the forward control stick? (B/3/2)
   a. Provides for static balancing of the elevator
   b. Provides a connection between the two control sticks
   c. Enhances control feedback and helps prevent over stressing of the airframe
   d. Mechanically limits the amount of elevator travel

5. The rudder controls aircraft movement around the vertical or yaw axis. (B/4/1)
   a. True
   b. False

6. Rudder pedal position is adjusted with a hand crank located on the ______ (B/4/2)
   a. left console
   b. lower portion of the center console
   c. right side of the cockpit
   d. upper portion of the center console
7. Which flight control electromechanical trim system(s) utilize movement of the actual primary control surface? (B/5/1)
   a. Aileron
   b. Elevator
   c. Rudder
   d. Flaps

8. In the event of conflicting aileron or elevator trim inputs from the front and rear cockpit, the front cockpit input will take priority. (B/5/2)
   a. True
   b. False

9. Visual indication of pitch, roll, and yaw trim can be found on the ______. (B/5/3)
   a. triple trim indicator on the center instrument panel
   b. trim advisory system
   c. TAD control panel on the center console
   d. trim position indicators located on both trim control panels

10. A primary purpose of the TAD system is to ______. (B/6/1)
    a. assist the pilot in maintaining roll trim
    b. assist the pilot in maintaining pitch trim
    c. assist the pilot by maintaining reduced control stick forces
    d. assist the pilot in maintaining directional trim

11. The TAD computes input to the rudder trim system based on ______. (B/6/2)
    a. engine torque, airspeed, altitude, and pitch rate
    b. engine torque, rudder pedal control forces, and altitude
    c. altitude, airspeed, pitch rate, and propeller RPM
    d. engine torque, airspeed, altitude, and temperature

12. In addition to the TRIM OFF advisory, actuating the trim interrupt button will also illuminate the ______ advisory. (B/6/3)
    a. NO TRIM
    b. TAD OFF
    c. RUDDER INOP
    d. ELEVATOR FAIL
13. What control surfaces are locked when the gust lock is engaged? (B/7/1)
   a. Elevator
   b. Rudder
   c. Ailerons
   d. All of the above

REVIEW QUESTIONS

1. The primary aircraft flight controls consist of the ______.
   a. electromechanical trim system, TAD, ailerons, and rudder
   b. ailerons, Trim Aid Device, and elevator
   c. ailerons, elevator, and rudder
   d. control stick, PCL, and rudder pedals

2. Which of the following best describes the function of the aircraft’s elevator?
   a. The elevator system is used to cause movement around the longitudinal or roll axis.
   b. The elevator system is used to cause movement in the lateral or pitch axis.
   c. The elevator system is used to cause movement in the vertical or yaw axis.
   d. The elevator system’s primary function is to assist the pilot in maintaining directional stability.

3. The aileron ground adjustable trim tabs are for maintenance use only and should not be tampered with by the aircrew.
   a. True
   b. False

4. Which statement best describes the purpose of the bobweight attached to the forward control stick?
   a. Provides increased aileron sensitivity during high speed flight
   b. Provides increased rudder authority during low altitude turns
   c. Prevents aircraft overcontrolling by the Trim Aid Device
   d. Provides higher stick forces as G-loading increases, helps prevent overstressing the airframe
5. Which of the following is NOT included in the rudder control system?
   a. Centering springs
   b. Cables
   c. Bellcrank
   d. Bobweight

6. Pilot control of aileron trim is accomplished by movement of an electromechanical trim tab installed on the right aileron.
   a. True
   b. False

7. The Trim Aid Device (TAD) computer relays trim input to the ______.
   a. elevator trim tab actuator
   b. rudder trim tab actuator
   c. rudder pedals
   d. aileron trim system

8. The TAD maintains a takeoff trim setting until ______ KIAS and no weight on the wheels.
   a. 40
   b. 60
   c. 80
   d. 100

9. A green TAD OFF advisory will illuminate when ______.
   a. there is an internal failure of the TAD system
   b. there is a failure of the rudder tab actuator
   c. the TRIM DISCONNECT switch is placed in the YAW CONNECT position
   d. the TRIM AID switch is set to off

10. The flight control gust lock is used to ______.
    a. prevent aircraft overcontrol during gusty landing conditions
    b. lock the secondary flight control surfaces when parked
    c. prevent excess wear and damage to the primary flight controls.
    d. lock only the elevator and rudder when parked
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>TABLE OF CONTENTS</td>
<td>4-1</td>
</tr>
<tr>
<td>LIST OF FIGURES</td>
<td>4-2</td>
</tr>
<tr>
<td>OVERVIEW</td>
<td>4-4</td>
</tr>
<tr>
<td>REFERENCES</td>
<td>4-4</td>
</tr>
<tr>
<td>STUDENT ASSIGNMENTS</td>
<td>4-4</td>
</tr>
<tr>
<td>LESSON OUTLINE</td>
<td>4-4</td>
</tr>
<tr>
<td>INTRODUCTION</td>
<td>4-5</td>
</tr>
<tr>
<td>HYDRAULIC SYSTEM BASICS</td>
<td>4-5</td>
</tr>
<tr>
<td>PRIMARY HYDRAULIC SYSTEM</td>
<td>4-5</td>
</tr>
<tr>
<td>EMERGENCY HYDRAULIC SYSTEM</td>
<td>4-18</td>
</tr>
<tr>
<td>LANDING GEAR SYSTEM</td>
<td>4-26</td>
</tr>
<tr>
<td>EXTENSION AND RETRACTION</td>
<td>4-26</td>
</tr>
<tr>
<td>CONTROLS AND INDICATIONS</td>
<td>4-31</td>
</tr>
<tr>
<td>EMERGENCY EXTENSION</td>
<td>4-39</td>
</tr>
<tr>
<td>LESSON QUESTIONS</td>
<td>4-45</td>
</tr>
</tbody>
</table>
## LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>SY104-1</td>
<td>Hydraulic System</td>
<td>4-5</td>
</tr>
<tr>
<td>SY104-2</td>
<td>Basic Hydraulic System</td>
<td>4-6</td>
</tr>
<tr>
<td>SY104-3</td>
<td>Hydraulic System Schematic</td>
<td>4-7</td>
</tr>
<tr>
<td>SY104-4</td>
<td>Landing Gear</td>
<td>4-7</td>
</tr>
<tr>
<td>SY104-5</td>
<td>Service Bay</td>
<td>4-8</td>
</tr>
<tr>
<td>SY104-6</td>
<td>Fill Rod</td>
<td>4-8</td>
</tr>
<tr>
<td>SY104-7</td>
<td>Pump Location</td>
<td>4-9</td>
</tr>
<tr>
<td>SY104-8</td>
<td>Reservoir Piston</td>
<td>4-10</td>
</tr>
<tr>
<td>SY104-9</td>
<td>Pressure Release Valve</td>
<td>4-10</td>
</tr>
<tr>
<td>SY104-10</td>
<td>Slide Valve Assembly</td>
<td>4-11</td>
</tr>
<tr>
<td>SY104-11</td>
<td>Slide Valve Assembly Closed</td>
<td>4-11</td>
</tr>
<tr>
<td>SY104-12</td>
<td>Selector Manifold</td>
<td>4-12</td>
</tr>
<tr>
<td>SY104-13</td>
<td>Electrical Selector Valves</td>
<td>4-13</td>
</tr>
<tr>
<td>SY104-14</td>
<td>Step 1</td>
<td>4-13</td>
</tr>
<tr>
<td>SY104-15</td>
<td>Step 2</td>
<td>4-14</td>
</tr>
<tr>
<td>SY104-16</td>
<td>Step 3</td>
<td>4-14</td>
</tr>
<tr>
<td>SY104-17</td>
<td>Step 4</td>
<td>4-15</td>
</tr>
<tr>
<td>SY104-18</td>
<td>Step 5</td>
<td>4-15</td>
</tr>
<tr>
<td>SY104-19</td>
<td>Analog Counter and Digital Display</td>
<td>4-16</td>
</tr>
<tr>
<td>SY104-20</td>
<td>Gauge Colors</td>
<td>4-17</td>
</tr>
<tr>
<td>SY104-21</td>
<td>HYDR FL LO Caution Advisory</td>
<td>4-17</td>
</tr>
<tr>
<td>SY104-22</td>
<td>Master Caution Annunciator</td>
<td>4-18</td>
</tr>
<tr>
<td>SY104-23</td>
<td>Devices Operated</td>
<td>4-19</td>
</tr>
<tr>
<td>SY104-24</td>
<td>Emergency System</td>
<td>4-20</td>
</tr>
<tr>
<td>SY104-25</td>
<td>Emergency Accumulator</td>
<td>4-20</td>
</tr>
<tr>
<td>SY104-26</td>
<td>Selector Valves</td>
<td>4-21</td>
</tr>
<tr>
<td>SY104-27</td>
<td>Emergency Hydraulic Lines</td>
<td>4-21</td>
</tr>
<tr>
<td>SY104-28</td>
<td>Emergency System T-Handle</td>
<td>4-22</td>
</tr>
<tr>
<td>SY104-29</td>
<td>Pressure Release Valve</td>
<td>4-22</td>
</tr>
<tr>
<td>SY104-30</td>
<td>Emergency System Sequence</td>
<td>4-23</td>
</tr>
<tr>
<td>SY104-31</td>
<td>Check Valve</td>
<td>4-24</td>
</tr>
<tr>
<td>SY104-32</td>
<td>Annunciator Advisories</td>
<td>4-25</td>
</tr>
<tr>
<td>SY104-33</td>
<td>Master Caution</td>
<td>4-25</td>
</tr>
<tr>
<td>SY104-34</td>
<td>Landing Gear Circuit Breaker</td>
<td>4-26</td>
</tr>
<tr>
<td>SY104-35</td>
<td>Landing Gear</td>
<td>4-27</td>
</tr>
<tr>
<td>SY104-36</td>
<td>Main Gear Doors</td>
<td>4-27</td>
</tr>
<tr>
<td>SY104-37</td>
<td>Nose Gear</td>
<td>4-28</td>
</tr>
</tbody>
</table>
Figure SY104-38 – Nose Gear Components ................................................................. 4-28
Figure SY104-39 – Main Gear Retraction ................................................................. 4-29
Figure SY104-40 – Nose Gear Retraction ................................................................. 4-30
Figure SY104-41 – Controls and Indicators ............................................................. 4-31
Figure SY104-42 – Gear Controls & Indications ...................................................... 4-31
Figure SY104-43 – Gear Position Indication ............................................................. 4-32
Figure SY104-44 – Emergency Controls ................................................................. 4-33
Figure SY104-45 – Landing Gear Indicator Lights .................................................. 4-34
Figure SY104-46 – Gear Lowering Airspeed ............................................................ 4-35
Figure SY104-47 – Gear Lowering Sequence .......................................................... 4-35
Figure SY104-48 – Aural Warning ......................................................................... 4-36
Figure SY104-49 – Gear Warning Horn Note ........................................................... 4-36
Figure SY104-50 – Warning Silence Control ........................................................... 4-37
Figure SY110-51 – Downlock Override Button ....................................................... 4-38
Figure SY110-52 – Downlock Override Notes 1-2 .................................................... 4-39
Figure SY104-53 – T-6B ....................................................................................... 4-39
Figure SY104-54 – Emergency Landing Gear Extension Handle ......................... 4-40
Figure SY104-55 – Landing Gear Selector Handle .................................................. 4-40
Figure SY104-56 – Emergency System Sequence ................................................... 4-42
Figure SY104-57 – Emergency Gear Down ............................................................. 4-43
Figure SY104-58 – Hydraulic System Schematic ..................................................... 4-44
OVERVIEW
This lesson is the first of two lessons on the hydraulic system and discusses the purpose, components and functions of the T-6B primary and emergency hydraulic systems. Landing gear extension/retraction, landing gear controls and indications, and emergency landing gear extension are also addressed. This lesson is designed to provide you with an understanding of the T-6B hydraulic system, systems that utilize the hydraulic system for operation, and their respective components. The last page of the student guide is an enlarged hydraulic system schematic for reference throughout the lesson.

REFERENCES
Personnel: None
Media Facilities: Student CAI Workstation
Support Resources: T-6B Flight Manual; T-6B Systems 1 Student Guide

STUDENT ASSIGNMENTS
Read applicable portions of T-6B Flight Manual, Section I.
Complete CAI lesson SY104, following along with this student guide.
Complete the practice questions provided.

LESSON OUTLINE
Topics in this lesson must be taken in sequential order. All topics must be completed prior to attempting the end of lesson quiz. The estimated time required to complete this lesson is 1.5 hours.
Introduction

Hydraulic System Basics

Primary Hydraulic System

<table>
<thead>
<tr>
<th>Number</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.18.0.0.1</td>
<td>Define terminology and concepts related to the hydraulic system</td>
</tr>
<tr>
<td>1.18.0.0.3</td>
<td>Identify major components of the hydraulic system</td>
</tr>
<tr>
<td>1.18.1.0.1</td>
<td>Identify purpose of the primary hydraulic system</td>
</tr>
<tr>
<td>1.18.1.0.3</td>
<td>Identify primary hydraulic system components</td>
</tr>
<tr>
<td>1.18.1.0.4</td>
<td>Match primary hydraulic system components to functions</td>
</tr>
<tr>
<td>1.18.1.0.5</td>
<td>Identify characteristics of normal operations for primary hydraulic system</td>
</tr>
</tbody>
</table>

Hydraulic System

Generally, aircraft use hydraulics (pressurized fluids) or pneumatics (compressed gases) to operate various systems like landing gear and flaps.

The T-6B has a hydraulic system that uses fluid pressurized to 3000 ± 120 pounds per square inch (psi).

Figure SY104-1 – Hydraulic System
Simple Hydraulic Demo

For a basic understanding of how a hydraulic system works, look at this example of a simplified hydraulic system.

A pump produces hydraulic pressure which is retained within the system until an electrical selector valve is opened, releasing the pressure necessary to operate an actuator.

The actuator then uses mechanical force to move the desired aircraft component like the flaps or landing gear.

Consequently, the hydraulic system can be referred to as electro-hydromechanical.

Figure SY104-2 – Basic Hydraulic System
Primary System

The T-6B’s hydraulic system includes a primary hydraulic system and, in the event of a primary hydraulic system failure or engine failure, an emergency system.

The primary hydraulic system operates the following devices in normal flight operations:

- Landing gear and main landing gear inboard doors
- Flaps
- Speed brake
- Nose wheel steering

Figure SY104-3 – Hydraulic System Schematic

Figure SY104-4 – Landing Gear
Service Bay

Many of the hydraulic system components are located in the hydraulic service bay shown here. It contains controls and indicators used to service the hydraulic system on the ground. Part of your preflight will include inspecting this area.

For example, this is where you will visually check the hydraulic system fluid level. The hydraulic reservoir fluid level indicator rod in the reservoir window indicates the hydraulic fluid level. If the rod shows in the green areas labeled FULL (AC) (Accumulator Charged) or FULL (AD) (Accumulator Discharged), then the system is fully serviced. If the indicator shows outside of either green marked area, maintenance should be notified.

Engine-Driven Pump 1

To understand how the T-6B primary hydraulic system operates, it’s best to begin with the source for the system’s critical 3000 ± 120 pounds of pressure, the engine-driven pump. Once pressure in the system exceeds 1800 psi, the system can be used to power nose wheel steering, landing gear, main gear doors, flaps, and speed brake operations.
Engine-Driven Pump 2

The engine-driven pump is located in the engine compartment. It is simply a hydraulic pump that is driven by the engine accessory gearbox.

---

Engine-Driven Pump 3

The pump creates and distributes pressure to the reservoir in the power package, onward to the individual selector valves in the selector manifold, and to the emergency system.
Reservoir Piston

The reservoir is an important part of the power package. It provides pressurized fluid back to the pump to keep the pump “charged” with fluid.

There is one problem however.

Because the pump produces 3000 ± 120 pounds of pressure, the fluid flowing back through the pump must be reduced so the pump itself is not damaged.

This problem is solved by using a piston that steps down the return side of the reservoir to 50 psi.

Pressure Release Valve

Located in the hydraulic service bay, the power package contains a pressure release valve that operates at 3250 to 3500 psi. Similar to the reservoir piston, this valve helps to avoid any damage caused by possible hydraulic overpressure.

Figure SY104-8 – Reservoir Piston

Figure SY104-9 – Pressure Release Valve
Slide Valve 1

The power package also has a slide valve assembly that is spring loaded in the normal open operating position.

The purpose of the slide valve is to isolate the hydraulic pressure coming from the engine-driven pump, through the power package, from the rest of the hydraulic system when the emergency system is activated.

Slide Valve 2

Pulling the landing gear emergency extension handle activates the emergency system and the slide valve moves to the closed position. The main hydraulic system is then isolated and emergency accumulator pressure is released to extend the landing gear and flaps.

The hydraulic pump pressure is prevented from energizing any hydraulic components except for the nose wheel steering actuator which is plumbed into the pressure line from the pump upstream of the power pack.
Slide Valve 3

Once accumulator pressure is released, hydraulic pressure from the pump is not available to recharge the accumulator.

The hydraulic system cannot return to normal mode operation without maintenance resetting the landing gear emergency extension handle and emergency selector manifold.

Selector Manifold

The selector manifold located in the hydraulic service bay allows the hydraulic system, the cockpit controls, and the aircraft devices operated by the hydraulic system to work together.

Figure SY104-12 – Selector Manifold
Specifically, the selector manifold contains an assembly of 5 electrical selector valves.

Each electrical selector valve connects to an actuator that physically moves the landing gear, main inboard gear doors, flaps, or speed brake.

Note that the nose wheel steering discussed in the next lesson is not a part of the manifold.

System Sequence

As a device such as the landing gear is activated, an electrical switch sends a signal to the selector manifold.
The selector manifold opens the appropriate electrical selector valve associated with the landing gear and main gear inboard doors.

Hydraulic pressure produced by the pump is released through selector valves and moves through the primary hydraulic lines leading to the respective actuator.
The increased hydraulic pressure activates the respective actuators.

The actuator strut extends, forcing the landing gear down. A separate strut, not shown here, also extends the main gear inboard doors.

Demo
EICAS Display

The Engine Indication and Crew Alerting System (EICAS), with a display placarded HYD PRESS, provides information about the condition of the hydraulic pressure in the primary hydraulic system in two ways:

- Analog scale
- Digital counter

Figure SY104-19 – Analog Counter and Digital Display
Scale Colors

There are three colors on the scale:

Green is within normal operating limits, ranging from 2880 to 3120 psi, in increments of 10. The digital counter will be white.

White is an extended scale, within safe operating limits. The digital counter remains white.

Yellow indicates that pressure is at a cautionary level and deserves special attention. The digital counter displays black characters on a yellow background.

Hydraulic Fluid Level

If the hydraulic fluid level in the reservoir drops below one quart, the Crew Alerting System (CAS) portion of the EICAS will display a yellow HYD FL LO caution advisory.
Master Caution Light

When the HYD FL LO advisory illuminates on the CAS display, the amber MASTER CAUTION annunciation on the master caution/warning panel in each cockpit will flash, and you will hear an audible warning tone.

These indications will also alert you to the possibility that the emergency system, rather than the primary hydraulic system, may need to be used to operate the landing gear and main inboard doors, and the flaps.

Emergency Hydraulic System

| 1.18.2.0.1 | Identify purpose of the emergency hydraulic system |
| 1.18.2.0.3 | Identify emergency hydraulic system components |
| 1.18.2.0.4 | Match emergency hydraulic system components to functions |
| 1.18.2.0.5 | Identify characteristics of normal operations for the emergency hydraulic system |
Emergency System

The emergency hydraulic system is independent from the primary system. It is pressurized at the time of engine start-up.

It will be used in any of three specific circumstances for emergency extension of the landing gear.

- In the event of primary hydraulic system failure
- In the event of engine failure
- In the event of battery bus failure

Emergency Operation

The emergency system provides sufficient pressure for a one-time lowering of both of the following aircraft components:

- The landing gear and main gear inboard doors
- The flaps

Once lowered by the emergency system, neither the landing gear nor the flaps can be retracted in flight.

Figure SY104-23 – Devices Operated
Components

This schematic shows the major components of the emergency system, also called the emergency package.

From the schematic, you can see that the emergency package does not have a pump like the primary system.

The emergency package gets its pressure to move the actuators from a major system component called the emergency accumulator.

Accumulator Bellows

It was mentioned earlier that the emergency package is pressurized at the time of engine start-up. Specifically, pressure from the primary system presses a metal bellows that in turn compresses helium gas stored inside the emergency accumulator.

After engine start the primary system will continuously keep the emergency system pressurized through a one-way check valve.
The compressed helium provides the emergency pressure needed to move the actuators without relying on electrical power.

Selector Valve Location

The emergency package has other components, including its own set of two selector valves. One valve activates the landing gear, and the other one activates the flaps.

Hydraulic Lines

The emergency package has separate and independent hydraulic lines that ensure gear and flap operation if there is no pressure available in the primary system’s hydraulic lines.
T-Handle

The pressure release T-Handle is located in the hydraulic service bay, and allows for the manual reduction of hydraulic pressure in the emergency accumulator by maintenance personnel.

Pressure Release Valve

The pressure release valve is located in the emergency package. It operates automatically to release excessive hydraulic pressure if it reaches 3500 psi.
Emergency System Sequence

When the emergency system is activated, the emergency extension selector valve in the emergency selector manifold opens, releasing stored pressure from the emergency accumulator.

This pressure moves fluid through the independent emergency hydraulic lines to the specified actuator which then activates the device.

Figure SY104-30 – Emergency System Sequence
Check Valve

A check valve in the emergency manifold prevents back flow from the emergency system to the main system, allowing the landing gear and flaps to be lowered using the emergency system.

If there is a leak within the emergency system, and the leak rate exceeds .25 gallons per minute, a hydraulic fuse located between the normal hydraulic system and the emergency selector manifold allows a maximum volume of 20-30 cubic inches (about 1 pint) to pass and then shuts off any further flow to the emergency system. This prevents the loss of all hydraulic fluid from the main system to the emergency system.

Demo
Indicators

If the pressure in the emergency accumulator drops to 2400 psi or below, the yellow EHYD PX LO caution advisory illuminates on the CAS portion of the EICAS display.

Master Caution

The MASTER CAUTION annunciator will flash, and you will hear an audible tone.
Landing Gear System

Extension and Retraction

| 1.18.3.0.1 | Identify purpose of landing gear extension/retraction system |
| 1.18.3.0.3 | Identify landing gear extension/retraction system components |
| 1.18.3.0.4 | Match landing gear extension/retraction system components to functions |
| 1.18.3.0.5 | Identify characteristics of normal operations for landing gear extension/retraction system |

Power

The landing gear system is one system that requires power from the T-6B hydraulic system. The T-6B has fully retractable tricycle landing gear. The extension and retraction system is hydraulically actuated, electrically sequenced, and mechanically operated.

Power for the landing gear controls is provided through a circuit breaker placarded LDG GR CONT, located on the battery bus circuit breaker panel in the front cockpit.

Figure SY104-34 – Landing Gear Circuit Breaker
Components

This schematic shows the major components of the main landing gear system, including the landing gear doors, the main landing gear, the nose gear doors, and the nose gear.

The landing gear system not only raises and lowers the wheels, but also operates the landing gear doors. However, 4 of the doors are mechanically operated while 2 are hydraulically raised and lowered.

Each gear leg is an oleo-pneumatic shock absorber, with a folding strut that has one end connected to the gear, and the other end attached to a main spar on the aircraft.

Main Gear Doors

Here you can see the landing gear doors. The inboard doors operate differently than the outboard doors in a very important way.

The hydraulically operated main gear inboard doors share a single actuator that turns a torque tube and bellcrank.
The mechanically operated main gear outboard doors are directly connected to the strut. These doors are simply pulled along as the strut is lowered and raised by their individual actuators which convert hydraulic pressure to mechanical force.

Nose Gear

The nose gear has two doors that are hinged at the fuselage and, when retracted, are held in place by the retracted nose gear.

Just like the main gear outboard doors, the nose wheel doors are simply pulled along with the nose strut as it lowers and raises.

Nose Gear Components

The major components for the nose gear include the spring strut, the nose leg actuator, and the nose gear door.

Unlike the main gear, the nose gear retracts rearward pulling its doors along with the nose strut.
Retraction Demo

In the following demonstration you will see the main wheels retract inboard into the wings, and the nose wheel rearward into the nose.

Once retracted, the main gear are covered by the main gear doors, but the nose wheel does not completely retract into the wheel well and is not completely covered by the nose gear doors. Once lowered, the main inboard gear doors close and must reopen before the gear can be raised. A normal gear extension/retraction sequence takes approximately six seconds.

Retracting Main Gear

This video demonstrates main gear retraction. An actuator opens the inboard door, and then the main gear actuator activates the strut to pull in the landing gear. The main gear up-lock engages during the closing of the doors.

Figure SY104-39 – Main Gear Retraction
Extending Main Gear

The main gear up-lock engages when the main doors are closing, and disengages when they are opening. Internal locks in the main gear actuators engage to lock the main gear in the down position.

Retracting Nose Gear

When the nose gear is raised, the actuator retracts and the doors are pulled up with the strut. The doors are locked into position by the actuator.

Notice that the wheel does not completely retract into the wheel well.

Extending Nose Gear

As the actuator extends the strut to extend the nose gear, the doors open and remain open while the gear is extended. The spring-strut locks the strut in the down position.

Figure SY104-40 – Nose Gear Retraction
Controls and Indications

Besides the various cockpit indicators used to monitor the hydraulic system, there are several controls and indications that aid in the operation of the landing gear:

One landing gear control handle in each cockpit for raising and lowering the gear

Gear position indicator lights

An unsafe gear aural warning tone

Figure SY104-41 – Controls and Indicators

Figure SY104-42 – Gear Controls & Indications
Gear Position Indicator

The position indicator depicts three types of information about the landing gear:

- The extension or retraction of the landing gear and doors is complete.
- The landing gear main inboard doors are open.
- The landing gear and/or gear doors are in transit.

*Figure SY104-43 – Gear Position Indication*
Gear Handle

To prevent inadvertent movement of the landing gear control handle, you must move it over a detent as it is raised.

The gear handle will illuminate red to indicate one of the following conditions:

The main gear inboard doors are not closed

The PCL is approaching IDLE with the gear handle UP

Figure SY104-44 – Emergency Controls
Indicator Lights

Each gear has its own position indicator light. A red light is illuminated whenever:

- the gear or inboard gear doors (main gear only) are in transit

- the PCL is approaching IDLE and the gear handle is UP, regardless of airspeed

Green is displayed only when the gear is down and locked.

Figure SY104-45 – Landing Gear Indicator Lights
Full Gear Retraction

When the gear and gear doors are fully retracted and the PCL is not in IDLE, there will be no lights illuminated.

Procedure

To operate the landing gear, simply move the landing gear control handle to the desired position. Make sure your airspeed is below 150 KIAS any time the gear is extended.

Demo

Position Indicator Demo

Here you see the normal sequence for raising and lowering the gear. Notice the sequence of the lights as the handle is raised and lowered.
Aural Warning

There is one other landing gear indicator, the aural landing gear position warning. This aural tone safeguards against a gear-up landing and is heard directly through the headset if any of the following conditions exists:

Gear handle not DOWN (regardless of gear indications), PCL below a mid-range position (approximately 87% N₁), airspeed below 120 KIAS, and flaps UP or TAKEOFF

All gear not indicating down and locked with flaps LDG (regardless of gear door position, power setting, or airspeed)

There is weight on the wheels with the gear handle not DOWN

Note

Gear warning horn will automatically silence when the gear handle is lowered with flaps UP or TAKEOFF, regardless of gear position. Checking actual gear down indication is essential to confirming proper safe gear configuration.

Figure SY104-48 – Aural Warning

Figure SY104-49 – Gear Warning Horn Note
Silencer

When the warning is activated, it may be silenced by the WARNING SILENCE button on the landing gear control unit, unless:

- gear UP and flaps LDG
- gear handle UP with aircraft on the ground.

If LDG flaps are not selected, the horn will not sound if the silence button is pressed when:

- airspeed is above 120 knots,
- PCL below approximately 87% N₁,
- and subsequently the aircraft is slowed below 120 knots.

The aural warning will reset only if the PCL is moved above 87% N₁, then retarded below 87% N₁.

An airspeed sensor prevents warnings above 120 knots, gear and flaps UP, regardless of PCL position.
Downlock Override 1

When the weight-on-wheels (WOW) switch senses the aircraft on the ground, the downlock solenoid prevents movement of the landing gear select handle.

The downlock override button (located in the front cockpit only) can be used to override the downlock solenoid when the right WOW switch is energized on the ground. This will only allow the landing gear selector handle to be raised and the landing gear will not retract.

Downlock Override 2

When the aircraft is airborne and use of the downlock override button is necessary (emergency situation), the landing gear selector handle can be raised and the landing gear will retract.

However, when the downlock override button is used with airborne failure of the WOW switch, only the landing gear selector handle can be raised and the landing gear will not retract.

Figure SY110-51 – Downlock Override Button
Notes 1-2

Emergency Extension

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.18.5.0.1</td>
<td>Identify purpose of landing gear emergency extension system</td>
</tr>
<tr>
<td>1.18.5.0.3</td>
<td>Identify landing gear emergency extension system components</td>
</tr>
<tr>
<td>1.18.5.0.4</td>
<td>Match landing gear emergency extension system components to functions</td>
</tr>
<tr>
<td>1.18.5.0.5</td>
<td>Identify characteristics of normal operations for landing gear emergency extension system</td>
</tr>
</tbody>
</table>

Purpose

As stated before, the emergency package allows a one-time lowering of the landing gear if:

- There is a failure of the primary hydraulic system
- There is a loss of engine power
- There has been a failure of the battery bus

Figure SY110-52 – Downlock Override Notes 1-2

Figure SY104-53 – T-6B
You will recall from the discussion on the emergency package, that the landing gear can be lowered using components that are independent of the primary system.

Extension Handle 1

The manual emergency landing gear extension handle, placarded EMER LDG GR, activates the emergency system, extending the landing gear. This extension handle is located on the lower left side of the front cockpit instrument panel.

Extension Handle 2

Pulling this handle will extend the landing gear regardless of the position of the landing gear selector handle. However, for emergency operations you should first set the landing gear selector handle to DOWN. This is an important part of the procedure since there is some chance that the primary hydraulic system may work and you will not need to activate the emergency system.

Once you emergency extend the landing gear, it cannot be retracted until serviced on the ground.

Figure SY104-54 – Emergency Landing Gear Extension Handle

Figure SY104-55 – Landing Gear Selector Handle
Procedure

The procedure for lowering the landing gear and flaps using the emergency package is as follows:

1. Reduce airspeed to 150 KIAS or below

2. Landing Gear Handle - DOWN (it will remain illuminated)

3. Emergency Landing Gear Handle - Pull handle

4. Confirm proper gear configuration

The gear indicator lights will show 3 green, 2 red main gear doors, and a red gear handle.

5. Flaps - As required

Lower flaps to desired setting (extension will be slow).
Emergency Extension

When the emergency system is activated by the emergency landing gear extension handle, the landing gear emergency extension selector valve is mechanically activated.

Selector valve opens releasing stored pressure from the emergency accumulator which moves through the emergency lines.

Pressure moving through the separate emergency lines activates four landing gear actuators.

- Main gear inboard gear doors
- Left main gear
- Right main gear
- Nose gear
- Flaps can also be lowered

Figure SY104-56 – Emergency System Sequence
Extension Time

You should be aware that the extension using the emergency system will take longer than the usual 5-6 seconds.

When you use the emergency system, the main gear inboard doors will extend and remain extended. You should get the cockpit indications shown here. The gear selector handle will remain illuminated.

Figure SY104-57 – Emergency Gear Down
Figure SY104-58 – Hydraulic System Schematic

Lesson Review Quiz
LESSON QUESTIONS

EMBEDDED QUESTIONS (Ref: Segment/Topic/Question)

1. What are the four devices operated by the primary hydraulic system under normal operations? (B/1/1)
   a. Landing gear/main gear doors, flaps, speed brake, and trim aid device
   b. Landing gear/main gear inboard doors, flaps, speed brake, and nose wheel steering
   c. Landing gear, flaps, speed brake, and flight controls
   d. Landing gear, main gear inboard doors, flaps, speed brake, and lights

2. The hydraulic system and the return side of the power package reservoir are pressurized to which levels respectively? (B/1/2)
   a. 2000 ± 120 and 50 psi
   b. 2000 ± 120 and 60 psi
   c. 3000 ± 120 and 40 psi
   d. 3000 ± 120 and 50 psi

3. When you select a cockpit control to lower the flaps, which element of the primary hydraulic system is responsible for activating the corresponding actuator? (B/1/3)
   a. Reservoir piston
   b. Electrical selector valve
   c. Main strut
   d. Release valve
4. The hydraulic pressure indicated by this EICAS display is ______. (B/1/4)
   a. in the extended scale, within safe and normal operating limits
   b. within normal operating limits
   c. at a cautionary level
   d. indicating a failure of the primary hydraulic system
5. During the loss of engine power, the primary hydraulic system, or the battery bus, the emergency package will allow a one-time extension of______. (B/2/1)
   a. flaps, speed brake, and nose wheel steering
   b. flaps, landing gear, and speed brake
   c. flaps, landing gear, and main gear inboard doors
   d. flaps, landing gear, and main gear inboard doors, and speed brake

6. The emergency package’s manifold contains which of the following? (B/2/2)
   a. 2 emergency extension selector valves
   b. 2 metal bellows compressing helium gas
   c. 2 actuators
   d. 2000 psi emergency accumulator

7. What is the purpose of the pressure release valve in the emergency hydraulic system? (B/2/3)
   a. To activate the actuators
   b. To automatically release pressure should it reach 3500 psi
   c. To prevent engine fires
   d. To provide manual reduction in pressure in the emergency accumulator

8. When the EHYD PX LO caution advisory illuminates, it means that emergency accumulator hydraulic pressure is at or below _____ psi. (B/2/4)
   a. 1790
   b. 1880
   c. 2400
   d. 3000

9. Which set of landing gear doors are operated hydraulically? (C/1/1)
   a. The nose wheel doors
   b. The main gear inboard and outboard doors
   c. The main gear inboard doors
   d. The main gear outboard doors
10. A red light illuminated in the landing gear selector handle indicates that the PCL is approaching IDLE, with the gear handle up, or which of the following? (C/2/1)
   a. The landing gear doors are up and locked.
   b. The landing gear doors are not closed.
   c. The landing gear circuit breaker needs to be reset.
   d. The landing gear is malfunctioning.

11. Match the statements with the correct gear indication. (C/2/2)
   a. Gear Down and Locked
   b. Gear Down (Doors Opening or Closing)
   c. Gear Up (Doors Closing or Opening)

12. Before extending the landing gear______. (C/2/3)
   a. activate the aural warning silence button
   b. reduce airspeed below 150 KIAS
   c. ensure at least 2000 psi is available
   d. reduce airspeed below 120 KIAS

13. What is the function of the emergency landing gear extension handle? (C/3/1)
   a. It releases hydraulic pressure once it reaches 3500 psi
   b. It activates the emergency system
   c. It closes the slide valve assembly
   d. It activates the accumulator piston
LESSON REVIEW QUIZ QUESTIONS

1. The engine-driven pump pressurizes the hydraulic system to which of the following?
   a. 1790 ± 120 psi
   b. 2000 ± 120 psi
   c. 3000 ± 120 psi
   d. 3600 ± 120 psi

2. The primary hydraulic system operates which of the following?
   a. Landing gear, main gear doors, flaps, trim aid device
   b. Landing gear, flaps, nose wheel steering, trim aid device, and speed brake
   c. Landing gear, main gear inboard doors, flaps, nose wheel steering, and speed brake
   d. Landing gear, flaps, speed brake, and wheel brakes

3. What is true about the power package reservoir?
   a. It releases excess pressure at 1790 psi
   b. It is pressurized using compressed nitrogen gas
   c. It is pressurized using compressed helium gas
   d. A piston helps to step-down pressure to protect the pump

4. The primary hydraulic system’s selector manifold contains which of the following?
   a. Engine-driven pump
   b. Electrical selector valves
   c. Actuators
   d. Reservoir piston

5. Two specific conditions in which the emergency hydraulic system is used are:
   a. The pressure drops below 3000 psi, and you’re below 6000 feet
   b. Loss of engine power or the primary hydraulic system fails
   c. Loss of engine power and the airspeed is less than 120 KIAS
   d. More than a 2-second drop in pressure, and altitude is less than 6000 feet

6. The emergency hydraulic system specifically operates which of the following?
   a. Landing gear, flaps, and speed brake
   b. Landing gear, main gear doors, speed brake, and flaps
   c. Landing gear, main gear doors, nose gear doors, and flaps
   d. Landing gear, main gear inboard doors, and flaps
7. The emergency package receives its pressure from which of the following?
   a. Directly from a nitrogen pre-charge in the reservoir
   b. From the emergency accumulator
   c. Directly from the reservoir piston
   d. From the emergency selector valves

8. Before lowering the gear using either the primary or emergency systems, ensure the _____.
   a. flaps are retracted
   b. airspeed is below 120 KIAS
   c. flap handle is in the LAND position and airspeed less than 120 KIAS
   d. airspeed is below 150 KIAS

9. The amber EHYD PX LO advisory means which of the following?
   a. Pressure in the emergency accumulator is below 2400 psi ± 150
   b. Pressure in the reservoir is below 3000 ± 120 psi
   c. Pressure in the emergency package is below 2870 psi
   d. Pressure in the emergency package is below 1 Qt

10. The HYD FL LO advisory means which of the following?
   a. Fluid level is below .5 Qt
   b. Fluid level is below 1790 psi
   c. Accumulator fluid level is below 1 Qt
   d. Reservoir fluid level is below 1 Qt

11. When the power package slide valve closes, the hydraulic pump pressure is prevented from energizing any hydraulic components except for the _____.
   a. main landing gear actuator
   b. nose wheel steering actuator
   c. flap actuator
   d. emergency selector manifold
TABLE OF CONTENTS

TABLE OF CONTENTS .......................................................................................................................... 5-1
LIST OF FIGURES ............................................................................................................................... 5-2
OVERVIEW ........................................................................................................................................... 5-4
REFERENCES ....................................................................................................................................... 5-4
STUDENT ASSIGNMENTS .................................................................................................................... 5-4
LESSON OUTLINE ............................................................................................................................... 5-4
INTRODUCTION .................................................................................................................................... 5-5
HYDRAULIC SYSTEM 2 ......................................................................................................................... 5-5
   FLAPS ................................................................................................................................................ 5-5
   SPEED BRAKE ................................................................................................................................... 5-11
   NOSE WHEEL STEERING ..................................................................................................................... 5-16
   WHEEL BRAKES ............................................................................................................................... 5-21
LESSON QUESTIONS ........................................................................................................................... 5-26
LIST OF FIGURES

| Figure SY015-1 – Split Flap Configuration | ................................................................. | 5-5 |
| Figure SY015-2 – Lift and Drag | ................................................................. | 5-5 |
| Figure SY015-3 – Effect of Flaps on Takeoff | ................................................................. | 5-6 |
| Figure SY015-4 – Effect of Flaps on Landing | ................................................................. | 5-6 |
| Figure SY015-5 – Flaps Circuit Breaker | ................................................................. | 5-6 |
| Figure SY015-6 – Hydraulic System Schematic | ................................................................. | 5-7 |
| Figure SY015-7 – Flap Selector | ................................................................. | 5-7 |
| Figure SY015-8 – Flap Indicator Gauge | ................................................................. | 5-8 |
| Figure SY015-9 – Selector Valve | ................................................................. | 5-8 |
| Figure SY015-10 – Flap Actuator | ................................................................. | 5-8 |
| Figure SY015-11 – Torque Tube | ................................................................. | 5-9 |
| Figure SY015-12 – Flap Operating Speed | ................................................................. | 5-9 |
| Figure SY015-13 – Battery Bus Failure | ................................................................. | 5-10 |
| Figure SY015-14 – Flap Operation Visual | ................................................................. | 5-11 |
| Figure SY015-15 – Speed Brake | ................................................................. | 5-11 |
| Figure SY015-16 – Speed Break Circuit Breaker | ................................................................. | 5-12 |
| Figure SY015-17 – Speed Brake Switch | ................................................................. | 5-12 |
| Figure SY015-18 – Speed Brake Operation | ................................................................. | 5-12 |
| Figure SY015-19 – PCL Switch | ................................................................. | 5-13 |
| Figure SY015-20 – Valve | ................................................................. | 5-13 |
| Figure SY015-21 – Actuator | ................................................................. | 5-14 |
| Figure SY015-22 – Actuator Strut | ................................................................. | 5-14 |
| Figure SY015-23 – PCL to MAX | ................................................................. | 5-15 |
| Figure SY015-24 – Dual Controls | ................................................................. | 5-15 |
| Figure SY015-25 – Taxi | ................................................................. | 5-17 |
| Figure SY015-26 – NWS Circuit Breaker | ................................................................. | 5-17 |
| Figure SY015-27 – NWS Control and Indicator | ................................................................. | 5-18 |
| Figure SY015-28 – Nose Wheel Turn Angle | ................................................................. | 5-18 |
| Figure SY015-29 – Primary Hydraulic NWS Schematic | ................................................................. | 5-19 |
| Figure SY015-30 – Actuator | ................................................................. | 5-19 |
| Figure SY015-31 – Selector Valve | ................................................................. | 5-20 |
| Figure SY015-32 – Servo Valve | ................................................................. | 5-20 |
| Figure SY015-33 – Centering Valve | ................................................................. | 5-20 |
| Figure SY015-34 – NWS | ................................................................. | 5-21 |
| Figure SY015-35 – NWS Warning | ................................................................. | 5-21 |
| Figure SY015-36 – Toe Brakes | ................................................................. | 5-23 |
Figure SY105-37 – Turn Radius.................................................................................................. 5-24
Figure SY105-38 – Parking Brake Controls ........................................................................... 5-24
Figure SY105-39 – Brake Handle............................................................................................ 5-25
Figure SY105-40 – Parking Brake Cable ............................................................................... 5-25
OVERVIEW
This is the second of two lessons on the T-6B hydraulic system. It discusses the purpose, components and functions of the T-6B flaps, speed brake, nose wheel steering, and wheel brake systems.

REFERENCES
Personnel: None
Media Facilities: Student CAI Workstation
Support Resources: T-6B Flight Manual, T-6B Systems 1 Student Guide,

STUDENT ASSIGNMENTS
Read applicable portions T-6B Flight Manual, Section 1
Review SY105-Hydraulic Systems Student Guide

LESSON OUTLINE
Topics in this lesson must be taken in sequential order. All topics must be completed prior to attempting the end of lesson quiz. The estimated time required to complete this lesson is 1.3 hours.
Introduction

Hydraulic System 2

Flaps

| 1.18.8.0.1 | Identify purpose of flaps system |
| 1.18.8.0.3 | Identify flaps system components |
| 1.18.8.0.4 | Match flaps system components to functions |
| 1.18.8.0.5 | Identify characteristics of normal operations for flaps system |

Purpose

A very important component to help you operate the T-6B is the flap system. The T-6B flap system allows you to control the flap settings to achieve various approaches and landings.

The T-6B uses a split flap concept with an inboard and outboard panel on each wing as illustrated above.

Takeoff and Landing

Flaps are used to produce an increase or decrease in the aerodynamic forces called lift and drag. Very simply, lift works against the weight of the aircraft to lift it up, and drag works against thrust to slow the motion of the aircraft.

Figure SY105-1 – Split Flap Configuration

Figure SY105-2 – Lift and Drag
Out of the three possible flap settings, the takeoff setting will produce the greatest amount of lift with least drag to shorten your takeoff ground run.

Here you can see how using flaps for landing (50°) allows you to maintain the approach glidepath while reducing your approach airspeed. Notice how the landing ground roll distance is shorter using flaps.

Power

The flaps are electrically controlled and hydraulically operated.

Electrical power for the flap system is provided through a circuit breaker placarded FLAP CONT on the battery bus circuit breaker panel in the front cockpit.
Flaps Schematic

The flaps are operated by the primary hydraulic system and the emergency hydraulic system.

Besides the flap indicators and the flap selectors in each cockpit, the flap system includes:

- Two selector valves
- An emergency extension selector solenoid
- A flap actuator
- A flap torque tube
- Associated microswitches

Controls

Flap position is controlled by a three-position flap selector located on the left console in each cockpit. To operate the flaps, simply move the flap selector on the PCL quadrant to one of the three positions. The flap selectors are interconnected so the movement of one will be duplicated by the other.

The switch can be set to UP, TO (Takeoff), or LDG (Landing).
You can monitor the position of the flaps using the flap indicator gauge in each cockpit.

Sequence

As you select the flap switch on the PCL quadrant, the electrical system sends a signal to the electrical selector valve in the manifold to open or close.

Pressure released by the selector valve moves through the hydraulic line to the flap actuator.

Figure SY105-8 – Flap Indicator Gauge

Figure SY105-9 – Selector Valve

Figure SY105-10 – Flap Actuator
The flap actuator drives the flap actuator strut which rotates the torque tube and flap segments to the selected setting.

As the torque tube rotates, a cam on the torque tube activates position sensing microswitches to drive the flap indicator in each cockpit.

Flap Operating Speed

Make sure your airspeed is below 150 KIAS before you operate the flaps.

Emergency Extension

Should the primary hydraulic system fail, the emergency hydraulic system operates the flaps for a one-time extension only. Emergency flap extension is activated by a solenoid located in the power system emergency package. Once extended, they can not be retracted.
However, emergency flap extension can only be operated after the emergency landing gear handle has been activated. When the handle is pulled, stored pressure from the emergency accumulator is released allowing the flaps to be lowered.

Flap Operations

Normal flap operation and position indication are unavailable when:

The battery bus has failed

or

The auxiliary battery is the only source of electrical power

Emergency flap operation is powered by the hot battery bus and is not available when the auxiliary battery is the only source of electrical power.
Should the flap position indicator fail, you can not visually confirm the position of the flaps from inside the cockpit. If the hydraulic system is operating properly, as you extend the flaps, you will detect a slight tendency for the nose to pitch up.

### Speed Brake

| 1.18.7.0.1 | Identify purpose of speed brake system  |
| 1.18.7.0.3 | Identify speed brake system components |
| 1.18.7.0.4 | Match speed brake system components to functions |
| 1.18.7.0.5 | Identify characteristics of normal operations for speed brake system |

### Purpose

The speed brake is a device used on many high performance aircraft. Basically, its purpose is to allow you to increase drag.

By increasing drag, you can do two things:

- Decelerate
- Increase descent rate without increasing airspeed

---

**Figure SY105-14 – Flap Operation Visual**

**Figure SY105-15 – Speed Brake**
Power

The speed brake operates using both the electrical and hydraulic systems.

The speed brake system receives electrical power through a circuit breaker placarded SPEED BRAKE on the generator bus circuit breaker panel.

It is electrically controlled by a cockpit switch, the speed brake switch, located on the PCL in each cockpit. A Crew Alerting System (CAS) advisory illuminates when the speed brake is extended.

Speed Brake Demo

The speed brake switch is a three-position switch. Moving the speed brake switch to the aft position will lower the speed brake. Moving the switch forward will retract the speed brake. Each time the switch is moved, it will return to its spring-loaded center position.
Sequence

As the pilot moves the speed brake switch, the selector manifold operates a selector valve that controls hydraulic pressure to the actuator.

The selector valve then opens or closes.
The actuator uses the pressure provided by the primary hydraulic system to create a mechanical force that will be used to extend or retract the speed brake. It has an internal hydraulic uplock to keep the speed brake retracted when the engine is off.

The actuator strut works to extend or retract the speed brake.
Operation Constraints

There are some operating constraints for the speed brake. The speed brake will not extend if the flaps are already extended. Once extended, the speed brake remains extended until any of three things take place.

- The speed brake switch is moved forward
- The flaps are extended to the landing or takeoff position
- The power control lever is moved to MAX

The speed brake is NOT operated by the emergency hydraulic system. Should the primary hydraulic system fail, you will not be able to use the speed brake.

Priority

Because there is a speed brake switch in both cockpits, it is important to note that the speed brake will respond to whoever makes the last input.
Speed Brake Effects

When the speed brake is extended, it will cause the nose of the aircraft to pitch up slightly and the opposite is true when it is retracted.

To help counteract this pitch change, the speed brake is interconnected to the elevator trim tab actuator through a flexible cable system to automatically input pitch trim changes when the speed brake is operated.

These inputs will counteract some, but not all of the pitch change tendency. Therefore, when operating the speed brake, you may still need to anticipate these pitch change tendencies and adjust the elevator trim as required.

Nose Wheel Steering

| 1.18.6.0.1 | Identify purpose of nose wheel steering system |
| 1.18.6.0.3 | Identify nose wheel steering system components |
| 1.18.6.0.4 | Match nose wheel steering system components to functions |
| 1.18.6.0.5 | Identify characteristics of normal operations for nose wheel steering system |
Purpose

Maneuvering on the ground during taxi, takeoff, and landing is a very critical aspect of operating the T-6B. There are actually three methods of steering the aircraft.

Through the application of differential braking

Operation of the hydraulic Nose Wheel Steering (NWS) system

Through use of the rudder (with sufficient propwash or airflow)

Power and Controls

The NWS system actually operates using electrical, mechanical and hydraulic power.

The NWS receives its electrical power through a circuit breaker placarded NWS on the generator bus circuit breaker panel in the front cockpit.

Figure SY105-25 – Taxi

Figure SY105-26 – NWS Circuit Breaker
You will activate NWS with a push button on the control stick grip. A green indicator illuminates on the left side of each instrument panel when NWS is activated.

Pedal Operations

NWS is mechanically operated by cables connected to the rudder pedals. After activating the NWS, you steer the aircraft by simply pushing the left or right rudder pedal to turn the nose wheel in the desired direction.

Nose Wheel

The nose wheel is free castoring, turning on its own up to 80° in either direction when the NWS is off and rudder or differential braking is used.

When selecting the NWS, you control the amount of movement of the nose wheel up to 12° in either direction.
Even though you have a greater turn radius than when using the brakes, NWS is more sensitive and you must take care not to lose control on the ground.

Sequence

The primary hydraulic system supplies the necessary pressure to steer and drive the nose wheel.

Most of the NWS components are located in the actuator assembly at the top of the nose wheel strut.

Here, you can see the rotary actuator which is the device that mechanically turns the nose wheel strut.
Components

The NWS selector control valve is located in the actuator assembly. An electrical solenoid controlled from the cockpit opens the valve which provides hydraulic pressure to the actuator.

The servo valve has a small lever that is connected to the rudder pedals by a push-pull cable. When you push on a pedal, the lever moves back and forth using hydraulic pressure to turn the rotary actuator.

Centering Valve

Finally, internally within the actuator, is a centering valve. It returns the wheel to a centered position before it is extended from or retracted into the nose wheel bay.
Operation Constraints

Here, you can see that NWS is not serviced by the emergency system, and is not a part of the selector manifold.

This means that you should expect to use rudder and/or differential braking to control the aircraft if the primary hydraulic system fails.

Warning

Failure of the nose wheel steering system may prevent the pilot from changing nose wheel direction without disengaging the system. If the nose wheel steering system fails to respond to pilot input, disengage nose wheel steering and use differential braking to maintain directional control while stopping the aircraft. Do not taxi with a known directional control problem.

Wheel Brakes

1.18.9.0.1 Identify purpose of wheel brakes system
1.18.9.0.3 Identify wheel brakes system components
1.18.9.0.4 Match wheel brakes system components to functions
1.18.9.0.5 Identify characteristics of normal operations for wheel brakes system

WARNING

NWS is to be used at ramp speeds only. Engaging NWS at high taxi speeds can result in directional control problems due to increased sensitivity.

Figure SY105-34 – NWS

Figure SY105-35 – NWS Warning
Purpose

The wheel brakes allow you to control the aircraft in two ways.

The primary purpose of the wheel brakes is to slow down and/or stop the aircraft on the ground.

The wheel brakes can also be used to turn the aircraft on the ground in case a tight turning radius is required.

Power

It is important to note that the T-6B wheel brake system is a non-boosted, mechanically actuated system that operates using an independent hydraulic system and is not a part of the aircraft's primary hydraulic system.

This means the brake system is not affected by the failure of the primary hydraulic system.
Controls

You will use the toe brakes by applying pressure to the top of each rudder pedal. You can use the same or different amounts of pressure on each toe brake to turn and/or stop the aircraft.

Master cylinders located on a bulkhead frame forward of the aft instrument panel are interconnected to both forward and rear cockpit rudder pedals. Toe activated pedals mounted to the rudder pedals in each cockpit operate the corresponding master cylinder and apply pressure to the disk brake unit on the desired main wheel.

The master cylinders receive their fluid from a reservoir which is the holding point for the fluid.

Brake Unit

Each brake unit is a disc brake with six pistons and two discs. There is a brake unit for the left and right main wheels only.

Pressure moving through the hydraulic line from the master cylinder activates the individual disc brake unit.
Since the front and rear brake pedals are interconnected by sharing a master cylinder for the left and right rudder pedals, the pilot applying the most force on the pedal will determine the amount of braking that will occur.

Brake Demo

Turn Demo

As mentioned before, wheel brakes are used when a tighter turning radius than the NWS performs is necessary.

Parking Brake

The parking brake is used once the aircraft is stopped.

It is activated by simply applying the toe brakes while simultaneously pulling and turning the parking brake handle 90° clockwise.

**Figure SY105-37 – Turn Radius**

**Figure SY105-38 – Parking Brake Controls**
To release the parking brake you need to turn the handle 90° counterclockwise. Take care to not let the handle slam back into position as you turn it. This will help avoid any damage.

Parking Brake Cable

The parking brake system is quite simple. When you push on the toe pedals while pulling and turning the handle, a separate cable closes a brake valve. This prevents the return of fluid.

The brake discs are then locked in place so the wheels can't rotate.

Lesson Review Quiz
LESSON QUESTIONS

EMBEDDED QUESTIONS (Ref: Topic/Question)

1. What does using flaps in the landing setting allow you to do? (B/1/1)
   a. Maintain approach glidepath while increasing airspeed
   b. Decrease approach glidepath while maintaining airspeed
   c. Decrease approach glidepath while increasing airspeed
   d. Maintain approach glidepath while reducing airspeed

2. What happens if the primary hydraulic system fails? (B/1/2)
   a. The flaps cannot be used until they are serviced on the ground.
   b. The electrical FLAPS CONT circuit breaker must be reset.
   c. The flaps can be operated using the emergency system package.
   d. The emergency system provides a one-time lowering and retraction of the flaps.

3. Before operating the flaps using the emergency system, you must ______. (B/1/3)
   a. check the flaps visually to find their position
   b. increase your speed above 150 KIAS
   c. check the Crew Alerting System (CAS) display for the BATT BUS advisory
   d. lower the landing gear using the emergency system

4. Which of the following is a critical limitation of the speed brake? (B/2/1)
   a. The speed brake will only extend if the flaps are extended.
   b. The speed brake does not operate using the emergency hydraulic system.
   c. The speed brake extends automatically if the PCL is moved to the MAX position.
   d. The speed brake’s actuator is a part of the selector manifold.

5. Where does the pressure come from that creates the mechanical force to extend the speed brake? (B/2/2)
   a. From the primary hydraulic system
   b. From the emergency accumulator
   c. From the turning of the torque tube
   d. From the circuit breaker placarded SPEED BRAKE on the generator bus circuit breaker panel
6. Which of the following is an important difference between using the NWS or differential braking? (B/3/1)
   a. Differential braking results in a wider turn radius than NWS.
   b. NWS is more sensitive than differential braking.
   c. Differential braking should be avoided above 20 knots.
   d. NWS provides a tighter turn radius than differential braking.

7. What happens to NWS if the primary hydraulic system fails? (B/3/2)
   a. The NWS receives its hydraulic pressure from the emergency accumulator.
   b. The pilot must manually deselect NWS.
   c. NWS sensitivity will increase because of differential pressure.
   d. The NWS system will be inoperative and use of rudder and/or differential braking on the ground will be necessary.

8. Which is true regarding the wheel brake system? (B/4/1)
   a. If the hydraulic system fails, the parking brake must be used.
   b. The wheel brakes are not serviced by the emergency system, and will not be available if the primary system fails.
   c. The wheel brake system will continue to operate if the primary hydraulic system fails.
   d. The wheel brake system shares the primary hydraulic system pressure lines.

9. Which is the procedure for activating the parking brake? (B/4/2)
   a. Pull and turn the handle 90° counterclockwise while pushing on the toe brakes.
   b. Push and turn the handle 90° clockwise while pushing on the toe brakes.
   c. Pull the handle while pushing on the toe brakes.
   d. Pull and turn the handle 90° clockwise while pushing on the toe brakes.

**LESSON QUIZ QUESTIONS**

1. Which is true regarding the nose wheel steering system?
   a. NWS has only one actuator in the manifold.
   b. The emergency system provides pressure to NWS through the alternate hydraulic lines.
   c. The NWS is separate from the selector manifold.
   d. NWS has two actuators in the manifold.
2. Which is true regarding the NWS and emergency systems?
   a. The emergency system powers the NWS through the accumulator.
   b. The NWS will not operate if the primary hydraulic system fails.
   c. Differential braking will not work if the primary hydraulic system fails.
   d. The emergency system powers the NWS through the selector control valve.

3. Which component specifically ensures the nose wheel is properly aligned before it is retracted or extended?
   a. Selector valve
   b. Centering valve
   c. Servo valve
   d. Rotary actuator

4. Engaging NWS at high speeds can result in ______.
   a. directional control problems due to increased sensitivity
   b. damage to the nose wheel steering actuator
   c. damage to the nose wheel steering centering valve
   d. the speed brake automatically extending, slowing the aircraft down

5. What are the functions of the speed brake?
   a. Reduce drag and reduce lift
   b. Decelerate, and increase descent rate without increasing airspeed
   c. Increase drag and accelerate
   d. Increase true airspeed while reducing induced and parasite drag

6. Which is true regarding the speed brake?
   a. It will not operate using the emergency system.
   b. It extends only partially using the emergency system.
   c. It extends but will not retract using the emergency system.
   d. It will remain extended until the PCL is moved to IDLE.

7. Which of the following will NOT cause the speed brake to retract?
   a. The PCL is moved to MAX.
   b. The flaps are extended.
   c. The speed brake switch is moved forward.
   d. The gear is retracted.
8. If the flap indicator fails, how can flap extension be confirmed?
   a. Observing a slight nose down tendency
   b. Observing a slight nose up tendency
   c. The pilot must visually confirm the flap position
   d. By using the hydraulic pressure gauge

9. Which statement below is correct regarding flap operations?
   a. Normal flap operation is available when the battery bus has failed.
   b. The flap position indicator will function normally when the battery bus has failed.
   c. Emergency flap operation IS NOT available when the auxiliary battery is the only source of electrical power.
   d. Emergency flap operation IS available when the auxiliary battery is the only source of electrical power.

10. Which is true regarding the parking brake?
    a. The parking brake will not operate if the hydraulic system fails.
    b. It is activated by first pulling and turning the handle 90° clockwise or counterclockwise.
    c. The parking brake will operate partially using the emergency system.
    d. The parking brake is applied by pushing on the toe brakes while simultaneously activating the handle.

11. Before lowering the flaps, you should ensure your airspeed is less than which value?
    a. 120 KIAS
    b. 138 KIAS
    c. 147 KIAS
    d. 150 KIAS

12. Which component is responsible for sending pressure to the main wheel brakes?
    a. Selector valve
    b. Reservoir
    c. Master cylinder
    d. Brake pedals
13. The ______ is (are) interconnected with the elevator trim tab actuator to automatically input pitch trim to compensate for pitch effects as it is operated.
   a. landing gear
   b. flaps
   c. rudder
   d. speed brake
TABLE OF CONTENTS

TABLE OF CONTENTS ................................................................. 6-1
LIST OF FIGURES ........................................................................... 6-2
OVERVIEW ......................................................................................... 6-3
REFERENCES .................................................................................. 6-3
STUDENT ASSIGNMENTS ................................................................. 6-3
LESSON OUTLINE ........................................................................... 6-3
INTRODUCTION ................................................................................. 6-4
FLIGHT CONTROLS ........................................................................ 6-4
  PRIMARY CONTROLS ..................................................................... 6-4
  SECONDARY CONTROLS ............................................................... 6-4
HYDRAULICS .................................................................................. 6-10
  PRIMARY AND EMERGENCY SYSTEMS ......................................... 6-10
  LANDING GEAR ............................................................................. 6-14
  FLAPS ............................................................................................. 6-14
  SPEED BRAKE .............................................................................. 6-14
  NOSE WHEEL STEERING .............................................................. 6-14
  WHEEL BRAKES ........................................................................... 6-14
ABNORMAL CONDITIONS ............................................................... 6-16
  FLIGHT CONTROLS ..................................................................... 6-16
  HYDRAULICS ................................................................................ 6-10
LESSON QUESTIONS ...................................................................... 6-18
LIST OF FIGURES

Figure SY106-1 – Controllability Check................................................................................. 6-7
Figure SY106-2 – Runaway Trim........................................................................................... 6-7
Figure SY106-3 – Runaway Trim Procedure ......................................................................... 6-8
Figure SY106-4 – TAD FAIL CAS Advisory ........................................................................ 6-8
Figure SY106-5 – TAD FAIL Checklist .................................................................................. 6-9
Figure SY106-6 – HYDR Indicator ........................................................................................ 6-10
Figure SY106-7 – HYD FL LO .............................................................................................. 6-11
Figure SY106-8 – EHYD PX LO .......................................................................................... 6-11
Figure SY106-9 – Hydraulic Pressure Above 1800 PSI ....................................................... 6-12
Figure SY106-10 – Hydraulic Pressure Below 1800 PSI ...................................................... 6-12
Figure SY106-11 – Landing Control Panel ........................................................................... 6-13
Figure SY106-12 – Landing Gear Malfunction Checklist .................................................... 6-14
Figure SY106-13 – Asymmetric Flaps .................................................................................. 6-15
Figure SY106-14 – Speed Brake Failure ............................................................................. 6-16
Figure SY106-15 – Emergency Shutoff Handle .................................................................... 6-17
OVERVIEW
This lesson provides a review of the normal operation of T-6B flight controls and hydraulic systems. The lesson also controls and hydraulic systems. The lesson also covers the characteristics of abnormal operations and false indications for these systems.

REFERENCES
Personnel: Classroom Instructor
Media Facilities: MIL Equipped Classroom
Support Resources: T-6B Flight Manual; SY103, SY104, and SY105 Student Guides

STUDENT ASSIGNMENTS
Review SY103, SY104, and SY105 student guides.

LESSON OUTLINE
Topics in this lesson will be presented in sequential order. Follow along with the instructor and student guides provided for SY103 through SY106. The estimated time required to complete this lesson is 1.9 hours.
## Introduction

### Flight Controls

#### Primary Controls
- 1.16.2.0.2 Describe aileron system operating principles
- 1.16.1.0.2 Describe elevator system operating principles
- 1.16.3.0.2 Describe rudder system operating principles

#### Secondary Controls
- 1.16.6.0.2 Describe trim system operating principles
- 1.16.6.0.6 Identify trim system operating limits
- 1.16.6.0.9 Specify how the trim system complements basic aircraft control
- 1.16.7.0.2 Describe TAD system operating principles
- 1.16.7.0.6 Identify TAD operating limits
- 1.16.8.0.5 Describe gust lock operating principles

For lesson topics **Primary Controls** and **Secondary Controls**, please refer to your student guide for SY103 – Flight Controls

### Hydraulics

#### Primary and Emergency Systems
- 1.18.1.0.2 Describe primary hydraulic system operating principles
- 1.18.1.0.6 Identify primary hydraulic system operating limits
- 1.18.2.0.2 Describe emergency hydraulic system operating principles
- 1.18.2.0.6 Identify emergency hydraulic system operating limits

#### Landing Gear
- 1.18.3.0.2 Describe landing gear extension/retraction system operating principles
- 1.18.5.0.2 Describe landing gear emergency extension system operating principles

#### Flaps
- 1.18.8.0.2 Describe flaps system operating principles
- 1.18.8.0.6 Identify flaps system operating limits

#### Speed Brake
- 1.18.7.0.2 Describe speed brakes system operating principles
- 1.18.7.0.6 Identify speed brakes system operating limits

#### Nose Wheel Steering
- 1.18.6.0.2 Describe nose wheel steering system operating principles
- 1.18.6.0.6 Identify nose wheel steering system operating limits

#### Wheel Brakes
- 1.18.9.0.2 Describe wheel brakes system operating principles
- 1.18.9.0.6 Identify wheel brakes system operating limits
For lesson topics Primary and Emergency Systems and Landing Gear, please refer to your student guide for SY104-Hydraulics Part 1

For lesson topics Flaps, Speed Brake, Nose Wheel Steering, and Wheel Brakes, please refer to your student guide for SY105-Hydraulics Part 2
Abnormal Conditions

**Flight Controls**

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.16.1.0.8</td>
<td>Identify characteristics of abnormal operations of the elevator system</td>
</tr>
<tr>
<td>1.16.2.0.8</td>
<td>Identify characteristics of abnormal operations of the aileron system</td>
</tr>
<tr>
<td>1.16.3.0.8</td>
<td>Identify characteristics of abnormal operations of the rudder system</td>
</tr>
<tr>
<td>6.4.33.0.1</td>
<td>Identify indications of runaway trim</td>
</tr>
<tr>
<td>6.4.34.0.1</td>
<td>Identify indication of TAD failure</td>
</tr>
</tbody>
</table>

Indications

Indications of abnormal primary flight control operations include:

- Uncommanded pitch, roll or yaw movements
- Sluggish response to control inputs
Controllability Check

If these abnormal flight conditions occur, follow the Controllability Check procedures.

Runaway Trim Indications

Indications of runaway trim
Flight controls
Trim position indicator
Trim Corrective Action

Corrective action: Perform runaway trim checklist procedures

![Figure SY106-3 – Runaway Trim Procedure](image)

TAD Failure

Indications of TAD failure

Increased effort to trim aircraft

CAS advisory

![Figure SY106-4 – TAD FAIL CAS Advisory](image)
TAD Failure Effect

TAD failure

Automatic rudder trim correction unavailable

Extra effort by pilot

Follow the TAD Failure Checklist

Figure SY106-5 – TAD FAIL Checklist
Hydraulics

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.4.27.0.1</td>
<td>Identify indications of low emergency accumulator hydraulic pressure</td>
</tr>
<tr>
<td>6.4.28.0.1</td>
<td>Identify indications of low hydraulic fluid quantity</td>
</tr>
<tr>
<td>6.5.8.0.1</td>
<td>Identify indications of landing gear not down and locked</td>
</tr>
<tr>
<td>6.5.9.0.1</td>
<td>Identify indications of one main gear up</td>
</tr>
<tr>
<td>6.5.10.0.1</td>
<td>Identify indications of nose gear up or unsafe and main gear down</td>
</tr>
<tr>
<td>6.5.4.0.1</td>
<td>Identify indications of no flaps</td>
</tr>
<tr>
<td>1.18.8.0.8</td>
<td>Identify characteristics of abnormal operations of the flaps system</td>
</tr>
<tr>
<td>1.18.7.0.8</td>
<td>Identify characteristics of abnormal operations of the speed brake system</td>
</tr>
<tr>
<td>6.5.12.0.1</td>
<td>Identify indications of brake failure</td>
</tr>
</tbody>
</table>

Low Hydraulic Fluid 1

Indications of low hydraulic fluid level

Indicator rod past FULL (AC) band when system charged

Indicator rod past FULL (AD) band when system discharged

This may also indicate level is low. To verify, ensure system is discharged and recheck level.

Figure SY106-6 – HYD Indicator
Low Hydraulic Fluid 2

Indications of low hydraulic fluid level

HYD FL LO - reservoir hydraulic fluid level below 1 quart

Consider inoperative:

Landing gear normal extension, flap normal extension, speed brake and nose wheel steering

Low hydraulic Pressure

EHYD PX LO - Emergency accumulator below 2400 ± 150 psi

Consider inoperative:

Emergency landing gear and flap extension
Reduced Capacity

Hydraulic pressure ranges

1800 psi or above:

Hydraulic operation available, but at a reduced capacity

Service prior to next flight

Below 1800 psi:

Digital counter will change from white to black on a yellow background

May need to use emergency hydraulic system
Gear Up

Indications of landing gear not down and locked

Unsafe Gear

Other indications of unsafe landing gear (main gear and/or nose gear)

- Lack of noticeable drag
- Lack of noticeable noise
- AOA indexer not active
- Inability to turn on landing or taxi lights
- Tendency to roll (main gear)

Figure SY106-11 – Landing Control Panel
Checklist

Response to unsafe landing gear (main gear and/or nose gear)

Failure of NWS

Indications of failure of nose wheel steering

Failure of the primary hydraulic system

Sluggish response to rudder pedal input

Figure SY106-12 – Landing Gear Malfunction Checklist
Asymmetric Flaps

Indication:

Uncommanded lateral rolling or yawing during flap extension

If exists:

Do not extend speed brake

Refer to the Asymmetric Flaps checklist

Loss of Flaps

Indications of the loss of normal flap operation

No response to flap controls

Loss of battery bus or only power source is the auxiliary battery

Visual verification from control tower or other aircraft

Emergency Operation

Conditions resulting from loss of normal operation of flaps

Figure SY106-13 – Asymmetric Flaps
Position indicator may be unavailable

Flaps may take longer to extend than normal operations

Gradual depletion of emergency pressure

Adjustments must be made for landing

Speed Brake Failure

Indications of speed brake failure

No change in drag

Nose does not tend to pitch up upon extension

Failure of primary hydraulic system

CAS advisory

Wheel Brake Failure

Indications of wheel brake failure

Inability to maintain directional control

Inability to decelerate

“Spongy” or soft brake
pedal

Aircraft pulls to one side

Emer Shutoff Handle

Engine fire

EMERGENCY FIREWALL SHUTOFF

1. RAISE GUARD

2. PULL HANDLE

Activates firewall fluid and cockpit air shut off valves

Located on the left console in the front cockpit

Lesson Review Questions

Figure SY106-15 – Emergency Shutoff Handle
LESSON QUESTIONS

EMBEDDED QUESTIONS  (Ref: Segment/Topic/Question)

1. The ailerons control aircraft movement around which axis? (B/1/1)
2. What are the aileron trailing edge traveling limits? (B/1/2)
3. How are the ailerons mass balanced and what function does this perform? (B/1/3)
4. What is the function of the bobweight? (B/1/4)
5. What is the purpose of the elevator system? (B/1/5)
6. If you move the control stick forward in flight, how will the aircraft react? (B/1/6)
7. What is the purpose of the rudder system? (B/1/7)
8. What happens when you step on the right rudder pedal? (B/1/8)
9. How does the pilot adjust the rudder pedals to position them at a more convenient setting? (B/1/9)
10. Which primary flight control surface actually moves as part of the trim system? (B/2/1)
11. Where are the trim controls for the aileron trim setting, the elevator trim setting, and the rudder trim setting? (B/2/2)
12. What is the function of the trim disconnect switch? (B/2/3)
13. What are the indications the trim disconnect switch has been selected? (B/2/4)
14. How is electrical power provided to operate the aileron and elevator trim system? (B/2/5)
15. What four factors does the TAD computer consider when calculating the rudder trim setting? (B/2/6)
16. If the gust lock is installed properly, how will the control surfaces appear when they are visually inspected? (B/2/7)
17. What aircraft components are operated by the primary hydraulic system? (C/1/1)
18. What component is the source of pressure for the primary hydraulic system? (C/1/2)
19. What gauge color indicates hydraulic pressure is in the extended scale, but within safe operating limits? (C/1/3)
20. When the HYD FL LO CAS advisory illuminates, what does it indicate? (C/1/4)
21. What is the purpose of the emergency hydraulic system? (C/1/5)
22. What are the normal operating ranges for the hydraulic system pressure and fluid quantity? (C/1/6)
23. What is the maximum speed to operate the landing gear? (C/2/1)
24. When is the emergency landing gear extension system used? (C/2/2)
25. What is the normal sequence for the emergency extension of the landing gear? (C/2/3)
26. What is the maximum flap operating speed? (C/3/1)
27. Can the flaps be operated in the event the primary hydraulic system fails? (C/3/2)
28. What is the purpose of the speed brake? (C/4/1)
29. Where is the SPEED BRAKE circuit breaker located? (C/4/2)
30. What can happen if NWS is engaged at high taxi speeds? (C/5/1)
31. Which has the larger turn radius, nose wheel steering or differential braking? (C/6/1)
32. What are the indications of abnormal primary flight control operations? (D/1/1)
33. What is the corrective action to take in the case of runaway trim? (D/1/2)
34. If the EHYD PX LO illuminates, what aircraft devices should you consider inoperative? (D/2/1)
35. What are some indications of unsafe landing gear? (D/2/2)
36. What indicator lights would illuminate with the main landing gear full down, the nose gear still fully retracted, and the PCL above IDLE? (D/2/3)
37. When lowering flaps using the emergency system, what two conditions might result? (D/2/4)
38. What are the indications of wheel brake failure? (D/2/5)

LESSON REVIEW QUIZ QUESTIONS

1. The elevator controls the aircraft around which axis?
2. The ailerons move opposite each other to cause the aircraft to move about which axis?
3. The rudder causes a yaw movement around the _____ axis.
4. A “ground-adjustable” trim tab is found on _____.
5. What are the factors used by the TAD computer to calculate proper rudder trim tab settings?
6. Once takeoff trim is set, the TAD will make no further trim inputs until ______.
7. The primary and emergency hydraulic systems are pressurized to what level?
8. What is the function of the hydraulic system engine-driven pump?
9. The emergency hydraulic system services which aircraft components?
10. When extending the landing gear, which gear door ultimately closes as part of the extension sequence?

11. What does the red light in the landing gear selector handle indicate when illuminated?

12. What happens to nose wheel steering if the hydraulic system fails?

13. What happens to the speed brake if the hydraulic system fails?

14. The flaps should not be operated above what airspeed?

15. When completing a sharp turn, how should nose wheel steering be used?

16. What causes the EHYD PX LO CAS advisory to illuminate?

17. Will you have use of the speed brake with the emergency hydraulic system?

18. Can you expect to use the wheel brakes if operating with a failure of the primary hydraulic system?
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>TABLE OF CONTENTS</td>
<td>7-1</td>
</tr>
<tr>
<td>LIST OF FIGURES</td>
<td>7-2</td>
</tr>
<tr>
<td>OVERVIEW</td>
<td>7-4</td>
</tr>
<tr>
<td>REFERENCES</td>
<td>7-4</td>
</tr>
<tr>
<td>STUDENT ASSIGNMENTS</td>
<td>7-4</td>
</tr>
<tr>
<td>LESSON OUTLINE</td>
<td>7-4</td>
</tr>
<tr>
<td>INTRODUCTION</td>
<td>7-5</td>
</tr>
<tr>
<td>COMPONENTS, DISPLAYS, AND CONVENTIONS</td>
<td>7-5</td>
</tr>
<tr>
<td>UFCP COMPONENTS, DISPLAYS AND CONVENTIONS</td>
<td>7-5</td>
</tr>
<tr>
<td>UFCP FUNCTIONS</td>
<td>7-22</td>
</tr>
<tr>
<td>PERSISTENT PAGE</td>
<td>7-22</td>
</tr>
<tr>
<td>PRIORITY FUNCTION BUTTONS</td>
<td>7-30</td>
</tr>
<tr>
<td>SYSTEM PRIORITY FUNCTION BUTTON</td>
<td>7-36</td>
</tr>
<tr>
<td>MFD/UFCP REPEAT FUNCTION</td>
<td>7-45</td>
</tr>
<tr>
<td>MFD/UFCP REPEAT FUNCTION</td>
<td>7-45</td>
</tr>
<tr>
<td>UFCP FAILURE AND TEST FUNCTIONS</td>
<td>7-48</td>
</tr>
<tr>
<td>UFCP FAILURE</td>
<td>7-48</td>
</tr>
<tr>
<td>UFCP TEST FUNCTIONS</td>
<td>7-50</td>
</tr>
<tr>
<td>LESSON QUESTIONS</td>
<td>7-52</td>
</tr>
</tbody>
</table>
LIST OF FIGURES

Figure SY017-1 – UFCP Upper and Lower Panels .................................................. 7-5
Figure SY017-2 – Upper Panel ............................................................................. 7-6
Figure SY017-3 – Window Control Keys ............................................................... 7-7
Figure SY017-4 – Master Mode Buttons ............................................................... 7-7
Figure SY017-5 – Priority Function Buttons ......................................................... 7-8
Figure SY017-6 – Data Entry Knob ..................................................................... 7-9
Figure SY017-7 – HUD Interaction Switch ......................................................... 7-9
Figure SY017-8 – HUD Display Brightness Control ............................................ 7-10
Figure SY017-9 – UFCP Brightness Control ......................................................... 7-10
Figure SY017-10 – MFD/UFCP REPEAT Switch .................................................. 7-11
Figure SY017-11 – BARO SET Knob .................................................................. 7-12
Figure SY017-12 – Left-Facing Chevron ............................................................ 7-13
Figure SY017-13 – Left-Facing Filled Triangle .................................................... 7-13
Figure SY017-14 – Left-Facing Arrow ................................................................. 7-13
Figure SY017-15 – Right-Facing Chevron .......................................................... 7-14
Figure SY017-16 – Invalid Data ........................................................................... 7-14
Figure SY017-17 – Failed Data ............................................................................ 7-15
Figure SY017-18 – Data Display Windows ........................................................... 7-15
Figure SY017-19 – System (SYS) Page ............................................................... 7-16
Figure SY017-20 – Persistent Display .................................................................. 7-17
Figure SY017-21 – CLR and RTN PFBs ............................................................... 7-19
Figure SY017-22 – Direct-To Page ..................................................................... 7-20
Figure SY017-23 – Defaults Table ..................................................................... 7-22
Figure SY017-24 – UHF Radio Management Page ............................................ 7-23
Figure SY017-25 – VHF Radio Management Page ............................................ 7-25
Figure SY017-26 – NAV TUNE PFB ................................................................. 7-26
Figure SY017-27 – DME Hold ............................................................................ 7-27
Figure SY017-28 – Transponder Management Page .......................................... 7-28
Figure SY017-29 – Identification (ID) PFB ......................................................... 7-29
Figure SY017-30 – NAV Master Mode Submodes ............................................. 7-29
Figure SY017-31 – PFD Page Baro Set ............................................................... 7-31
Figure SY017-32 – Clock Page ......................................................................... 7-33
Figure SY017-33 – User Waypoint Page ............................................................. 7-33
Figure SY017-34 – Mark Page .......................................................................... 7-34
Figure SY017-35 – FMS Scratchpad Page .......................................................... 7-35
Figure SY017-36 – FMS Scratchpad Delete ....................................................... 7-36
Figure SY017-37 – System (SYS) Top-Level Page ............................................. 7-37
<table>
<thead>
<tr>
<th>Figure SY107-37b – System (SYS) Sub-Level Pages</th>
<th>7-37</th>
</tr>
</thead>
<tbody>
<tr>
<td>Figure SY107-38 – SYS ALT/SPD Page</td>
<td>7-38</td>
</tr>
<tr>
<td>Figure SY107-39 – SYS Heading Page</td>
<td>7-39</td>
</tr>
<tr>
<td>Figure SY107-40 – SYS Display Page</td>
<td>7-40</td>
</tr>
<tr>
<td>Figure SY107-41 – HUD Page</td>
<td>7-41</td>
</tr>
<tr>
<td>Figure SY107-42 – TCAS Page</td>
<td>7-42</td>
</tr>
<tr>
<td>Figure SY107-43 – G Limits Page</td>
<td>7-43</td>
</tr>
<tr>
<td>Figure SY107-44 – MFD Declutter Page</td>
<td>7-43</td>
</tr>
<tr>
<td>Figure SY107-45 – BGO/IP Page</td>
<td>7-44</td>
</tr>
<tr>
<td>Figure SY107-46 – IP Offset (OFS) Functions</td>
<td>7-45</td>
</tr>
<tr>
<td>Figure SY107-47 – MFD/UFCP REPEAT Switch</td>
<td>7-46</td>
</tr>
<tr>
<td>Figure SY107-48 – NAV Display for Failed UFCP</td>
<td>7-49</td>
</tr>
<tr>
<td>Figure SY107-49 – UFCP BUTTON TEST Page</td>
<td>7-50</td>
</tr>
</tbody>
</table>
OVERVIEW
This lesson covers the Up Front Control Panel (UFCP) of the integrated avionics system on the T-6B. The lesson examines the purpose and operating principles of the UFCP as well as its components, functions, operating limits, and displays. It also discusses normal operation of the UFCP, failure indications, and the procedures used when responding to various system failures.

REFERENCES
T-6B Flight Manual
T-6B Systems 1 Student Guide

STUDENT ASSIGNMENTS
Read applicable portions of T-6B Flight Manual, Section I.
Complete CAI lesson SY107, following along with this student guide.
Complete the practice questions provided.

LESSON OUTLINE
Topics in this lesson must be taken in sequential order. All topics must be completed prior to attempting the end of lesson quiz. The estimated time required to complete this lesson is two hours.
Introduction

Components, Displays, and Conventions

UFCP Components, Displays and Conventions

<table>
<thead>
<tr>
<th>1.22.29.0.1</th>
<th>Identify purpose of Up Front Control Panel (UFCP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.22.29.0.3</td>
<td>Identify Up Front Control Panel (UFCP) components</td>
</tr>
<tr>
<td>1.22.29.0.7</td>
<td>Locate Up Front Control Panel (UFCP) components</td>
</tr>
<tr>
<td>1.22.29.0.4</td>
<td>Match Up Front Control Panel (UFCP) components to functions</td>
</tr>
</tbody>
</table>

Purpose

The configuration of the integrated avionics system in the T-6B includes three Multifunction Displays (MFDs) and one Up Front Control Panel (UFCP) in each cockpit.

The purpose of the UFCP is to provide data entry functionality. It controls a wide variety of displays and subsystems: the MFDs, the communication and navigation radios, and the Flight Management System (FMS).

Figure SY107-1 – UFCP Upper and Lower Panels
Purpose (Cont.)

The UFCP is the primary means of:

- Communication radio selection and tuning
- Navigation radio selection and tuning
- Navigation waypoint entry
- Selecting pre-planned waypoints
- Selecting pre-planned flight plans
- Other system control functions

Alphanumeric Keypad 1

The UFCP consists of upper and lower panels.

The upper panel alphanumeric keypad includes the number keys with their associated letters.

It also includes the following:

- Clear (CLR) key
- Enter (ENT) key
- The ± and decimal point key

Figure SY107-2 – Upper Panel
Return (RTN) key

Direct-To (DIR) key

The white dots on the CLR and RTN keys indicate the press and hold function.

Alphanumeric Keypad 2

Each of the four data display windows has an associated window control key located left of the window. The windows are referred to as W1 through W4 from top to bottom. Each window can display up to eight characters.

Master Mode Buttons (MMBs)

The UFCP operates in one of three master modes, commanded by pressing a master mode button. They are:

- NAV - Navigation
- A/A - Air-to-Air
- A/G - Air-to-Ground

The master mode determines the MFD layout, format of the persistent display, and affects the Head Up Display (HUD).
NAV Master Mode Button (MMB)

The NAV master mode, applicable to basic students, is selected with the NAV master mode button. It is the default.

Subsequent presses of the NAV master mode button select one of four submodes: FMS, VOR or LOC, or OFF. The NAV master mode is discussed in detail in the next topic.

The A/A and A/G master modes are used in the advanced student level and are not discussed in this lesson.

Priority Function Buttons (PFBs)

The remaining keys, called Priority Function Buttons (PFBs), provide control of the major functions of the Flight Management System (FMS). Common functions include:

- Tune communication and navigation radios
- Reply to a transponder interrogation (squawk)
- Enter data into the FMS
- Set the barometric correction
- Set values for the airspeed and altitude bugs

Figure SY107-5 – Priority Function Buttons
Data Entry Knob

The lower panel includes controls for data entry, display lighting and barometric correction.

The DATA ENTRY knob in the lower left corner is used to:

- Increment and decrement numerical values in the display windows
- Select alpha characters
- It has a push-to-select function.

HUD Interaction Switch

The Head Up Display (HUD) interaction switch is a three-position toggle switch.

- When HUD TEXT is selected, the contents of the four UFCP windows are projected onto the HUD.
- FPM UNCAGE selects the Flight Path Marker (FPM) uncage mode from the Climb Dive Marker (CDM).
- Select CAGE to eliminate drift effects on the FPM lateral positioning caused by strong winds.
- These functions are covered in more detail in the HUD lesson.
HUD Display Brightness Control

The LGT NIGHT/DAY/AUTO HUD brightness mode switch works in conjunction with the HUD brightness knob to control HUD symbology brightness.

The AUTO HUD mode automatically adjusts HUD symbology brightness relative to changes in ambient light levels.

The DAY switch position allows full MFD and HUD intensity range (0-100%). HUD brightness is controlled with the HUD brightness knob.

The NIGHT switch position limits MFD and HUD intensity range (0-10%). The HUD brightness is set for night and low light conditions but is still controlled using the HUD brightness knob.

UFCP Brightness Control

The UFCP brightness knob controls the four UFCP display windows. The UFCP bezel panel lighting is controlled by the aircraft instrument lighting control.
MFD/UFCP REPEAT Switch

The MFD/UFCP REPEAT switch is used to make the displays of one cockpit duplicate the displays and controls of the other cockpit.

When REPEAT is selected in the forward cockpit, the displays in the forward cockpit mirror the displays in the aft cockpit.

When REPEAT is selected in the aft cockpit, the displays in the aft cockpit mirror the displays in the forward cockpit.

The NORM switch position restores normal operation between the UFCP and its associated IAC.

The repeat function will be discussed in greater detail later in this lesson.

Figure SY107-10 – MFD/UFCP REPEAT Switch
BARO SET Knob

The barometric correction setting knob, labeled BARO SET, is located on the lower panel.

If a Primary Flight Display (PFD) is displayed on any of the three Multifunction Displays (MFDs) or if the PFD page is displayed on the UFCP, turning this knob changes the barometric correction setting on all MFDs. It does not affect the setting on the Backup Flight Instrument (BFI).

If a PFD is not displayed on any of the three MFDs and the PFD page is not displayed on the UFCP, turning this knob has no affect.

The filled circle at the left of W1 indicates the press and hold function. Pressing the W1 window control key for one second sets the barometric correction to the standard 29.92 inches of mercury.

Figure SY107-11 – BARO SET Knob
UFCP Symbols 1

The data display windows use different symbols to indicate different functions. The following symbols display in the left-most character position:

Left-facing chevron - the adjacent display window is not active for data entry. To make the window active, press the window control key. Doing so causes the chevron to become a filled triangle.

Left-facing filled triangle - the adjacent display window is active for data entry. Data is entered using the alphanumeric keypad or with the data entry knob.

UFCP Symbols 2

Also in the left-most character position:

Left-facing arrow - this is a link to a new page. For example, the System (SYS) Display page lists HUD, TCAS, G, and MFD, each with a link-to-new-page arrow. Pressing the window control key displays the lower-level UFCP page for the selected function.
Right-facing chevron – indicates toggle capability between two or more options. Pressing the window control key causes the chevron to become a filled triangle and cycles to the next option.

Invalid Data

An asterisk indicates invalid data and an X indicates failed data. Data is invalid when the integrated avionics system is unable to compute reliable data for any reason other than system failure.

Invalid frequency data is indicated by an asterisk displayed in the first character position followed by the last entered frequency right justified.

Conditions that cause data to be invalid include:

COM1/2 data shown does not match what the radio is tuned to

Data fails internal integrity check

Incorrect use of ± sign
Failed Data

Failed data is any data that is not received from the source. This can occur in any of the following ways:

- External subsystem is off
- Loss of data signal from external system for more than 2.5 seconds
- Any other invalid data that is caused by a system or subsystem failure

Failed frequency data is indicated by an X displayed in the first character position and the frequency right justified.

For all failures other than frequency-related failures, the remaining 7 character positions are blank.

Displays 1

The information displayed in the four data display windows is collectively referred to as a "page."

Data in each window takes one of four forms:

- Data entry
- Navigation
- Data selection
- Data display
Data entry windows allow for initial entry or modification of data and are identified by a left facing chevron.

In this example of the persistent display, once the window is active, the data can be modified using the DATA ENTRY knob or the alphanumeric keypad.

The persistent display will be discussed in a moment.

Displays 2

Navigation windows are used to navigate to lower-level UFCP pages. In this example of the System (SYS) page, left-facing arrows display in the left-most character positions and text is right justified.

Data selection windows allow the pilot to make a selection from two or more options. In this example altimeter units can be set to inches of mercury (IN HG) or millibars (HPA) and the altitude minimums alert can be set ON or OFF.

Data display windows show data that is not editable. Text in these windows is left justified. Pressing the associated control key has no affect.
Persistent Display

The persistent display is the default display and shows the most important information for the currently selected master mode. Since A/A and A/G are not applicable to basic students, the focus here is the persistent display for the NAV master mode.

The persistent display is shown:

- When the Return (RTN) button is pressed for one second or more

- After 20 seconds of inactivity on the UFCP

From this display the COM1, COM2, and VHF navigation radio frequencies can be viewed and changed, as can the transponder mode and code.

Data Entry Keypad 1

Numerical entries, the / symbol, spaces, and the decimal point are entered with the keypad. Letters are entered by pressing the number key and then turning the data entry knob.

We'll enter the numeric VHF frequency 118.7 in W2.

The first step is to press the W2 arrow key to make the window active for data entry. The characters flash during the data entry process.

Figure SY0107-20 – Persistent Display
Entry of trailing zeros is unnecessary. Once 118.7 is displayed, ENT is pressed to enter the frequency. When ENT is pressed the data stops flashing.

Data Entry Keypad 2

When ENT is pressed, the entry is checked for correct syntax. If the format is incorrect or the entry is out of range, the entry continues to flash until corrected.

A couple of syntax conventions:

As data is entered, underscores indicate data entry locations.

Data is entered from right to left.

Trailing zeros are not required.

The decimal point is not required when followed by zeros.
Data Entry Keypad 3

The Clear (CLR) and Return (RTN) Priority Function Buttons (PFBs) are used to correct mistakes. The dot on these keys indicates a press and hold function is available.

Pressing the CLR key deletes the most recent character entry and the data shifts one place to the right.

Pressing the CLR key for one second or more deletes the data from all positions and displays underscores so data can be re-entered.

Pressing the RTN key for one second or longer at any time during data entry restores the original value to the window.

Figure SY107-21 – CLR and RTN PFBs
Data Entry 1

Let's work through a sample entry of RYNOL Initial Approach Fix (IAF) before giving you a chance to practice.

Pressing the Direct-To (DIR) key displays the Direct-To page with the data entry mode active at W2.

Number keys 2 through 9 each have associated letters. The / symbol is accessed with the 1 key and a space is entered with the 0 key.

These functions are controlled with the DATA ENTRY knob after the number key is pressed.

Data Entry 2

To enter RYNOL begin by pressing the 7 key.

The DATA ENTRY knob has 16 detents or clicks. Turning it clockwise one click replaces the 7 with the letter P and two more clicks selects the letter R.

Pushing the DATA ENTRY knob enters the letter R and shifts it one place to the left.

The same letter is copied into the right-most character position. Turn the DATA ENTRY knob clockwise to increment and counterclockwise to decrement the letter. Follow this turn-and-push process to enter the remaining letters.

The last step is to press ENT.

Figure SY107-22 – Direct-To Page
Data Entry 3

Another method of entering data is to turn the DATA ENTRY knob clockwise to increase the value or counterclockwise to decrease the value.

The Course Deviation Indicator (CDI) setting (W4) is modified using this method. In this example rotating the data entry knob increments the value from 129.

Larger changes can also be made with the alphanumeric keypad. Changes made with the keypad do not take effect until ENT is pressed, while changes made with the data entry knob are instantaneous.

Direct-To Exercise
Defaults Table

The UFCP has default values for most data items. These depend on how the UFCP is powered up.

The initial default values are set on the first power application.

Cold start values are set when the aircraft has been powered up and power is interrupted for more than 90 seconds.

Warm start values apply in all other cases and when the aircraft is airborne. In most cases the warm start values are persistent.

Figure SY107-23 – Defaults Table

UFCP Functions

Persistent Page

| 1.22.29.0.8 | Interpret Up Front Control Panel (UFCP) displays |
COM1 Introduction

The persistent display for the Navigation (NAV) master mode provides immediate viewing of communication and navigation radio frequencies and transponder settings.

The PFBs to the right of the data display windows provide control of the functions displayed. Transponder control will be discussed separately.

Pressing the COM1 PFB displays the UHF radio management page.

This page provides control of UHF presets, frequency, modes, and squelch.

COM1 UHF Presets

When the UHF radio management page is first displayed, the display window at W1 is in the active data entry mode.

Changing presets is done by rotating the DATA ENTRY knob and then pushing it to enter the selected preset, or by using the keypad and ENT key.

The entry range is 01 to 99. When entering a preset between 01 and 09 the preceding zero need not be entered.

The UHF communication frequency can be entered manually in W2.

Tune UHF Preset Exercise
COM1 UHF Active Modes

Windows W3 and W4 are data selection windows as indicated by the right-facing chevron.

The UHF radio operates in one of three active modes. Pressing the W3 window control key toggles through the modes. They are:

- **TR + G** - Transmit and receive on the selected preset frequency and receive Guard frequency. This is the default setting.

- **T/R** - Transmit and receive on the selected preset frequency without Guard monitor active.

- **G** - Monitor Guard frequency 243.000.

COM1 UHF Squelch

The W4 data selection window is the toggle for squelch control. ON is the default for both UHF and VHF squelch.

When the UHF radio frequency or active mode is changed using the UFCP, the new frequency is displayed in both forward and aft cockpits.

Let's look at the COM2 PFB.
COM2 Introduction

The COM2 PFB brings up the VHF radio management page.

The VHF radio management page functions are similar to the UHF functions.

If presets are not assigned to the frequency shown, two “#” symbols appear right justified in place of a preset.

When the VHF frequency is changed using the UFCP, the new frequency is displayed in both forward and aft cockpits.

Tune VHF Exercise

COM2 VHF Dual Mode

The T-6B VHF transceiver is a dual mode, 25 kilohertz (kHz) and 8.33 kHz channel spacing radio. It operates over the frequency range of 118.00 to 151.95 MHz.

On the UFCP, channel spacing control function is transparent, so you may directly enter a 3-digit 8.33 kHz channel. Sample frequency/channel entry and terminologies are:

- 25 kHz - "frequency"
  118.000

- 8.33 kHz - "channel"
  118.005

- 8.33 kHz - "channel"
  118.010
NAV TUNE PFB

The UFCP provides an efficient method of controlling NAVAID frequencies and transponder settings.
Pressing the NAV TUNE PFB displays the information for the previously displayed radio navigation aid.
Subsequent presses of the NAV TUNE PFB cycle through the displays in the following order:
VOR or LOC, DME, XPDR, VOR or LOC
The last tuned frequency determines the VOR or LOC display. A sample LOC page is shown.

NAV TUNE DME Hold 1

When two navigation facilities are required to fly an approach, such as an ILS approach with a DME arc transition, the DME Hold function is used to hold the distance from the VOR.
While those procedures are covered in a later Instrument lesson, the process is as follows:

Figure SY107-26 – NAV TUNE PFB
Tune the NAVAID with the DME information (the VOR).

Access the DME page.

Select the Hold option by pressing the W2 toggle. An H is displayed after the frequency.

Tune the ILS frequency.

**NAV TUNE DME Hold 2**

Distance Measuring Equipment (DME) is controlled by the VHF radio navigation aid. When a VOR or ILS/LOC frequency is selected, the paired DME frequency is automatically tuned and populates W2 on the DME page.

The right-facing chevron indicates the Hold Off or On option.

- Hold Off - blank right-most character position
- Hold On - H displayed in right-most position

When the VOR or ILS/LOC frequency and DME hold mode is changed using the UFCP, the new frequency and mode is displayed in both forward and aft cockpits.

**Figure SY107-27 – DME Hold**
NAV TUNE Transponder

The transponder is controlled from the transponder management page.

The W1 option selection is used to place the transponder from standby (XPDRSBY) to active operation (XPDRACT) or vice versa. Standby is the default.

W2 is active for data entry when this page is first accessed. Change the Mode A code in this window. The range is 0000 to 7777. 1200 is the default code.

Selecting the W3 option turns altitude encoding (ALT) on or off.

Transponder operation is covered in greater detail in a later Systems lesson.
Identification (ID) PFB

The Identification (ID) PFB is used to initiate a transponder identification squawk, in response to an external request.

When this PFB is pressed, in addition to transmitting the squawk, the ID page is displayed for 5 seconds. It lists the current Mode A code and altitude encoding status. None of this information is editable. Pressing the window control key has no affect.

After 5 seconds, the ID page display is cancelled and the UFCP reverts to the previous display.

After pressing the ID button, triggering the squawk, you may immediately select another UFCP function.

Set Transponder Code Exercise

NAV Submodes 1

The Navigation (NAV) master mode is the default. It has three submodes that include:

FMS

VOR or LOC

OFF

Figure SY107-29 – Identification (ID) PFB

Figure SY107-30 – NAV Master Mode Submodes
UP FRONT CONTROL PANEL

Pressing the NAV hardkey sets NAV as the master mode and allows you to change the course setting for the Course Deviation Indicator (CDI) on the HSI.

The current course setting for the VOR or LOC is shown in W4. This window does not display the course for the current FMS waypoint.

The default submode for the navigation source is FMS.

NAV Submodes 2

Pressing the NAV hardkey repeatedly cycles through the navigation sources. The last tuned frequency determines if the VOR or LOC page displays.

The navigation source is also selected on the PFD by pressing LSK L4, or on the NAV display by pressing LSK L3.

When VOR is the navigation source, pressing LSK LL displays the NAV-VOR page on the UFCP.

W4 is active for data entry. Set the desired course using standard data entry procedures. 360 is the default navigation course.

Set LOC Course Exercise

Priority Function Buttons

| 1.22.29 | Operate Up Front Control Panel (UFCP) |
PFD Page Baro Set

Pressing the PFD hardkey displays the PFD page. The settings on this page include:

- Barometric correction setting
- Altitude caret setting
- Radar Altitude (RA) setting
- Speed (SPD) caret setting

While the fastest way to set the barometric correction is with the BARO SET knob, this page provides an alternate method of setting the correction or setting the standard 29.92 IN HG. On initial display of the PFD page, W1 is active for data entry.

Recall that a filled circle indicates the press and hold function. Pressing W1 for one second sets 29.92.

PFD Page Altitude Bug

The AB prefix in W2 stands for Altitude Bug. Pressing W2 makes the window active for data entry and a filled circle is displayed left justified.

Pressing the window control key for one second sets the current altitude of the aircraft as the altitude bug setting.

A 3 to 5 digit altitude, to the nearest foot, may also be manually entered.
Set Altitude Bug Exercise

PFD Page RADALT

Press W3 to make the Radar Altitude (RA) window active for data entry. Enter a 2 to 4 digit RA value from 0 to 2500, to the nearest foot. The default is 0 ft.

When the radar altitude of the airplane is less than the radar altimeter setting, the PFD digital readout changes from white to yellow and flashes.

The Speed (SPD) caret is set using W4. Pressing W4 makes the window active for data entry and a filled circle is displayed.

Pressing the window control key for one second sets the current Knots Indicated Airspeed (KIAS) as the speed bug value. This entry is a 2 to 3 digit airspeed, from 40 to 360, entered to the nearest knot. The default is 200 kt.
Clock

The Clock (CLK) button displays the current Greenwich Mean Time (GMT), commonly referred to as Zulu (Z) time.

W3 is the start and stop toggle for the timer. Elapsed time is displayed in W4.

The Reset (R) function is controlled with W4. Once the timer is stopped with W3, it is reset by pressing W4.

If W4 is pressed while the timer is running, the timer is stopped, STOP displays in W3, and the timer is reset by pressing W4 again.

The timer defaults are: inactive, START displayed in W3, and 00:00 displayed in W4.

User Waypoint 1

Pressing the User Waypoint (USER WPT) PFB displays three data points about each user waypoint. The waypoints are numbered from 01 to 99 and the default is the first user waypoint in the route or 01.

Pressing W2 toggles between:

- Latitude - North or South
- Longitude - East or West
- Elevation - feet MSL
Leading zeros are required for latitude and longitude entries. The format is degrees (DD or DDD), minutes (MM), and hundredths of minutes (HH) per the table.

User Waypoint 2

Sample data for the ramp at Corpus Christi NAS are:

Latitude - the default parameter
N 27°41.82'

Longitude
W 097°17.08'

Elevation
15 ft MSL

Standard conventions for data entry using the alphanumeric keypad or the DATA ENTRY knob apply.

Mark Function

The Mark (MRK) hardkey allows you to create a MARK ON TOP waypoint and save it to the FMS.

MARK ON TOP waypoints created using the UFCP mark function may be used in flight planning using standard FMS protocols and pages.

The MRK page displays the coordinates of the waypoint and the GMT it was created.

None of the fields are editable.
FMS Scratchpad

The scratchpad is used for data entry and to display FMS alert, advisory, and maintenance messages. The FMS Scratchpad (FMS SPAD) hardkey accesses the scratchpad page.

If no FMS messages are waiting to be acknowledged, underscores are displayed allowing data entry of up to 24 characters.

As data is entered, it populates W2 from left to right and wraps to W3 and W4 as necessary.

Data entered on the FMS scratchpad page appears on the NAV display under the FMS waypoint information.

It also displays in the scratchpad at the bottom of FMS pages.

FMS SPAD Messages

If there are messages that have not been acknowledged, the UFCP will tell you there is a white or yellow message waiting to be read and cleared.

FMS alert (yellow), advisory (white), and maintenance (white) messages are displayed on FMS pages in the scratchpad. The CLR key (or LSK R1 on the NAV MFD) is used to acknowledge these messages.
The FMS provides the MFD MESSAGE RECALL page to view and acknowledge these messages also.

FMS SPAD Delete

The ENTRY ERROR message is displayed if a scratchpad entry contains a syntax or out of range error. Re-entering the data or pressing the CLR key resets this window.

Pressing the CLR key when the scratchpad is empty inserts the word DELETE into the scratchpad, which can then be used to delete data on FMS pages.

Execute (EXEC) Function

The Execute (EXEC) hardkey is used to execute changes made to the FMS flight plan.

Pressing the EXEC hardkey when the green EXEC advisory is flashing at the upper right of NAV display and PFD sends the execute command to the FMS.

FMS flight plan modification status is indicated by MOD in inverse video preceding the FMS page title.

System Priority Function Button

| 1.22.29.0.2 | Describe Up Front Control Panel (UFCP) operating principles |
System Diagram 1

The System (SYS) PFB displays the SYS top-level page.

Each window on this menu page branches to a lower-level page.

The diagram illustrates the three levels of SYS pages. The top-level page is highlighted.

System Diagram 2

The next tier of pages provides access to various parameters, and several branch to a third level of pages.

The DISPLAY page and BGO/IP page contain links to the third level of pages.

The HUD, TCAS, G limits, and MFD pages, accessed from the DISPLAY page, are outlined in green in this diagram.

SYS Top Level

The SYS top-level page provides access to four lower-level pages as follows:
ALT/SPD - provides a redundant link to the PFD page and toggles for barometric units and the minimums alert

HEADING - provides for setting the heading caret value, Magnetic (MAG) or True (T) compass reference setting, and sources for both Bearing Pointers (BPs)

DISPLAY - this menu provides access to four lower-level pages: HUD, TCAS, G limits, and MFD declutter mode

BGO/IP - gives access to setting the bingo fuel level and branches to the Initial Point (IP) page

We'll look at each in more detail.

SYS ALT / SPD

On the SYS top-level page W1 links to the ALT/SPD page.

W1 links to the PFD page, discussed in the previous topic.

W2 is a toggle for barometric units, either inches of mercury (IN HG), or HPA (hectopascals), referred to as millibars. The selected units display on the PFD and the HUD. The default is IN HG.

The minimums alert is toggled
on or off with W3.
With MIN alert ON, the MIN advisory light is displayed constantly and flashes for 10 seconds when the altitude bug setting is penetrated. The default is OFF.

SYS HEADING

On the SYS top-level page the W2 window control key links to the HEADING page.
Just as with the airspeed and altitude carets controlled from the PFD page, W1 lets you set the value from 001 to 360 for the heading caret displayed in magenta on the HSI and NAV display compass rose.
Pressing LSK LR on the PFD also displays this page with W1 active for data entry. The default value is 360.

SYS HEADING MAG/T

The W2 window control key is a toggle for the compass reference setting, magnetic or true. MAG is the default.
When set to MAG, the degree symbol (°) displays to the right of the heading readout above the HSI and NAV display compass rose.
When True (T) is selected, a T replaces the degree symbol.

SYS HEADING BPs

The sources for the bearing
pointers are set with window control keys W3 and W4.

The options for each pointer are:

FMS

VOR or LOC

OFF

VOR or LOC is displayed selectively depending on whether the frequency corresponds to a VOR or localizer installation. OFF is the default setting for both pointers.

Routinely, bearing pointer 1 is set for VOR and the No. 2 pointer is set for FMS. Bearing pointers are normally set on the PFD using LSK L6 and R6.

Set Heading Bug Exercise

SYS DISPLAY

On the SYS top-level page the W3 window control key links to the DISPLAY page.

The DISPLAY page is a menu for accessing four lower-level pages as follows:

HUD - provides control of the pitch (PCH) reference on the head up display

TCAS - provides control of traffic collision avoidance system settings

G limits - gives access to set

Figure SY107-40 – SYS Display Page
positive and negative G limits

MFD - gives access to control the MFD declutter mode

SYS DISPLAY HUD 1

The HUD page provides toggles for control of the pitch (PCH) reference, declutter mode, and digital speed reference units on the head up display.

Pitch reference options include:

- Climb Dive Marker (CDM)
- Water Line (WL)

The available declutter modes are 0 (full symbol set), 1, and 2. This declutter setting is independent of the declutter mode set for the MFDs.

SYS DISPLAY HUD 2

Options for speed reference units are:

- Groundspeed (GS)
- Indicated Airspeed (IAS)
- True Airspeed (TAS)

The application and display of HUD declutter settings is explained in the HUD lesson.

Figure SY107-41 – HUD Page
SYS DISPLAY TCAS 1

The TCAS page provides options for control of system status, look angle, and flight level settings.

The TCAS status settings are:

- Standby (SBY), the default
- ON

TCAS control is generally initiated from NAV MFD LSK R2, which brings up the TCAS page on the UFCP.

SYS DISPLAY TCAS 2

The Flight Level (FL) setting refers to how altitude information about the traffic is displayed.

Options include:

- REL - relative to your altitude, the default
- ABS - absolute altitude expressed as a flight level

TCAS operation is discussed in greater detail in the Navigation Systems lesson.
SYS DISPLAY G LIMITS

The G Limits page allows you to set values for positive and negative G audio alerts that are more restrictive than the default 7.0 and -3.5 airframe acceleration limits.

The range for data entry is:

Positive (POS) - 0.0 to 7.0

Negative (NEG) - 0.0 to 3.5

On the accelerometer, the digital readout and pointer both turn red when the aircraft IAC computed values are exceeded.

The accelerometer, or G meter, is covered in detail in the Flight Instruments 2 lesson.

SYS DISPLAY MFD Declutter

The MFD page provides control of the declutter mode for the PFD and NAV display.

The declutter settings are 0 (all elements displayed), 1, and 2. The default is 0.

Declutter mode 0 is non-restrictive, all display features are visible. Declutter mode 1 removes display features and mode 2 removes additional features.
This declutter setting is independent of the declutter mode set for the HUD.

Further information is provided in the Flight Instruments 1 lesson.

SYS Bingo/Initial Point

On the SYS top-level page, W4 links to the BGO/IP page.

The Bingo/Initial Point (BGO/IP) page allows for setting the bingo fuel level at W1.

The allowable range is 0 to 1200 lb and the default is 400 lb. The data entry knob step value is 100 lb per click.

Standard data entry procedures using the alphanumeric keypad and ENT key or the data entry knob apply.

W2 links to the lower-level IP data entry page.

SYS IP Offset (OFS) Functions

The IP Offset (OFS) functions provide additional steering capability for the FMS. It allows enhanced flexibility in navigation solutions, and its use is beyond the scope of this lesson.
MFD/UFCP REPEAT Function

<table>
<thead>
<tr>
<th>Code</th>
<th>Function Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.4.84.0.1</td>
<td>Identify indications of a RPT AFT advisory</td>
</tr>
<tr>
<td>6.4.83.0.1</td>
<td>Identify indications of a RPT FWD advisory</td>
</tr>
<tr>
<td>6.4.84.0.2</td>
<td>Identify procedure for a RPT AFT advisory</td>
</tr>
<tr>
<td>6.4.83.0.2</td>
<td>Identify procedure for a RPT FWD advisory</td>
</tr>
</tbody>
</table>

Repeat Mode Overview

The MFD/UFCP REPEAT switch is used to cause the UFCP displays and MFDs of one cockpit to duplicate or mirror those of the other cockpit.

The switch has two positions, NORM and REPEAT.

When REPEAT is selected, the UFCP and MFDs in the cockpit where REPEAT is selected duplicate the displays of the other cockpit.

Selecting REPEAT in one cockpit has no affect on the other cockpit.

Once REPEAT is selected in one cockpit, selecting REPEAT in the other cockpit has no affect on either cockpit.
Normal Mode

Normal operation is defined as the MFD/UFCP REPEAT switch in both cockpits set to NORM.

With NORM selected in each cockpit the UFCP and MFDs of the forward cockpit communicate with Integrated Avionics Computer 1 (IAC1) and are controlled independently of the aft cockpit.

Likewise, the UFCP and displays of the aft cockpit communicate with IAC2 and are controlled independently of the forward cockpit.

Repeat Mode By Cockpit

When the repeat mode is initiated from the forward cockpit, display control inputs from both cockpits communicate with IAC2.

The displays of the forward cockpit mirror the displays of the aft cockpit.

The RPT AFT status advisory appears on the Crew Alerting System (CAS) display.

When the repeat mode is initiated from the aft cockpit, display control inputs from both cockpits communicate with.
IAC1.

The displays of the aft cockpit mirror the displays of the forward cockpit and the RPT FWD status advisory appears on the CAS display.

Repeat Mode Control Inputs

If the repeat mode is selected on a UFCP that is in the data entry mode, that data modification is lost when the switch is placed in REPEAT.

In repeat mode, control inputs made with UFCP pages or with MFDs can be made from either cockpit and affect the displays in both cockpits.

To exit the repeat mode, select NORM in both cockpits. When the switch is placed to NORM, the UFCP in that cockpit reverts to the persistent display for the master mode selected (NAV).

Repeat Mode Malfunction

If the repeat mode malfunctions, the RPT ERR status advisory appears on the CAS display in the cockpit where the error occurs. This advisory means the REPEAT switch is in the REPEAT position but the UFCP and MFDs are not in the repeat mode.

Selecting NORM in the cockpit where the RPT ERR message appears clears the message.

Selecting NORM in the other cockpit also clears the RPT
ERR message but replaces it with RPT FWD (or RPT AFT).

Selecting NORM in both cockpits clears the message and allows either cockpit to select REPEAT.

UFCP Failure and Test Functions

**UFCP Failure**

| 6.4.73.0.1 | Identify indications of Up Front Control Panel 1 (UFCP1) failure |
| 6.4.74.0.1 | Identify indications of Up Front Control Panel 2 (UFCP2) failure |
| 6.4.73 | Respond to a Up Front Control Panel 1 (UFCP1) failure |
| 6.4.74 | Respond to a Up Front Control Panel 2 (UFCP2) failure |

UFCP Failure Indications

The UFCP is powered through the UFCP circuit breaker on the battery bus circuit breaker panel. When the battery switch is on, the UFCP is powered. Any interruption to this power source because of component failure results in a loss of power to the UFCP.

If the UFCP in the forward cockpit fails or is not communicating with either Integrated Avionics Computer 1 (IAC1) or IAC2, the yellow UFCP 1 FAIL caution advisory appears on the CAS display.

Likewise, if the aft UFCP fails or loses communication with the IACs, the UFCP 2 FAIL caution advisory displays.
NAV Display

If the UFCP fails, shortcuts are provided on the NAV display to provide for entering a frequency and an altimeter setting.

In the cockpit of the failed UFCP, LSK L5 provides access to the ALT BARO page. This page allows you to change the barometric correction setting using the MFD.

LSK R5 provides access to the ALT CNS 1/2 page. This page allows you to enter a radio frequency into the scratchpad using the MFD.

Responses

If the forward UFCP fails, check the UFCP circuit breaker on the forward battery bus circuit breaker panel for possible power interruption. If the aft UFCP fails, check its circuit breaker in the aft cockpit.

If power has not been
interrupted, the unit has failed. Frequencies are entered using the ALT CNS 1/2 FMS page accessed with LSK R5. The altimeter setting is entered using the ALT BARO page accessed with LSK L5.

Once a frequency is entered in the scratchpad, access the FREQUENCY page, select the desired radio page, and upselect the frequency in the active data line.

**UFCP Test Functions**

| 1.22.29.0.2 | Describe Up Front Control Panel (UFCP) operating principles |

**UFCP Button Test**

The UFCP test functions are accessed from the STS/BIT page. It is accessed by pressing LSK UR on the NAV display.

Pressing R4, UFCP TEST, accesses the UFCP BUTTON TEST page.

All upper panel buttons and lower panel controls can be checked for positive function.
LED Window Test

On the UFCP BUTTON TEST page, L1 starts or stops the Light Emitting Diode (LED) test for the data display windows.

A series of H characters display in each of the 32 character positions. During the test normal operation of the UFCP is inhibited.

Pressing any alphanumeric key, priority function key, window control key, or master mode key toggles the LED window displays from "H" to "#" to "I" in cyclic fashion.

Lesson Review Quiz
LENSON QUESTIONS

EMBEDDED QUESTIONS (Ref: Segment/Topic/Question)

1. The UFCP is the primary means of system control functions including (B/1/1)
   a. communication and navigation radio selection and tuning.
   b. navigation waypoint entry.
   c. selection of pre-planned waypoints and flight plans.
   d. All of the above.

2. The master mode (B/1/2)
   a. affects the persistent display.
   b. affects the Head Up Display (HUD).
   c. Both A and B
   d. is not applicable to basic students.

3. A filled circle left justified in a data display window indicates the window _______. (B/1/3)
   a. is active for data entry
   b. is inactive for data entry
   c. has toggle capability for two or more options
   d. has a press and hold function

4. Invalid frequency data is indicated by what symbol? (B/1/4)
   a. Asterisk
   b. Left-facing chevron
   c. Left-facing filled triangle
   d. Right-facing chevron

5. The persistent display is the ______ presentation and displays after ______ seconds of inactivity. (B/1/5)
   a. primary; 20
   b. basic; 10
   c. advanced; 10
   d. default; 20
6. The UHF radio operates in one of three active modes, set using the UFCP. They include: (C/1/1)
   a. Mode A, mode C, mode S
   b. Preset, manual, automatic
   c. Transmit, receive, monitor Guard
   d. Transmit/receive, monitor Guard, or both

7. The VHF communication frequency can be changed by pressing _______ or _______. (C/1/2)
   a. COM1; pressing the W2 window control key
   b. COM2; SYS
   c. COM1; pressing the pilot control knob
   d. COM2; pressing the W2 window control key

8. On the PFD page, if the barometric correction is 30.01 inches of mercury in W1, you can set the standard correction (29.92) by pressing the (C/2/1)
   a. DATA ENTRY knob momentarily.
   b. DATA ENTRY knob for one second.
   c. window control key momentarily.
   d. window control key for one second.

9. On the PFD page, the altitude bug (W2) window control key is used to _______ and to _______. (C/2/2)
   a. make W2 active for data entry; change the value to the current aircraft altitude.
   b. set a new altitude value; enable the DATA ENTRY knob for data entry.
   c. reset the default altitude value; change the value to the current aircraft altitude.
   d. make W2 active for data entry; enable the DATA ENTRY knob for data entry

10. The three levels of System (SYS) pages provide control of displays including the settings for _______. (C/3/1)
    a. TCAS, MFD declutter, and bingo fuel.
    b. the active FMS waypoint and the navigation course.
    c. UHF and VHF communication frequencies
    d. selecting DME Hold for a VOR/DME approach
11. What System (SYS) page provides access to TCAS settings? (C/3/2)
   a. ALT/SPD
   b. HEADING
   c. DISPLAY
   d. BGO/IP

12. When REPEAT is selected in one cockpit, selecting REPEAT in the other cockpit has no
    affect on either cockpit. (D/1/1)
   a. True
   b. False

13. If the MFD/UFCP REPEAT switch is placed in the REPEAT position when the UFCP data
    entry mode is active, (D/1/2)
   a. that data entry action is lost and must be reaccomplished.
   b. the data entry is sent to the appropriate integrated avionics computer.
   c. the data entry must be cleared by pressing the CLR key.
   d. the Enter (ENT) key must be pressed to save the data entry.

14. A yellow UFCP 2 FAIL caution advisory appears on the Crew Alerting System (CAS)
    display. This means the aft UFCP (E/1/1)
   a. is not communicating with Integrated Avionics Computer 2 (IAC2).
   b. is not communicating with IAC2 or IAC1, or the unit has failed.
   c. power source has failed.
   d. is not communicating with IAC1.

15. The UFCP test functions, accessed from the STS/BIT page, provide for checking the
    __________. (E/2/1)
   a. alphanumeric keys
   b. priority function buttons
   c. window control keys
   d. lower panel controls
   e. All of the responses are correct.
LESSON REVIEW QUIZ QUESTIONS

1. All of the following statements are true. Which one best describes the purpose of the UFCP?
   a. The UFCP provides data entry functionality.
   b. The UFCP provides data entry functionality and control of a wide variety of displays and
      subsystems.
   c. The UFCP upper panel provides communication and navigation radio frequency setting
      functionality.
   d. The hardkeys provide access to various UFCP pages.

2. The data entry knob on the lower panel _________.
   a. increments numerical values (clockwise rotation)
   b. decrements numerical values (counterclockwise rotation)
   c. is used to select alpha characters
   d. has a push-to-select function
   e. All of the responses are correct.

3. The Priority Function Buttons (PFBs), located ________ provide control of ________ and
   include the CLR, ENT, RTN, and DIR hardkeys.
   a. on the left side of the upper panel; numeric data entry and selection of letters and
      symbols
   b. on the right side of the upper panel; the major functions of the Flight Management
      System (FMS)
   c. left of the data entry displays; active data entry status and data editing functions
   d. right of the data entry displays; data entry display functions and option selection
      capability

4. A left-facing filled triangle left justified in a data display window indicates the window
   _________.
   a. is not active for data entry
   b. is active for data entry
   c. branches to a lower-level page
   d. has toggle capability between two or more options
5. From the persistent display the _______ can be viewed or changed.
   a. UHF communication frequency
   b. VHF communication frequency
   c. VHF navigation frequency
   d. transponder mode and code
   e. All of the answers are correct.

6. Pressing the _______ Priority Function Button (PFB) toggles through the available
   NAV AIDs.
   a. COM1
   b. COM2
   c. NAV TUNE
   d. ID

7. There are _______ levels of System (SYS) pages. The _______ page provides access to
   TCAS and declutter settings.
   a. four; ALT/SPD
   b. two; HEADING
   c. three; DISPLAY
   d. five; BGO/IP

8. The following statements describe MFD/UFCP functionality. Which statement is false?
   a. With the MFD/UFCP REPEAT switch in REPEAT, the UFCP pages and MFDs of one
      cockpit duplicate those of the other cockpit.
   b. When REPEAT is selected in the forward cockpit, the RPT FWD status advisory
      appears in the Crew Alerting System (CAS) display.
   c. When NORM is selected in both cockpits, the MFDs and UFCP pages communicate
      with their respective Integrated Avionics Computers (IACs).
   d. Selecting REPEAT in one cockpit has no affect on the other cockpit.

9. The RPT ERR status advisory appears in the Crew Alerting System (CAS) display. This
   means _______.
   a. that REPEAT is selected in one cockpit and NORM is selected in the other
   b. that a miscompare between display switch positions is detected by IAC1 or IAC2
   c. the affected UFCP is in the repeat mode, but one or more of the MFDs is not
   d. the REPEAT switch is in the REPEAT position but the UFCP and MFDs are not in the
      repeat mode.
10. A yellow UFCP 1 FAIL caution advisory appears on the Crew Alerting System (CAS) display. This means the forward UFCP
   a. power source has failed.
   b. is not communicating with Integrated Avionics Computer 1 (IAC1).
   c. is not communicating with IAC2.
   d. is not communicating with IAC1 or IAC2, or the unit has failed.
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>TABLE OF CONTENTS</td>
<td>8-1</td>
</tr>
<tr>
<td>LIST OF FIGURES</td>
<td>8-2</td>
</tr>
<tr>
<td>OVERVIEW</td>
<td>8-4</td>
</tr>
<tr>
<td>REFERENCES</td>
<td>8-4</td>
</tr>
<tr>
<td>STUDENT ASSIGNMENTS</td>
<td>8-4</td>
</tr>
<tr>
<td>LESSON OUTLINE</td>
<td>8-4</td>
</tr>
<tr>
<td>INTRODUCTION</td>
<td>8-5</td>
</tr>
<tr>
<td>T-6B FLIGHT INSTRUMENTS</td>
<td>8-5</td>
</tr>
<tr>
<td>RADIO NAVIGATION SYSTEMS</td>
<td>8-5</td>
</tr>
<tr>
<td>INTEGRATED AVIONICS SYSTEM</td>
<td>8-12</td>
</tr>
<tr>
<td>PRIMARY FLIGHT DISPLAY</td>
<td>8-25</td>
</tr>
<tr>
<td>BACKUP FLIGHT INSTRUMENT</td>
<td>8-53</td>
</tr>
<tr>
<td>LESSON QUESTIONS</td>
<td>8-59</td>
</tr>
</tbody>
</table>
# LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>SY0108-1</td>
<td>Radio Navigation Antennas</td>
<td>8-5</td>
</tr>
<tr>
<td>SY0108-2</td>
<td>VOR Types</td>
<td>8-7</td>
</tr>
<tr>
<td>SY0108-3</td>
<td>Chart Showing Radials</td>
<td>8-7</td>
</tr>
<tr>
<td>SY0108-4</td>
<td>ILS Signal</td>
<td>8-8</td>
</tr>
<tr>
<td>SY0108-5</td>
<td>Marker Beacons</td>
<td>8-9</td>
</tr>
<tr>
<td>SY0108-6</td>
<td>DME Two-Way Interrogation</td>
<td>8-10</td>
</tr>
<tr>
<td>SY0108-7</td>
<td>DME Slant Range</td>
<td>8-10</td>
</tr>
<tr>
<td>SY0108-8</td>
<td>Navaid Tuning</td>
<td>8-11</td>
</tr>
<tr>
<td>SY0108-9</td>
<td>Forward Cockpit MFDs</td>
<td>8-12</td>
</tr>
<tr>
<td>SY0108-10</td>
<td>Integrated Avionics System Principal Components</td>
<td>8-13</td>
</tr>
<tr>
<td>SY0108-11</td>
<td>Integrated Avionics System Electrical Power, Generator Bus</td>
<td>8-14</td>
</tr>
<tr>
<td>SY0108-12</td>
<td>Integrated Avionics System Electrical Power, Battery Bus</td>
<td>8-15</td>
</tr>
<tr>
<td>SY0108-13</td>
<td>MFD Cluster</td>
<td>8-16</td>
</tr>
<tr>
<td>SY0108-14</td>
<td>MFD With Bezel</td>
<td>8-17</td>
</tr>
<tr>
<td>SY0108-15</td>
<td>MFD Line Select Keys</td>
<td>8-18</td>
</tr>
<tr>
<td>SY0108-16</td>
<td>MFD Rocker Switches</td>
<td>8-19</td>
</tr>
<tr>
<td>SY0108-17</td>
<td>Green Chevrons</td>
<td>8-20</td>
</tr>
<tr>
<td>SY0108-18</td>
<td>Display Symbols</td>
<td>8-21</td>
</tr>
<tr>
<td>SY0108-19</td>
<td>Boxed Display Name</td>
<td>8-22</td>
</tr>
<tr>
<td>SY0108-20</td>
<td>MFD MENU 1/2 Page</td>
<td>8-23</td>
</tr>
<tr>
<td>SY0108-21</td>
<td>MFD MENU 2/2 Page</td>
<td>8-23</td>
</tr>
<tr>
<td>SY0108-22</td>
<td>Select NAV From MFD MENU</td>
<td>8-24</td>
</tr>
<tr>
<td>SY0108-23</td>
<td>NAV Display ARC MAP</td>
<td>8-24</td>
</tr>
<tr>
<td>SY0108-24</td>
<td>NAV Display ROSE MAP</td>
<td>8-25</td>
</tr>
<tr>
<td>SY0108-25</td>
<td>Primary Flight Display (PFD)</td>
<td>8-26</td>
</tr>
<tr>
<td>SY0108-26</td>
<td>Primary Flight Display Default</td>
<td>8-27</td>
</tr>
<tr>
<td>SY0108-27</td>
<td>PFD Sections</td>
<td>8-28</td>
</tr>
<tr>
<td>SY0108-28</td>
<td>Primary Flight Instruments Air Data Sources</td>
<td>8-28</td>
</tr>
<tr>
<td>SY0108-29</td>
<td>Primary Flight Instruments</td>
<td>8-29</td>
</tr>
<tr>
<td>SY0108-30</td>
<td>Angle of Attack Indicator</td>
<td>8-30</td>
</tr>
<tr>
<td>SY0108-31</td>
<td>Airspeed Indicator</td>
<td>8-30</td>
</tr>
<tr>
<td>SY0108-32</td>
<td>Airspeed Trend Vector</td>
<td>8-31</td>
</tr>
<tr>
<td>SY0108-33</td>
<td>Attitude Indicator</td>
<td>8-32</td>
</tr>
<tr>
<td>SY0108-34</td>
<td>LOC and GS Scales</td>
<td>8-32</td>
</tr>
<tr>
<td>SY0108-35</td>
<td>ADS Instrument Power</td>
<td>8-33</td>
</tr>
<tr>
<td>SY0108-36</td>
<td>Zenith and Nadir Symbols</td>
<td>8-34</td>
</tr>
<tr>
<td>Figure SY108-37 – Altitude Indicator (Altimeter)</td>
<td>8-34</td>
<td></td>
</tr>
<tr>
<td>---------------------------------------------------------------------</td>
<td>-----</td>
<td></td>
</tr>
<tr>
<td>Figure SY108-38 – Radar Altimeter Indications</td>
<td>8-35</td>
<td></td>
</tr>
<tr>
<td>Figure SY108-39 – Vertical Speed Indicator</td>
<td>8-36</td>
<td></td>
</tr>
<tr>
<td>Figure SY108-40 – UFCP Windows</td>
<td>8-37</td>
<td></td>
</tr>
<tr>
<td>Figure SY108-41 – UFCP Primary Instrument Settings</td>
<td>8-37</td>
<td></td>
</tr>
<tr>
<td>Figure SY108-42 – PFD and NAV Advisories</td>
<td>8-38</td>
<td></td>
</tr>
<tr>
<td>Figure SY108-43 – Horizontal Situation Indicator (HSI)</td>
<td>8-39</td>
<td></td>
</tr>
<tr>
<td>Figure SY108-44 – Compass Rose</td>
<td>8-40</td>
<td></td>
</tr>
<tr>
<td>Figure SY108-45 – Heading Readout</td>
<td>8-41</td>
<td></td>
</tr>
<tr>
<td>Figure SY108-46 – Heading Bug</td>
<td>8-42</td>
<td></td>
</tr>
<tr>
<td>Figure SY108-47 – Heading Bug Set to Current Heading</td>
<td>8-42</td>
<td></td>
</tr>
<tr>
<td>Figure SY108-48 – Setting the Heading Bug</td>
<td>8-43</td>
<td></td>
</tr>
<tr>
<td>Figure SY108-49 – Bearing Pointers</td>
<td>8-43</td>
<td></td>
</tr>
<tr>
<td>Figure SY108-50 – Bearing Pointer Data Fields</td>
<td>8-44</td>
<td></td>
</tr>
<tr>
<td>Figure SY108-51 – Bearing Pointer Options</td>
<td>8-44</td>
<td></td>
</tr>
<tr>
<td>Figure SY108-52 – Bearing Pointer Data Fields</td>
<td>8-45</td>
<td></td>
</tr>
<tr>
<td>Figure SY108-53 – Ground Track Pointer</td>
<td>8-45</td>
<td></td>
</tr>
<tr>
<td>Figure SY108-54 – Course Deviation Indicator (CDI)</td>
<td>8-45</td>
<td></td>
</tr>
<tr>
<td>Figure SY108-55 – CDI With FMS as Nav Source</td>
<td>8-46</td>
<td></td>
</tr>
<tr>
<td>Figure SY108-56 – HSI Showing Phase of Flight</td>
<td>8-47</td>
<td></td>
</tr>
<tr>
<td>Figure SY108-57 – Groundspeed and TAS</td>
<td>8-48</td>
<td></td>
</tr>
<tr>
<td>Figure SY108-58 – Windspeed</td>
<td>8-48</td>
<td></td>
</tr>
<tr>
<td>Figure SY108-59 – Navigation Relationships</td>
<td>8-49</td>
<td></td>
</tr>
<tr>
<td>Figure SY108-60 – “G” Meter</td>
<td>8-49</td>
<td></td>
</tr>
<tr>
<td>Figure SY108-61 – UFCP Showing Declutter Level 0</td>
<td>8-50</td>
<td></td>
</tr>
<tr>
<td>Figure SY108-62 – PFD Showing Declutter Level 1</td>
<td>8-51</td>
<td></td>
</tr>
<tr>
<td>Figure SY108-63 – PFD Showing Declutter Level 2</td>
<td>8-51</td>
<td></td>
</tr>
<tr>
<td>Figure SY108-64 – ADI Automatic Declutter Level</td>
<td>8-52</td>
<td></td>
</tr>
<tr>
<td>Figure SY108-65 – PFD Default Position</td>
<td>8-52</td>
<td></td>
</tr>
<tr>
<td>Figure SY108-66 – Backup Flight Instrument (BFI)</td>
<td>8-53</td>
<td></td>
</tr>
<tr>
<td>Figure SY108-67 – BFI Power</td>
<td>8-54</td>
<td></td>
</tr>
<tr>
<td>Figure SY108-68 – BFI Air Data Sources</td>
<td>8-55</td>
<td></td>
</tr>
<tr>
<td>Figure SY108-69 – BFI Airspeed Indicator</td>
<td>8-56</td>
<td></td>
</tr>
<tr>
<td>Figure SY108-70 – BFI Attitude Indicator</td>
<td>8-56</td>
<td></td>
</tr>
<tr>
<td>Figure SY108-71 – BFI Altimeter</td>
<td>8-57</td>
<td></td>
</tr>
<tr>
<td>Figure SY108-72 – BFI Vertical Speed Indicator</td>
<td>8-57</td>
<td></td>
</tr>
<tr>
<td>Figure SY108-73 – BFI Heading Indicator</td>
<td>8-57</td>
<td></td>
</tr>
<tr>
<td>Figure SY108-74 – BFI ATT FAIL</td>
<td>8-58</td>
<td></td>
</tr>
</tbody>
</table>
OVERVIEW
This lesson discusses the purpose and functions of the primary T-6B flight instrument systems, and addresses interpretation of instrument displays. This lesson is designed to provide you with an understanding of T-6B flight instruments as they are used in normal flight operations.

REFERENCES
Personnel: None.
Media Facilities: Student CAI Workstation.
Support Resources: T-6B Flight Manual

STUDENT ASSIGNMENTS
Read the applicable portions of T-6B Flight Manual, Section I.
Complete CAI lesson SY108, following along with this student guide.
Complete the practice questions provided.

LESSON OUTLINE
Topics in this lesson must be taken in sequential order. All topics must be completed prior to attempting the end of lesson quiz. The estimated time required to complete this lesson is 1.6 hours.
Introduction

T-6B Flight Instruments

Radio Navigation Systems

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.22.0.0.1</td>
<td>Define terminology and concepts related to the avionics and instruments system</td>
</tr>
<tr>
<td>1.22.0.0.3</td>
<td>Identify major components of the avionics and instruments system</td>
</tr>
</tbody>
</table>

VOR/ILS/DME Introduction

The T-6B is equipped with these radio navigation systems:

- VHF Omnidirectional Range (VOR)
- Instrument Landing System (ILS)
- Distance Measuring Equipment (DME).

The ILS consists of Localizer (LOC), Glideslope (GS), and Marker Beacon (MB). VOR/ILS antennas on the fuselage and vertical fin connect to an integrated VOR/LOC/GS/MB Navigation (NAV) receiver.

A separate DME radio has its own antenna on the bottom of the fuselage. The DME receiver is in the left avionics bay and the VHF NAV receiver is in the right avionics bay.

Figure SY108-1 – Radio Navigation Antennas
VOR Overview

A VOR is a ground-based navigation aid (navaid) radio station that transmits complex signal patterns which provide azimuth data for a full 360° around the station. The azimuth data is referenced to magnetic North at the station.

The VOR module in the airplane’s NAV receiver decodes these signal patterns and determines the airplane's current azimuth relative to the VOR station. This azimuth represents a radial from the VOR station. Radials appear on the instruments and charts in 1° increments, from 001 through 360.

VOR signals also include an audio sub-channel that carries a Morse code or voice identifier for the station. This identifier repeats at least once every 30 seconds. The audio sub-channel may also be used to broadcast voice messages.

VOR signals are subject to line-of-sight restrictions and their range varies with the altitude of the receiving aircraft.
VOR Types

You will be using three types of VOR facilities: VOR, VOR/DME, and VORTAC. Chart symbols for each are shown below.

- VOR-Radial and audio signals only
- VOR/DME-VOR station with DME
- VORTAC-Colocated VOR and military tactical air navigation (TACAN) stations

TACAN and VOR azimuth signals are different and the radio receivers are not compatible. The T-6B is not equipped with TACAN.

DME signals used with VOR/DME, VORTAC, and ILS are the same. The DME radio in the T-6B is compatible with all of these DME stations.

VOR Radials

As mentioned earlier, VOR system resolution is accurate to a tolerance of 1° azimuth. Since each degree of azimuth represents a radial, 360 radials (001 through 360) are available.
The 360 radial of each station is oriented to magnetic north, so each radial represents a magnetic course away from the station.

**ILS Signals**

Let's look closer at ILS signals.

Localizer (LOC)-lateral guidance referenced to runway centerline

Glideslope (GS)-vertical guidance for proper approach angle

LOC is in the VHF band and GS is in the UHF band. When you tune ILS, you set the LOC frequency and the radio tuning system sets the paired GS frequency.

Some ILS installations include Marker Beacons (MBs). There are three types of MBs: Outer Marker (OM), Middle Marker (MM), and Inner Marker (IM). Each MB is at a specified distance from the end of the runway. ILS systems equipped with MBs may have one, two, or all three MBs.
Marker Beacons

A marker beacon transmits a tightly-focused elliptical signal pattern directly above its antenna. All MBs transmit with 3 watts or less on 75 MHz (VHF). This frequency is preset in the aircraft NAV receiver and is not tunable.

Each MB broadcasts an audio tone that is unique to the type of marker. These tones are standardized for all installations. As you pass over each marker, you will hear the tone and see an annunciation associated with that marker.

OM    -    -    -

MM    •    -    •    -

IM    •    •    •    •

Figure SY108-5 – Marker Beacons
DME

DME operates in the UHF band and may be paired with VOR and ILS. A VORTAC always has DME.

Each aircraft DME radio transmits a precisely-timed pulse pair signal that forms its own unique signature pattern. Navaid DME equipment receives aircraft DME signals, reproduces them, and then retransmits exact duplicate signature patterns. The station DME also transmits an audio ident.

When the aircraft DME recognizes its own signature back from the ground station, it measures the signal round-trip time and computes slant range distance in nautical miles from aircraft to station. Remember that slant range distance is greater than ground distance.
Navaid Tuning

To tune a VOR station, enter the published frequency into the Up Front Control Panel (UFCP). The radio tuning system will tune the VOR frequency in the NAV receiver and automatically tune the DME radio paired frequencies.

To tune an ILS or Localizer (LOC) runway, enter the published localizer frequency into the UFCP. The radio tuning system will tune the localizer and glideslope frequencies in the NAV receiver and automatically tune the DME radio paired frequencies. Remember that the marker beacon frequency never changes.

You cannot tune the DME or glideslope directly and these frequencies are not displayed.

Figure SY108-8 – Navaid Tuning
Integrated Avionics System

The "glass cockpit" integrated avionics system in the T-6B utilizes dual Integrated Avionics Computers (IACs) that provide data to the Multifunction Displays (MFDs) in each cockpit.

The dual IACs form the core of the integrated avionics system. They integrate the various components of the system and provide backup capability.

Integrated Avionics System Continued

Except for the Head Up Display (HUD) in the forward (FWD) cockpit, the integrated avionics system display configuration is identical for both FWD and aft cockpits.
Integrated Avionics System Principal Components

Let's look at the principal components of the integrated avionics system.

Three Multifunction Displays (MFDs) in each cockpit
One Up Front Control Panel (UFCP) in each cockpit
Two Integrated Avionics Computers (IACs), IAC 1 and IAC 2 (located in the left avionics bay)

IAC 1 supports the FWD cockpit and acts as backup for the aft cockpit for redundancy. IAC 2 supports the aft cockpit and acts as backup for the FWD cockpit for redundancy.

Integrated Avionics System Integration

The integrated avionics system integrates with these systems:

Air Data Computer (ADC)
Angle of Attack (AOA) Computer
Aural Warning Generator
Distance Measuring Equipment (DME)
Engine Data Monitor (EDM)
Flight Data Recorder (FDR)
GPS Antenna
Inertial Reference System (IRS)
Radar Altimeter (RADALT)
Transponder (XPDR)
Traffic Collision Avoidance System (TCAS)
Trim Aid Device (TAD)
UHF two-way Communication radio (UHF COMM)
VHF two-way Communication radio (VHF COMM)
VOR/ILS Navigation (NAV) receiver

Electrical Power

Electrical power for the radio navigation and integrated avionics system components is distributed and controlled through the generator bus circuit breaker panels and battery bus circuit breaker panels in each cockpit.

Note the highlighted areas on the generator bus panels.

Figure SY108-11 – Integrated Avionics System Electrical Power, Generator Bus
Note the highlighted areas on the battery bus panels.

Electrical power is addressed in greater detail in the electrical systems lesson.

MFD Overview

The multifunction displays (MFDs) are the primary displays for basic flight instruments, navigation data, engine indications, and aircraft system advisories.

Each MFD may be operated independently in each cockpit, permitting selection of a wide variety of display variations to suit particular mission requirements.

The MFDs may also be operated in the repeat mode where the displays in one cockpit duplicate or mirror the displays of the other cockpit.

Figure SY108-12 – Integrated Avionics System
Electrical Power, Battery Bus
MFD Configurations

From left to right, the default display arrangement at power-up is:

- Navigation (NAV)
- Primary Flight Display (PFD)
- Engine Indication and Crew Alerting System (EICAS)

There are two display configuration levels: basic student level and advanced student level. This lesson covers only the basic student level.

In basic student level, one MFD must always display a PFD and one MFD must always display the EICAS.

Left Side MFD

After power-up, the left MFD can be configured to show any of the following:

- MFD MENU
- NAV
- PFD
- EICAS
- Flight Management System (FMS) data pages
- MFD Status/Built-in Test (STS/BIT) pages
The MFD MENU and PFD will be covered in more detail later in this lesson. The EICAS, NAV, FMS, and STS/BIT displays will be covered in more detail in separate lessons.

MFD Description

An MFD consists of a five-inch by seven-inch sunlight readable Liquid Crystal Diode (LCD) display screen surrounded by a bezel embedded with push buttons and rocker switches.

Each MFD displays symbology generated by its associated IAC. In normal operation, IAC 1 drives the three FWD MFDs and UFCP and IAC 2 drives the three aft MFDs and UFCP.

Failure of an IAC automatically switches the displays and controls to the other IAC. No pilot action is required.

Let's look at the MFD basic features. Since each unit is physically identical, these features apply to all six MFDs.

Figure SY108-14 – MFD With Bezel
MFD LS Key Descriptions

When referring to push button arrangement, the buttons are referred to as line select keys (LSKs). The arrangement is as follows:

- Left side, top to bottom - LSK L1 through LSK L6
- Right side, top to bottom - LSK R1 through LSK R6
- Upper left and upper right - LSK UL and LSK UR
- Lower left and lower right - LSK LL and LSK LR

The physical push buttons sometimes may be referred to as "soft keys" since the function assigned to each button changes when the display changes.

Figure SY108-15 – MFD Line Select Keys
MFD Rocker Switches

There are two rocker switches on an MFD; one at top center and one at bottom center. These switches control MFD brightness.

Pressing the down arrow on the left side of either rocker switch decreases display backlighting and symbology brightness.

Pressing the up arrow on the right side of either rocker switch increases display backlighting and symbology brightness.

MFD LS Key Functions

The LSKs on the left and right sides of the MFD access a wide variety of display and control options associated with each different MFD display.

The top LSKs (UL and UR) are reserved for screen navigation between the current display and another readily available display.

The bottom LSKs (LL and LR) access a variety of control options associated with each different display and also provide screen navigation between peer displays.
The captions adjacent to the LSKs (soft keys) vary depending on the page displayed.

Display Symbols

A green chevron facing inwards indicates the capability to select through several options. Momentarily pressing the LSK adjacent to the displayed option enables the next available option. The caption will change to reflect the currently selected option. If the page or function associated with the chevron is restricted or unavailable, the chevron does not appear.

A green chevron facing outwards indicates data entry or page navigation capability. Momentarily pressing the LSK adjacent to the displayed parameter enables the selection or modification of the respective parameter.

Figure SY108-17 – Green Chevrons
Display Symbols Continued

A cyan triangle indicates display navigation links to pages generated by the Flight Management System (FMS). Momentarily pressing the LSK adjacent to the FMS page title changes the MFD display to the selected FMS page. This will be addressed in more detail in the FMS lesson.

A green dot indicates that a default value is associated to the dot. To set the default, press the adjacent LSK for one second.

Figure SY108-18 – Display Symbols
MFD Display Navigation

As previously mentioned, the NAV display is the power-up default for the left MFD. After power up, you can configure this MFD to display any one of several available options.

Note that the current display name, NAV in this example, appears in white text directly below LSK UL. When a solid white box surrounds this annunciation, it means that the current display will change to the MFD MENU when you press LSK UL.

The MFD MENU has two pages: MFD MENU 1/2 and MFD MENU 2/2. Pages with X/X numbers following the name are known as peer pages. Notice the NEXT page navigation function assigned to LSK LR. The NEXT and PREV functions allow you to navigate back and forth between peer pages.

Figure SY108-19 – Boxed Display Name
MFD MENU

All displays and FMS pages available for display on the MFD are listed on the MFD MENU pages. Displays are listed in white font with green chevrons and FMS pages are listed in cyan font with cyan triangles.

Notice that the SMS, SAT, and NDS displays do not have green chevrons pointing to their adjacent LSKs. These displays are not available in basic student level configuration.

MFD MENU Page 2

Note that the NEXT function has been replaced by the PREV function. This lets you navigate to the previous peer page, MFD MENU 1/2 in this example. LSK LR is disabled and LSK LL is now the functional soft key.

As you will see in the FMS lesson, some FMS pages have three or more peer pages. In those examples, both PREV and NEXT will be available to allow you to navigate back and forth between the pages.
Select a Display From the Menu

To select a display from the MFD MENU, simply press the LSK adjacent to the display or FMS page that you want to appear on the MFD.

Select a Display Option

Recall that an inward-pointing green chevron indicates that display options are available. The label for the currently displayed option appears next to the chevron. When you press the LSK adjacent to the chevron, the next available option will appear. Stop when you see the option you want.

Figure SY108-22 – Select NAV From MFD MENU

Figure SY108-23 – NAV Display ARC MAP
Display Option Summary

You have seen how to reconfigure the left MFD to show different displays and pages. You have also seen how to select display options and navigate between peer pages.

These basic functions work the same way on all MFD displays and pages. As you progress through this and subsequent lessons, you will see additional functions.

Primary Flight Display

<p>| | |</p>
<table>
<thead>
<tr>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
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</tr>
<tr>
<td>1.22.1b.0.3</td>
<td>Describe MFD primary flight display normal operating principles</td>
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<tr>
<td>1.22.1b.0.4</td>
<td>Identify MFD primary flight display symbology</td>
</tr>
</tbody>
</table>

Figure SY0108-24 – NAV Display ROSE MAP
Primary Flight Display Overview

The Primary Flight Display (PFD) combines all of the primary flight instruments required for the primary instrument scan into one compact display. These instruments include:

- Airspeed indicator
- Attitude indicator
- Altimeter
- Sideslip Indicator
- Vertical speed indicator
- Horizontal situation indicator
- "G" meter

We'll take a closer look at each of these as we progress through the lesson.
Primary Flight Display Critical

When all MFDs are working, the default position for the PFD is the center MFD; however, the PFD can be displayed on any MFD as desired.

Due to the flight critical nature of the PFD, it will always be displayed while in flight (weight off wheels), even if only one MFD is working. Here is the sequence:

Center MFD fails - The PFD reverts to the left MFD and replaces whatever is displayed there; the EICAS remains as is.

Center and left MFDs fail in flight - The PFD reverts to the right MFD and replaces the EICAS.

Center and right MFDs fail in flight - The PFD reverts to the left MFD and replaces whatever is displayed there.

Figure SY108-26 – Primary Flight Display Default
PFD Sections

Let’s break the PFD into two main sections and then examine each section individually.

These sections are

- Primary flight Instruments
- Horizontal Situation Indicator (HSI)

Air Data Sources

Before we look at the primary flight instruments, let's take a look at the air data sources for these instruments.

The pitot-static system consists of open ports and tubes that sample ram air (pitot) and ambient (static) dynamic air pressures. There are primary system and secondary system probes.
The primary pitot probe on the right wing and the primary static ports on the aft fuselage vent to the Air Data Computer (ADC). The secondary system vents to the Backup Flight Instrument (BFI).

Pressure transducers in the ADC convert these air pressures into electrical signals which the ADC uses to calculate air data digital outputs. These digital signals are used by the airspeed indicator, altimeter, vertical speed indicator, and flight data recorder.

Primary Flight Instruments

The primary flight instrument indicators are arranged in standard instrument configuration.

Left to right

AIRSPEED
ATTITUDE
ALTITUDE

Some of the primary flight indications require data entry using the UFPD. We'll show this later in the lesson.

Figure SY108-29 – Primary Flight Instruments
Angle of Attack Indicator

The Angle of Attack (AOA) indicator shows aircraft pitch angle relative to an attitude of minimum lift and shows the AOA limits. These values are generated by the AOA computer.

The major elements of the AOA indicator are:

- Approach angle target range
- Max endurance caret
- AOA pointer
- Max range caret
- AOA digital readout
- Stall caret

Airspeed Indicator

The airspeed indicator displays both a digital readout and a "moving-tape" scale which shows the current aircraft indicated airspeed (IAS) displayed in knots.

The airspeed indicator includes:

- Airspeed tape
- Digital airspeed readout
- Airspeed bug (set using UFCP)
- Airspeed bug digital readout
- Flap extension speed band
Mach number

The Mach number only appears when current aircraft Mach is greater than 0.30. It appears in red when the Mach number exceeds maximum operating Mach.

Airspeed Trend Vector

The airspeed indicator also includes an airspeed trend vector. This vector indicates the airspeed expected six seconds ahead if the current rate of acceleration or deceleration remains the same.

When displayed, the airspeed trend vector is a green arrow that originates from the center of the airspeed scale. The arrow points up along the right edge of the scale during acceleration and points down during deceleration. The arrow length increases and decreases in proportion to the rate of acceleration or deceleration.

Figure SY108-32 – Airspeed Trend Vector
Attitude Indicator

The attitude indicator shows the aircraft pitch and roll attitude relative to the horizon.

The major elements of the Attitude indicator are:

- Pitch attitude scale
- Aircraft reference symbol (wings)
- Horizon reference line
- Roll pointer
- Roll attitude scale
- Sideslip (slip) indicator
- Rate of turn indicator

LOC and GS Scales

Recall that when you tune a Localizer (LOC) frequency, the navigation radio automatically tunes the paired glideslope (GS) frequency. In this respect, tuning a LOC frequency is referred to as tuning an ILS frequency.

Localizer and glideslope scales automatically appear on the PFD when an ILS frequency is tuned. A diamond-shaped pointer will appear on each scale respectively when the navigation radio receives (captures) usable localizer and
glideslope signals.

If a localizer or glideslope signal is missing, out of range, or otherwise unusable, the associated pointer will not appear on the scale.

Pointer indications are discussed in detail in the instrument lessons.

Pitch Chevrons, Zenith, and Nadir

The pitch attitude scale on the attitude indicator helps to determine the amount of aircraft pitch attitude. To assist with pitch orientation at attitudes that are more than 50° pitch up or 50° down, chevrons are included with this scale.

These chevrons indicate the direction of the horizon.

The pitch scale also includes a zenith symbol and a nadir symbol. The zenith symbol indicates direct vertical up (+90°) and the nadir symbol indicates direct vertical down (-90°).

Figure SY108-35 – ADS Instrument Power
Altitude Indicator

The altitude indicator (altimeter) displays both a digital readout and a "moving-tape" scale which indicates the current barometric-corrected altitude of the aircraft.

The major elements of the altitude indicator are:

Altitude scale
Digital altitude readout
Altitude bug
Altitude bug setting readout
Altimeter barometric setting

The altitude bug and altimeter barometric settings are both made using the UFCP.
Radar Altimeter

The Radar Altimeter (RA or RAD ALT) indicates aircraft altitude Above Ground Level (AGL).

The RA is only active when the aircraft is at or below 2,500 feet AGL, bank angle is less than 30°, and pitch angle is less than 15°. To declutter the display, only the letters "RA" appear when the aircraft is above 2,500 feet AGL.

The digital readout is visible at or below 2,500 feet AGL when the pitch and bank angles are within the limits stated above.

When the aircraft radar altitude is below the radar altitude setting, the readout changes to yellow and flashes. The radar altitude setting is made using the UFCP.

Figure SY108-38 – Radar Altimeter Indications
Vertical Speed Indicator

The Vertical Speed Indicator (VSI) displays current aircraft vertical speed in ft/min on a digital readout and with a scale and pointer. The digital readout range is -9,900 to +9,900 ft/min and the scale range is -6,000 to +6,000 ft/min.

When vertical speed is greater than ±6,000 ft/min, the pointer pegs at -6,000 ft/min or +6,000 ft/min respectively. When vertical speed is greater than ±9,900 ft/min, the digital readout displays -9,999 ft/min or +9,999 ft/min respectively.

The major elements of the vertical speed indicator are:

- Vertical speed scale
- Vertical speed pointer
- Vertical speed digital readout
Primary Instrument UFCP Settings

As previously mentioned, these settings require using the UFCP:

Altimeter barometric setting
Altitude bug
Radar altitude setting
Airspeed bug

These settings are entered using the PFD page of the UFCP. You learned how to do this in the UFCP lesson.

Each UFCP page is organized into windows. These are numbered from top to bottom as W1, W2, W3, and W4.

Primary Instrument Settings

A left-facing arrow in a window indicates that the window is selected and ready for data entry. Each window is labeled; you will enter data in these formats.

W1 - Altimeter setting "SET" - Up to four digits for current altimeter setting in inches of mercury or millibars

W2 - Altitude bug setting "AB" - Up to five digits for current altitude bug setting in feet

W3 - Radar altimeter setting

Figure SY108-40 – UFCP Windows

Figure SY108-41 – UFCP Primary Instrument Settings
"RA" - Up to four digits for current radar altimeter setting in feet

W4 - Airspeed bug setting
"SPD" - Three digits for current airspeed bug setting in knots IAS

PFD and NAVAdvisories

Let's look at advisories that may appear at the top of the PFD or NAV displays.

TFC - TCAS has issued a traffic advisory
DR - FMS navigation solution is dead reckoning
MSG - New alert message in the FMS scratchpad

The remaining advisories are as follows:

IRS - FMS navigation solution is IRS
GPS - GPS solution with integrity is not available
OFS - FMS is conducting offset navigation
NPA - FMS has activated a non-precision approach
EXEC - FMS flight plan has been modified

Figure SY108-42 – PFD and NAV Advisories
Horizontal Situation Indicator

The course data section consists of a compass rose and related indications, pointers, alphanumeric data, and selectable options. The "G" meter also appears in this section. For simplicity, the course data section is referred to as the horizontal situation indicator (HSI).

The HSI is highly adaptive with the capability to display selective data from radio navigation sources, the FMS, and the Inertial Reference System (IRS).

Figure SY108-43 – Horizontal Situation Indicator (HSI)
Compass Rose

The compass rose is a circular scale with cardinal direction marks (N, E, S, W) at 0°, 90°, 180°, and 270° respectively, and numbers without trailing zeros at all other 30° increments as shown.

Major graduations indicate 10° increments and minor graduations indicate 5° increments. The rose rotates as the aircraft heading changes so that the current aircraft heading is always located at the top of the display.

Fixed tick marks on the outside of the scale at 45°, 135°, 225°, and 315° from the top of the scale allow easy heading reference at 45° increments. The aircraft symbol in the center always points toward the top of the display.
Heading Readout

The heading readout indicates the current aircraft heading from 001° to 360°. The white box around the readout has two attachments: a triangular caret (heading pointer) and a compass setting symbol.

The tip of the heading pointer provides a precise heading reference point at the top of the compass rose.

The compass setting symbol will be either a degree symbol “°” or the letter T. The degree symbol indicates that the compass setting is magnetic and T indicates that the compass setting is True.

The compass setting is selected using the UFCP. We'll see this later.

Figure SY108-45 – Heading Readout
Heading Bug

The heading bug consists of two parts: the heading bug and the heading bug caption.

The heading bug is positioned on the outside edge of the compass rose such that the V point in the notch aligns the current heading bug setting to the compass rose. The bug rotates with the compass rose to maintain this alignment.

The heading bug caption displays the current heading bug setting and allows you to set the heading bug using the UFCP.

Setting the Heading Bug

The heading bug can be set to the current heading by pressing and holding LSK LR for 1 second.

To set the bug to any other heading, momentarily press and release LSK LR. This changes the UFCP display to the heading page.
With the UFCP heading page displayed, you can set the heading bug by turning the data entry knob to slew the bug to the desired position. Another option is to enter the desired bug setting in W1 and then press the ENT key to select.

You can also select the compass setting by pressing the select arrow adjacent to W2. As previously mentioned, the options are magnetic (MAG) and TRUE.

Bearing Pointers

There are two bearing pointers on the HSI: bearing pointer #1 and bearing pointer #2.

Note that the bearing pointers are not labeled 1 and 2; instead, bearing pointer #1 is displayed as a single green line and bearing pointer #2 is displayed as a cyan double line.

Depending on phase of flight, navigation source availability, and mission requirements, the pointers may be configured so that both pointers appear, only one pointer appears, or no pointers appear.

The default power state for the bearing pointers is OFF.
Bearing Pointers Continued

A bearing pointer indicates the heading to its slaved navigation source. If a bearing pointer is slaved to VOR and the navigation source is tuned to a VOR frequency (112.00 through 117.95), the pointer will point to the tuned VOR station (more on navigation source later).

If a bearing pointer is slaved to VOR and the navigation source is tuned to a LOC frequency (108.00 through 111.95 - ILS mode), the bearing pointer is not displayed.

When a bearing pointer is slaved to the FMS, the bearing pointer will either point toward the next waypoint (if the aircraft is on track) or indicate the flight path to regain track (if the aircraft is off track).

Bearing Pointer Selections

In the T-6B, the bearing pointer selections options are:

- OFF
- FMS
- VOR or LOC

Figure SY108-50 – Bearing Pointer Data Fields

Figure SY108-51 – Bearing Pointer Options
Pressing the LSK adjacent to a navigation source data field will cycle the associated pointer to the next available source.

Notice that the #2 bearing pointer disappears. The associated bearing pointer caption displays the pointer icon and OFF. Subsequent presses of LSK R6 will cycle the #2 pointer through the available sources.

Ground Track Pointer

The ground track pointer indicates the current ground track of the aircraft on the compass rose. The IRS computer provides the data to position the pointer.

The pointer is locked at the 12 o’clock position when there is weight on wheels and a true airspeed of less than 30 kt.

Course Deviation Indicator

The course deviation indicator (CDI) consists of these elements:

CDI head
CDI tail
Deviation bar
Deviation scale
TO/FROM arrow

Figure SY108-52 – Bearing Pointer Data Fields

Figure SY108-53 – Ground Track Pointer

Figure SY108-54 – Course Deviation Indicator (CDI)
CDI Description

The CDI head, tail, deviation bar and scale display in white when the selected navigation source is VOR. The CDI head, tail and deviation bar display in magenta when the selected navigation source is FMS.

The CDI head is oriented on the compass rose to indicate either the desired course (when the navigation source is VOR) or desired track (when the navigation source is FMS).

The CDI tail is always aligned with the CDI head but at the opposite side of the compass rose.

This example shows the CDI with FMS selected as the navigation source.

Lateral Deviation Indicator

The deviation bar indicates the lateral deviation from the desired course or track by moving back and forth along the deviation scale.

The amount of lateral deviation indicated by the scale depends on the current navigation source, VOR or LOC, and the phase of flight if the source is FMS.
Here are the deviation values:

- VOR - 5° course error per dot
- FMS - Enroute phase of flight, 2.5 nm per dot
- FMS - Terminal phase of flight, 0.5 nm per dot
- FMS - Approach phase of flight, 0.15 nm per dot

TO/FROM Arrow

The TO/FROM arrow is only displayed when the navigation source is VOR and is displayed in white. This arrow indicates whether the aircraft is flying to or from the VOR station along the selected course radial indicated by the CDI head.

Phase of Flight

As previously mentioned, when FMS is selected as the navigation source, all CDI symbology is magenta and the lateral deviation indicator shows deviation from the FMS-computed desired track.

The T-6B FMS computes three phases of flight. These are:

- Enroute - ENR
- Terminal - TERM
- Approach – APR

Figure SY108-56 – HSI Showing Phase of Flight
The current phase of flight is annunciated in magenta.

Groundspeed, True Airspeed, and Windspeed

The Groundspeed (GS) indicator displays current aircraft speed (in knots) with respect to the ground. Groundspeed is calculated by the FMS. The digital readout indicates current aircraft speed with respect to the ground track.

The True Airspeed (TAS) indicator displays the current aircraft true airspeed (in knots).

Windspeed and direction indications consist of a digital readout and a rotating arrow. The arrow shows wind direction relative to the aircraft such that the current heading of the aircraft is at the top of the display; i.e., an aircraft flying in a tailwind will display the arrow pointing vertically upwards.

Figure SY108-57 – Groundspeed and TAS

Figure SY108-58 – Windspeed
Take a moment to review the navigation relationships.

Figure SY108-59 – Navigation Relationships

**Accelerometer/"G" Meter**

The “G” meter (accelerometer) displays the instantaneous vertical acceleration of the aircraft in units of "G."

The “G” meter is addressed in greater detail in the lesson Flight Instruments, Part 2.

Figure SY108-60 – “G” Meter
Declutter

You can declutter the PFD and NAV displays by using the DCLTR 0, DCLTR 1, and DCLTR 2 options. DCLTR 0 is the default. No information is removed from the displays with DCLTR 0 selected.

From the persistent display, pressing the SYS key accesses the SYS menu.

Pressing the W3 window control key selects the DISPLAY page.

Pressing the W4 window control key selects the MFD declutter page.

Pressing the W1 window control key toggles through the options.

Figure SY08-61 – UFCP Showing Declutter Level 0
Declutter Level 1 and Level 2

With DCLTR1 selected, the following items are removed from the PFD:

- Airspeed Trend Vector
- True Airspeed
- Wind Speed & Direction
- Ground Track Pointer
- Groundspeed

Notice the DCLTR 1 label displayed below the compass rose.

With DCLTR2 selected, these additional items are removed from the PFD:

- Airspeed Bug & Setting Readout
- Altitude Bug & Setting Readout
- Radar Altimeter Display

NAV display declutter is shown in the Navigation lesson.
ADI Automatic Declutter

The radar altimeter digital readout is removed from view when pitch is 15° or greater or bank is 30° or greater.

Figure SY108-64 – ADI Automatic Declutter Level

PFD Summary

This topic covered the Primary Flight Display (PFD).

The Engine Indication and Crew Alerting System (EICAS) will be covered in the Flight Instruments, Part 2 lesson.

Figure SY108-65 – PFD Default Position
Backup Flight Instrument

The integrated Backup Flight Instrument (BFI) consists of:

- Airspeed indicator
- Attitude indicator
- Altimeter
- Vertical speed indicator
- Heading indicator

This instrument provides backup primary flight instrument indications in case of failure of the integrated avionics system.

The BFI has its own internal air data system and three-axis gyro stabilization system. It is fully independent from the integrated avionics system and receives no external data inputs.
Backup Flight Instrument Power

If the aircraft primary electrical systems fail, the BFI will continue to operate for a limited time from the auxiliary battery.

The BFI normally receives power from the battery bus.

If the battery bus should fail, the BFI is then powered by the auxiliary battery, which is activated with the AUX BAT switch on the right forward switch panel in the front cockpit.

Instrument Lighting

The BFI is internally back lighted. The brightness may be adjusted:

Automatic: A bezel sensor input adjusts the lighting level in response to ambient light conditions.

Manual: The lighting level may be adjusted by an instrument panel dimmer switch on the front left console panel in each cockpit.

Fixed: When the Aux Battery is powering the system the lighting level

Figure SY108-67 – BFI Power
remains fixed and cannot be adjusted.

BFI Air Data Sources

The secondary pitot-static system provides the air data pressures directly to the BFI. These pressures are NOT fed to the Air Data Computer (ADC) as with the primary system.

Backup Airspeed Indicator

The backup airspeed indicator displays airspeed from 40 to 350 knots. The digital airspeed readout and airspeed tape indicate airspeed in 10-knot increments.

The airspeed tape displays red and white cross-hatches at the top of the tape to indicate the velocity/Mach limit.
Backup Attitude Indicator

The backup attitude indicator displays pitch and roll information on an attitude barrel in relation to a reference plane representing the aircraft.

As with the primary flight display, the blue portion of the attitude barrel represents above the horizon while the brown portion represents below the horizon.

Roll is indicated by an arc scale and pointer at the bottom of the indicator. This scale is marked in 10° increments up to 30°; then is marked in 15° increments.

Backup Altimeter

The backup altimeter digital altitude readout is graduated in 20-foot increments. The altitude tape is graduated in 100-foot increments.

To alert the pilot that altitude is below 10,000 feet, the 10,000 foot counter is covered by a hatched pattern.

The barometric altitude setting can be set in inches of mercury (in) or in millibars (mb). To set the baro altitude, rotate the
knob in the lower right corner of the display.

The backup vertical speed indicator is a digital readout in the upper right corner below the barometric setting readout. The vertical speed readout displays in 20-ft/min increments.

Backup Heading Indicator

The backup heading indicator is a moveable tape scale at the bottom of the instrument. The scale moves smoothly left or right as the aircraft heading changes. Current heading is indicated at the center of the scale.

The scale is marked at 5° increments for the short marks and 10° for the long marks. As on the PFD, the cardinal headings (N, E, S, W) are marked at the appropriate positions.
BFI heading information is provided by a magnetometer (flux valve) in the right wing. No navigation information is displayed via the BFI.

BFI Fail

If the BFI detects an internal attitude fail condition, the attitude indicator disappears and is replaced by a red ATT FAIL annunciation.

Lesson Review Quiz

Figure SY108-74 – BFI ATT FAIL
LESSON QUESTIONS

EMBEDDED QUESTIONS (Ref: Segment/Topic/Question)

1. The T-6B is NOT equipped with which of the following radio navigation systems? (B/1/1)
   a. Distance Measuring Equipment (DME)
   b. VHF Omnidirectional Range (VOR)
   c. Instrument Landing System (ILS)
   d. Tactical Air Navigation (TACAN)

2. Which statement best describes VOR radials. (B/1/2)
   a. Oriented to true North
   b. Oriented to magnetic North
   c. Represent azimuth in 0.1° increments
   d. Provide lateral guidance to runway centerline

3. Which of the following statements best describes DME slant range distance? (B/1/3)
   a. Slant range distance equals ground distance.
   b. Slant range distance is greater than ground distance.
   c. Slant range distance is greater than ground distance when approaching the station and shorter than ground distance when going away from the station.
   d. Slant range distance is shorter than ground distance when approaching the station and greater than ground distance when going away from the station.

4. An inward-facing green chevron indicates _____. (B/2/1)
   a. a link to a Flight Management System (FMS) page
   b. the associated Line Select Key (LSK) is disabled
   c. a selectable option is available
   d. a non-selectable fixed value
5. When operating in the T-6B basic student level display configuration, which MFD defaults to allow display of the MENU page? (B/2/2)
   a. Left
   b. Center
   c. Right
   d. Any of them

6. The term "soft key" means that _______. (B/2/3)
   a. the Line Select Key (LSK) associated with an option is disabled until enabled using the MFD MENU page
   b. you can touch the option or data on the screen itself to select the option
   c. the option associated to a LSK changes when the display changes
   d. the LSKs only require a light touch to operate
7. How do you set the altitude bug? (B/3/1)
   a. Access the PFD page on the UFCP and select AB in W2.
   b. Press and hold Line Select Key (LSK) R1.
   c. Press and hold LSK R2.
   d. Press and hold LSK R3.

8. In order from left to right, what is the basic configuration of the primary flight instruments section (top half) of the PFD? (B/3/2)
   a. Altitude, attitude, airspeed
   b. Airspeed, attitude, altitude
   c. Airspeed, altitude, attitude
   d. Airspeed, heading, attitude
9. Where is the heading indicator located? (B/3/3)
   a. At the bottom of the attitude indicator roll scale
   b. On the center deviation indicator scale
   c. In the center of the attitude indicator
   d. At the top of the compass rose

10. Which of these statements is correct with regard to bearing pointers? (B/3/4)
    a. Bearing pointer number 1 always displays VOR data.
    b. Bearing pointer number 1 is always displayed.
    c. Only one bearing pointer may be turned off.
    d. Both bearing pointers may be turned off.
11. The backup flight instrument can be used for a limited time in the event of a failure of the aircraft primary ______ system(s). (B/4/1)
   a. propulsion
   b. electrical
   c. environmental
   d. hydraulic

12. The digital airspeed readout and digital tape on the backup flight instrument is marked in increments of ______ knots. (B/4/2)
   a. 5
   b. 10
   c. 20
   d. 25

13. The altimeter on the backup flight instrument ______. (B/4/3)
   a. is a digital readout only
   b. is a moving tape and triangular pointer
   c. is both a digital readout and a moving tape
   d. can be switched between a digital readout or a moving tape

14. The backup flight instrument attitude indicator gyro inputs come from ______. (B/4/4)
   a. the integrated avionics system Inertial Reference Unit (IRU)
   b. the Global Positioning System (GPS)
   c. its own internal three-axis reference source
   d. both its own reference source and the integrated avionics system

LESSON REVIEW QUIZ QUESTIONS

1. Which system is NOT integrated with the T-6B integrated avionics system?
   a. Primary Flight Display (PFD)
   b. Radio navigation system
   c. Backup Flight Instrument (BFI)
   d. Navigation (NAV) display

2. The Primary Flight Display (PFD) contains all of the instruments required for the primary instrument scan.
   a. True
   b. False
3. The primary pitot probe at the right wingtip and primary static ports on the sides of the aft fuselage provide necessary pressures to the ______.
   a. Air Data Computer (ADC)
   b. integrated avionics system computers
   c. Primary Flight Display (PFD)
   d. Backup Flight Instrument (BFI)

4. How do you select declutter level 1 (DCLTR 1)?
   a. Press Line Select Key (LSK) Upper Left (UL).
   b. Press LSK Upper Right (UR).
   c. Press LSK Right 4 (R4).
   d. Use the Up Front Control Panel (UFCP).

5. The altimeter barometric setting data can be set in which format(s)?
   a. Inches of mercury
   b. Millibars
   c. Millimeters
   d. Both A and B

6. What are the two main sections of the Primary Flight Display (PFD)?
   a. PFD MENU 1; PFD MENU 2
   b. Primary flight instruments; Horizontal Situation Indicator (HSI)
   c. Primary flight instruments; backup flight instruments
   d. Primary flight instruments; Navigation (NAV) display
7. The Backup Flight Instrument (BFI) includes which one of the follow indications?
   a. Bearing pointers
   b. Center Deviation Indicator (CDI)
   c. “G” meter
   d. Airspeed indicator

8. When the navigation source is selected to Flight Management System (FMS), the course deviation indicator shows deviation from the _______.
   a. radial
   b. localizer
   c. glideslope
   d. desired track

9. What are the three phases of flight generated by the Flight Management System (FMS)?
   a. Enroute, terminal, approach
   b. Departure, enroute, approach
   c. Lateral, vertical, time enroute
   d. Lateral, vertical, required time of arrival

10. Which radio navigation system transmits a unique pulse-pair signature that is received by a ground station and is then retransmitted back to the aircraft?
    a. Marker Beacon (MB)
    b. Distance Measuring Equipment (DME)
    c. Instrument Landing System (ILS) localizer
    d. ILS glideslope
SY0109 – FLIGHT INSTRUMENTS 2
STUDENT GUIDE

<table>
<thead>
<tr>
<th>TABLE OF CONTENTS</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>TABLE OF CONTENTS</td>
<td>9-1</td>
</tr>
<tr>
<td>LIST OF FIGURES</td>
<td>9-2</td>
</tr>
<tr>
<td>OVERVIEW</td>
<td>9-4</td>
</tr>
<tr>
<td>REFERENCES</td>
<td>9-4</td>
</tr>
<tr>
<td>STUDENT ASSIGNMENTS</td>
<td>9-4</td>
</tr>
<tr>
<td>LESSON OUTLINE</td>
<td>9-4</td>
</tr>
<tr>
<td>INTRODUCTION</td>
<td>9-5</td>
</tr>
<tr>
<td>SYSTEMS INSTRUMENTATION</td>
<td>9-5</td>
</tr>
<tr>
<td>EICAS</td>
<td>9-5</td>
</tr>
<tr>
<td>AOA</td>
<td>9-18</td>
</tr>
<tr>
<td>ACCELEROMETER</td>
<td>9-28</td>
</tr>
<tr>
<td>CLOCK</td>
<td>9-34</td>
</tr>
<tr>
<td>FLIGHT DATA RECORDER</td>
<td>9-40</td>
</tr>
<tr>
<td>LESSON QUESTIONS</td>
<td>9-44</td>
</tr>
<tr>
<td>Figure</td>
<td>Description</td>
</tr>
<tr>
<td>--------</td>
<td>-------------</td>
</tr>
<tr>
<td>SY109-1</td>
<td>Forward Instrument Panel</td>
</tr>
<tr>
<td>SY109-2</td>
<td>Basic EICAS Display</td>
</tr>
<tr>
<td>SY109-3</td>
<td>CAS Messages</td>
</tr>
<tr>
<td>SY109-4</td>
<td>HYD PRESS Caution Indication</td>
</tr>
<tr>
<td>SY109-5</td>
<td>FUEL QTY Caution Indication</td>
</tr>
<tr>
<td>SY109-6</td>
<td>EICAS Warning Indications</td>
</tr>
<tr>
<td>SY109-7</td>
<td>Invalid Data</td>
</tr>
<tr>
<td>SY109-8</td>
<td>Failed Data</td>
</tr>
<tr>
<td>SY109-9</td>
<td>CAS Message Hierarchy</td>
</tr>
<tr>
<td>SY109-10</td>
<td>CAS Message MORE Prompt</td>
</tr>
<tr>
<td>SY109-11</td>
<td>CAS Message Overflow</td>
</tr>
<tr>
<td>SY109-12</td>
<td>Warning Switchlight and Message</td>
</tr>
<tr>
<td>SY109-13</td>
<td>Caution Switchlight and Message</td>
</tr>
<tr>
<td>SY109-14</td>
<td>CK ENG Warning Message</td>
</tr>
<tr>
<td>SY109-15</td>
<td>CK ENG Caution Message</td>
</tr>
<tr>
<td>SY109-16</td>
<td>Warning and Caution</td>
</tr>
<tr>
<td>SY109-17</td>
<td>Extinguishing Switchlight</td>
</tr>
<tr>
<td>SY109-18</td>
<td>Extinguishing Switchlight</td>
</tr>
<tr>
<td>SY109-19</td>
<td>Warning Tone Audio</td>
</tr>
<tr>
<td>SY109-20</td>
<td>Warning Tone Table</td>
</tr>
<tr>
<td>SY109-21</td>
<td>CWS Power</td>
</tr>
<tr>
<td>SY109-22</td>
<td>AOA Indexer and Indicator</td>
</tr>
<tr>
<td>SY109-23</td>
<td>AOA Computer</td>
</tr>
<tr>
<td>SY109-24</td>
<td>AOA Vane</td>
</tr>
<tr>
<td>SY109-25</td>
<td>AOA Indicator Blowout</td>
</tr>
<tr>
<td>SY109-26</td>
<td>AOA Indicator Marks</td>
</tr>
<tr>
<td>SY109-27</td>
<td>Optimum AOA for Landing</td>
</tr>
<tr>
<td>SY109-28</td>
<td>Max Endurance and Max Range AOA</td>
</tr>
<tr>
<td>SY109-29</td>
<td>Stall AOA</td>
</tr>
<tr>
<td>SY109-30</td>
<td>High AOA</td>
</tr>
<tr>
<td>SY109-31</td>
<td>Low AOA</td>
</tr>
<tr>
<td>SY109-32</td>
<td>AOA Indexer Blowout</td>
</tr>
<tr>
<td>SY109-33</td>
<td>AOA Indexer Optimum Approach</td>
</tr>
<tr>
<td>SY109-34</td>
<td>AOA Indexer Slow Approach</td>
</tr>
<tr>
<td>SY109-35</td>
<td>AOA Indexer Fast Approach</td>
</tr>
<tr>
<td>SY109-36</td>
<td>Stick Shaker</td>
</tr>
</tbody>
</table>
Figure SY109-37 – AOA System Test .............................................................. 9-26
Figure SY109-38 – AOA Low (LO) Test ......................................................... 9-26
Figure SY109-39 – AOA High (HI) Test .......................................................... 9-27
Figure SY109-40 – AOA Test Complete ........................................................ 9-27
Figure SY109-41 – AOA Power ...................................................................... 9-28
Figure SY109-42 – Accelerometer .................................................................. 9-28
Figure SY109-43 – Accelerometer Min/Max Carets ......................................... 9-29
Figure SY109-44 – Accelerometer Caret Readouts Off ..................................... 9-30
Figure SY109-45 – G Load Exceedance .......................................................... 9-30
Figure SY109-46 – G Load Exceedance Indications .......................................... 9-31
Figure SY109-47 – Accelerometer Caret Readouts Off ..................................... 9-31
Figure SY109-48 – Setting Mission Specific G Limits ....................................... 9-32
Figure SY109-49 – Mission Specific G Load Exceedance ................................. 9-33
Figure SY109-50 – G Meter Demo ................................................................. 9-33
Figure SY109-51 – Accelerometer Fail ............................................................ 9-33
Figure SY109-52 – Digital Clock Blowout ...................................................... 9-34
Figure SY109-53 – Digital Clock ................................................................... 9-34
Figure SY109-54 – Digital Clock Functions ..................................................... 9-35
Figure SY109-55 – Digital Clock Menu ............................................................ 9-35
Figure SY109-56 – Clock Menu SET GMT ..................................................... 9-36
Figure SY109-57 – Clock Number Set ............................................................. 9-36
Figure SY109-58 – Clock Menu Exit ............................................................... 9-36
Figure SY109-59 – Setting Local Time and GMT ............................................ 9-36
Figure SY109-60 – Elapsed Time Count Up .................................................... 9-37
Figure SY109-61 – Count Down Timer ............................................................ 9-38
Figure SY109-62 – Count Down Timer Alarm ................................................ 9-38
Figure SY109-63 – Clock Power .................................................................... 9-39
Figure SY109-64 – IDARS System ................................................................. 9-40
Figure SY109-65 – Flight Data Recorder ......................................................... 9-41
Figure SY109-66 – Data Transfer Module and Receptacle ................................ 9-42
Figure SY109-67 – FDR MAINT/FAIL Annunciator ....................................... 9-42
Figure SY109-68 – FDR Annunciator Lights ................................................... 9-43
Figure SY109-69 – IDARS Power ................................................................. 9-43
OVERVIEW

This lesson covers T-6B engine displays, the crew alerting system, the angle of attack sensor and indicator system, the stand-alone clock, and the flight data recorder system. The lesson is designed to provide you with a basic understanding of the operation and interpretation of these components so you can use them effectively in-flight.

REFERENCES

Personnel: None
Media Facilities: Student CAI Workstation
Support Resources: T-6B Flight Manual, T-6B Systems 1 Student Guide

STUDENT ASSIGNMENTS

Read applicable portions of T-6B Flight Manual, Section 1.
Complete CAI lesson SY109, following along with this student guide.
Complete the practice questions provided.

LESSON OUTLINE

Topics in this lesson must be taken in sequential order. All topics must be completed prior to attempting the end of lesson quiz. The estimated time required to complete this lesson is 1.1 hours.
Introduction

Systems Instrumentation

EICAS

<table>
<thead>
<tr>
<th>Standard</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.22.10b.0.1</td>
<td>Identify purpose of engine indication and crew alerting system</td>
</tr>
<tr>
<td>1.22.10b.0.2</td>
<td>Describe engine indication and crew alerting system operating principles</td>
</tr>
<tr>
<td>1.22.10b.0.3</td>
<td>Identify engine indication and crew alerting system components</td>
</tr>
<tr>
<td>1.22.10b.0.4</td>
<td>Match engine indication and crew alerting system components to functions</td>
</tr>
<tr>
<td>1.22.10b.0.8</td>
<td>Interpret engine indication and crew alerting system displays</td>
</tr>
<tr>
<td>1.22.20.0.1</td>
<td>Identify purpose of communication/aural warnings system</td>
</tr>
<tr>
<td>1.22.20.0.3</td>
<td>Identify communication/aural warnings system components</td>
</tr>
<tr>
<td>1.22.20.0.4</td>
<td>Match communication/aural warnings system components to functions</td>
</tr>
<tr>
<td>1.22.20.0.5</td>
<td>Identify characteristics of normal operations for communication/aural warnings system</td>
</tr>
</tbody>
</table>

EICAS Overview

Like the Primary Flight Display (PFD), the Engine Indication and Crew Alerting System (EICAS) display is a principal component of the “glass cockpit” integrated avionics system.

The EICAS display integrates engine gauges and critical aircraft system indications with Crew Alerting System (CAS) messages.
EICAS Critical

With the aircraft on the ground (weight on wheels) and the avionics master switch OFF, application of battery or ground power will turn on only the right-hand MFD. EICAS is the default display in this condition. The center and left MFDs remain off until the avionics master switch is turned ON.

In flight, the PFD has priority over EICAS if only one MFD is operating. If at least two MFDs are operating, both the PFD and EICAS displays will always be present.

EICAS Data Groupings

The EICAS is organized into three display groups, these are:

- Fuel, electrical, and environmental
- Engine performance
- Crew Alerting System (CAS) messages
Fuel, Electrical, Environmental

The fuel, electrical, and environmental data indications are:

- Fuel quantity by tank
- Fuel quantity total
- Bingo Fuel
- Fuel Flow (FF)
- Indicated Outside Air Temperature (IOAT)
- Electrical system (AMPS and VOLTS)
- Cockpit Altitude (CKPALT)
- Cabin pressure differential ("Delta" P)

Engine Data

The engine performance indications are:

- % Torque
- Interstage Turbine Temperature (°C ITT)
- Gas turbine speed (% N1)
- Oil pressure (PSI OIL PRESS)
- Oil temperature (°C OIL TEMP)
- Hydraulic pressure (PSI HYD PRESS)
- Propeller RPM range (NP %)
CAS

The CAS window displays warning, caution, status, and condition messages.

There are over 50 different CAS messages, but only 30 can appear in the window at one time. If the CAS triggers over 30 messages, the additional messages can be viewed by selecting a MORE option.

We’ll take a closer look at the CAS later in this lesson.

Color Conventions

As with all MFDs, color coding is a very important EICAS feature. Each color has a specific meaning and aids in organizing and interpreting the displays. The colors used on EICAS are:

- White
- Green
- Yellow
- Red

White and Green

White color conventions

Data labels and digital readouts in normal range
Scale ladder and scale arc normal range
Scale marks and numbers in normal and optimal (nominal) operating ranges
Indicator tape or pointer when in normal operating range
Indicator gauge labels and display name
Soft-key option labels

Green color conventions

Optimal-range scale arc
Indicator pointer when in optimal range
Pilot-selectable values

Yellow

Yellow indicates caution. Cautions are conditions or situations where timely pilot intervention or action is required. These include:

Marginal conditions
Out of range (high or low)
System failure
Indications trend

When a pointer enters the yellow arc on the scale (out-of-range), the pointer turns yellow and the digital readout and label display in black against yellow.

Figure SY109-4 – HYD PRESS Caution Indication
A fuel quantity indicating tape is yellow when in the 1-150 lb. yellow caution band on the ladder scale. The TOTAL LBS digital readout and label are yellow when total fuel quantity is less than 300 lb.

Red

RED indicates warning. Warnings are hazardous conditions that require immediate pilot attention and may require immediate pilot action.

Red also indicates out of range conditions (exceedances). These conditions are:

- System failure
- System malfunction
- Out of range limits (high or low)
- Exceedance indications (arcs, pointers, and readouts)

When a pointer enters a red arc on the scale (exceedance), the pointer turns red and the digital readout and label display in white against red.
Invalid Data

If data for any of the parameters becomes invalid, the related pointer is removed (if normally provided) and yellow asterisks appear in place of the digital readout and label.

Failed Data

If data for any of the parameters indicated by a gage fails, a red "X" replaces the entire gage.

For alphanumeric indications, a red “X” replaces the indication but the label remains.
CAS Message Hierarchy

The CAS has six rows and five columns. Messages fill from left to right and sort first by priority and then by order of occurrence. When a row is completely filled, a new message causes the existing message at the end of row to wrap around and begin a new row.

From highest to lowest, the priorities are:

- Warnings (red)
- Cautions (yellow)
- Status messages (white)
- Condition messages (green)

A new warning or caution message flashes when it first appears and continues flashing until acknowledged. Status and condition messages do not flash.

CAS Message Overflow

If the CAS display is full, an outward-facing green caret and the MORE label appear at LSK L5. Pressing LSK L5 with the MORE label present shows the overflow message(s).
The RETURN label at LSK L5 indicates that one or more CAS overflow messages are displayed. Notice that the active warning messages still appear.

Switchlights

CAS messages are interconnected with the aural warning system and with the master warning (MASTER WARN) and master caution (MASTER CAUT) switchlights.

When a red CAS warning message appears, it triggers the MASTER WARN switchlights and aural warnings in both cockpits.

When a yellow caution message appears, it triggers the MASTER CAUT switchlights and aural warnings in both cockpits.
CK ENG Messages

Some exceedance, or out-of-range, conditions don’t have an assigned CAS message. When one of these conditions occurs, a generic red or yellow CK ENG message appears.

For example, high TORQUE doesn’t have an assigned CAS message. This condition triggers the red CK ENG message and the MASTER WARN switchlight.

Low HYD PRESS doesn’t have an assigned CAS message. This condition triggers the yellow CK ENG message and the MASTER CAUT switchlight.

Figure SY109-14 – CK ENG Warning Message

Figure SY109-15 – CK ENG Caution Message
Switchlight Flashing

Once triggered, a switchlight will flash in both cockpits and the warning tone will continue until the condition is acknowledged. In this example, both the MASTER WARN and MASTER CAUT switchlights have been triggered.

We’ll see how to acknowledge a triggered condition on the next page.

Extinguishing Switchlights

A triggered caution or warning condition is acknowledged by pressing the flashing MASTER CAUT or MASTER WARN switchlight in either cockpit. This turns off the switchlight in both cockpits, rearms the switchlights, and stops the warning tone. The CAS message remains on steady until the condition is cleared.

Each new caution or warning, or a recurrence of a previously acknowledged caution or warning, will trigger the associated switchlight and CAS message.

If both the MASTER CAUT and the MASTER WARN are triggered, each will need to be acknowledged individually.
Fire Annunciator

The red FIRE annunciator triggers the MASTER WARN switchlight and the master warning tone.

Tone Generator

An electronic tone generator in the Audio Management Unit (AMU) provides various distinguishable warning tones. These tones are triggered using the same logic as the individual alert messages.

These tones route through the audio system to the helmet audio inputs; however, warning tones are independent of the Intercommunication System (ICS). Warning tone volume is fixed and cannot be changed.
Warning Tones

This table presents the basic warning tones.

Click on the audio symbol to the left of each tone to imagine hearing that tone.

CWS Power

Power for the tone generator unit is provided by the audio system; there is not a separate circuit breaker for aural warnings. Audio system power is distributed by AUDIO circuit breakers, one each on the battery bus panel and the generator bus panel.

Keep in mind that the AUDIO circuit breakers power the entire audio system, not just the warning tones.
AOA

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.7.2.48.1</td>
<td>Recognize AOA LOW test condition</td>
</tr>
<tr>
<td>1.7.2.48.2</td>
<td>Recognize AOA HIGH test condition</td>
</tr>
<tr>
<td>1.22.6b</td>
<td>Interpret the angle of attack (AOA) symbology on the PFD</td>
</tr>
<tr>
<td>1.22.6b.0.1</td>
<td>Identify purpose of the PFD AOA symbology</td>
</tr>
<tr>
<td>1.22.6b.0.2</td>
<td>Describe PFD AOA normal operating principles</td>
</tr>
<tr>
<td>1.22.6b.0.4</td>
<td>Locate AOA system components</td>
</tr>
<tr>
<td>1.22.6b.0.5</td>
<td>Interpret AOA indexer displays</td>
</tr>
</tbody>
</table>

AOA System Overview

The Angle of Attack (AOA) system provides angle of attack information and stall warning. This information appears on each of these units and indicators:

- Head Up Display (HUD) in the front cockpit
- AOA indexer on the upper left glareshield in each cockpit
- AOA indicator on the PFD in each cockpit

AOA information appears on the HUD and on the AOA indicators in all flight configurations.

The AOA indexers are activated only when the landing gear are down and locked.

[Figure SY109-22 – AOA Indexer and Indicator]
AOA Computer

The AOA computer is the heart of the AOA system. The computer is located on the avionics shelf under the front cockpit glareshield.

The computer receives inputs from the AOA vane near the left wing tip, the flap position microswitch, and the landing gear (when extended).

Based on these inputs, the AOA system automatically adjusts the information outputs to compensate for the various flap position and landing gear position configurations.

AOA system information is valid for all combinations of aircraft weight, configuration, and steady state bank angles.

AOA Vane

The wedge-shaped AOA vane is attached to a post on the leading edge of the left wing.

The vane moves up and down to align with the relative airflow. As the vane moves, it turns a belt and pulley to position a potentiometer which provides an electronic signal to the AOA computer.
AOA Indicator

The AOA indicator consists of a movable pointer and a fixed linear scale. Scale range is from 0 units to 20 units where 0 indicates minimum lift and 18 indicates maximum lift. The red band from 18 to 20 units indicates stall range.

The AOA pointer moves up and down the scale to continuously indicate aircraft angle of attack. A digital readout of pointer position appears at the bottom of the scale.

Keep in mind that AOA information is compensated for landing gear and flap configurations. As a result of these variables, AOA is indicated in “units,” not “degrees.”

Remember, the higher the number, the greater the angle of attack.
AOA Indicator Marks

These fixed marks appear on the AOA indicator:

The red caret at 18 units and the red band above 18 units indicate stall.

The green band from 10 to 11 units indicates the optimum AOA range for “on-speed” approach.

The white diamond caret at 8.8 units indicates maximum endurance AOA.

The white triangle caret at 4.4 units indicates maximum range AOA.

The significance of the AOA indications will be discussed in other lessons.

AOA Use

When scanned and verified with indicated airspeed, angle of attack indications can be used to fly the optimum no-wind airspeed in the landing pattern.

When flying the optimum AOA for landing, the pointer is in the green band and the amber “donut” on the AOA indexer lights.

Figure SY109-26 – AOA Indicator Marks

Figure SY109-27 – Optimum AOA for Landing
To establish the AOA for no-wind maximum endurance or no-wind maximum range, adjust aircraft pitch so that the pointer positions at the appropriate caret.

The pointer and the digital readout both turn red when AOA reaches the computed stall angle.

Figure SY109-28 – Max Endurance and Max Range AOA

Figure SY109-29 – Stall AOA
AOA System Demo 1

This video demonstrates the relationship between aircraft angle of attack, vane position, and gauge displays.

Figure SY109-30 – High AOA

AOA System Demo 2

This video demonstrates the relationship between aircraft angle of attack, vane position, and gauge displays.

Figure SY109-31 – Low AOA
AOA Indexer

When the landing gear is down and locked, the AOA indexer provides a heads-up display of angle of attack information. This aids in setting-up and maintaining the proper approach speed for landing.

The AOA indexer indicates the difference between indicated angle of attack and reference angle of attack. Each of the three signals represents a distinct AOA condition.

AOA Indexer Amber Donut

The middle amber donut lights when the aircraft is in the optimum angle of attack range for landing (on-speed). As seen earlier, this indication occurs when the pointer is in the green band on the AOA indicator.

For a normal approach, the optimum approach speed is approximately 100 KIAS at maximum landing weight. This optimum approach airspeed decreases approximately one knot for every 100 pounds of fuel used.
AOA Indexer Green Chevron

The upper green chevron indicates the angle of attack is too high (slow approach speed).

Its direction (downward pointing) indicates that pitch attitude must be adjusted downward to achieve the correct angle of attack and airspeed for landing.

AOA Indexer Red Chevron

The lower red chevron indicates the angle of attack is too low (fast approach speed).

Its direction (upward pointing) indicates that pitch attitude must be adjusted upward to achieve the correct angle of attack and airspeed for landing.

Stick Shaker

A stick shaker provides stall warning and is activated by the AOA computer at approximately 5 to 10 knots above stall speed (15.5 units).

The stick shaker consists of a small electric motor which drives an eccentric weight that shakes both the front and the rear control sticks.
Be aware that there is NO AUDIBLE STALL WARNING indication in the T-6B.

AOA System Test

When the aircraft is on the ground (weight on wheels), the AOA indicator and stick shaker are normally inhibited and only the red chevron will show on the indexers.

An operational test of the system can be performed using the AOA switch on the system test switch panel in the front cockpit. Low (LO) is tested first, then high (HI), then the switch is released.

AOA LOW and HIGH Tests

Holding the test switch to LO

Activates the amber donut on the indexers
Deactivates the red chevron on the indexers
Positions the AOA indicator on each PFD to the 10.5 unit position, plus or minus 0.4 units
Holding the test switch to HI

Activates the green chevron on the indexers
Deactivates the amber donut on the indexers
Positions the AOA indicator on each PFD to the 18.0 unit position, plus or minus 0.4 units
Operates the stick shaker

AOA Test Complete

Releasing the test switch

Returns the system to the normal operating mode
Lights the red chevron
Deactivates the green chevron, AOA indicators, and stick shaker

Figure SY109-39 – AOA High (HI) Test

Figure SY109-40 – AOA Test Complete
AOA Power

AOA system power is provided through the AOA circuit breaker on the front cockpit battery bus circuit breaker panel.

AOA vane anti-ice heat power is provided through the AOA HT circuit breaker on the generator bus circuit breaker panel in the front cockpit.

Figure SY109-41 – AOA Power

Accelerometer

1.22.7b Interpret the accelerometer symbology on the PFD
1.22.7b.0.1 Identify purpose of the PFD accelerometer symbology
1.22.7b.0.2 Describe PFD accelerometer normal operating principles
1.22.7b.0.3 Describe PFD accelerometer abnormal/emergency operating principles

Accelerometer Introduction

Recall that the accelerometer display appears on the Horizontal Situation Indicator (HSI). The accelerometer is commonly referred to as the “G” meter.

The accelerometer is a sensor that measures positive and negative vertical acceleration forces (G forces) that act on the airframe. The G meter pointer and scale indicate the current instantaneous G force measured by the accelerometer.

Figure SY109-42 – Accelerometer
The G meter scale and pointer indicate from -4.0G to +7.5G and the digital readout in the center of the scale indicates from -9.9G to +9.9G.

Note that the G meter indicates 1, not 0, with the aircraft on the ground or in level flight.

Accelerometer Max-Min Carets

Two small carets on the G meter scale indicate the maximum positive and maximum negative G loads experienced since the last “G” RESET. Each caret has an associated digital readout, one at each end of the G meter scale.

The G meter pointer determines the position of each caret. As the pointer moves up and down, the associated caret follows the pointer to the maximum position reached on the scale. The caret then stays in that position until reset.

Pressing and holding LSK R4 for at least one second resets the max G load carets and digital readouts to the current load value.

Figure SY109-43 – Accelerometer Min/Max Carets
**Turn Off G Load Digital Readouts**

Pressing line select key R5 toggles the maximum positive and maximum negative G load readouts off and on.

**G Load Exceedance**

When a G load reaches the maximum positive or maximum negative limit established for the airframe (-3.5G to +7.0G), the G meter pointer pegs at the end of the scale and the pointer and digital readout turn red. The affected max G load caret and digital readout also turn red.

Remember that all three G load digital readouts indicate from -9.9G to +9.9G.
G Load Exceedance Indications

When the G load returns to normal range, the G meter pointer and digital readout return to normal color (white). However, the affected max G load caret and digital readout stay red and the caret stays pegged at the end of the scale.

The max G load caret and digital readout exceedance indications cannot be reset in flight if the aircraft G limits have been exceeded. These can only be reset by maintenance after landing.

Mission Specific G Limit

Some missions require G limits that are more restrictive than the normal -3.5G to +7.0G range. To set mission-specific G limits, navigate to the UFCP SYS display level 3 page and then select the G limits page.

This is the display level 3 page. You can select the G limits page from these display options. We’ll do this on the next page of the lesson.

Figure SY109-46 – G Load Exceedance Indications

Figure SY109-47 – Accelerometer Caret Readouts Off
Enter Mission Specific G Limit

Unless previously set otherwise, the default G values appear.

Use standard UFCP data entry techniques to input the desired limits where POS N.N is a value from 0.0 to 7.0 and NEG N.N is a value from 0.0 to 3.5.

We’ve entered the new numbers for you.

Note that this entry changes the trigger point for the over G aural warning only. This does NOT change the IAS-computed airframe limits.

Mission Specific G Limit Exceedance

Recall that the over G aural warning triggers at 1/2G prior to the exceedance, either mission specific or IAS-computed. Since we have set the mission-specific exceedance point at -1.5G, the aural warning will trigger at -1.0G. The aural warning is independent of the airframe G limits.

Figure SY109-48 – Setting Mission Specific G Limits
Airframe G limits can be exceeded in clean, configured, symmetric, and asymmetric values. This can occur below to the limits set in the UFCP. The airframe exceedance indications are computed by the IAC and cannot be modified.

In this example, the G meter indications are not red because the current G force is below the computed airframe limit.

The over G warning continues to sound as long as the aural trigger point is exceeded.

G Meter Demo

This video takes the aircraft through a normal loop while the G meter indicates the loads.

Accelerometer Fail Indications

The entire G meter display is removed (blanks) if the G Meter receives invalid data or if the accelerometer fails.
Clock

1.22.8.0.1 Identify purpose of clock system
1.22.8.0.3 Identify clock system components
1.22.8.0.4 Match clock system components to functions
1.22.8.0.5 Identify characteristics of normal operations for clock system
1.22.8.0.8 Interpret clock instrument displays

Digital Clock Intro

A digital clock is installed on the left side of the instrument panel in each cockpit.

Clock Displays

The clock provides these pilot-selectable displays:

- Greenwich Mean Time (GMT) in 24 hour format
- Local Time (LT) selectable in 24 hour format
- Resettable Elapsed Time (ET) up to 99 hours, 59 minutes, 59 seconds
- Count Down Timer (CDT) with elapsed time alarm
Function Buttons

The SELECT button (SEL) controls the display.

The CONTROL button (CTL) controls what is being displayed.

When MODE appears above the SEL button, each press on the SEL button sequentially steps through the clock function options:

- Local time
- Elapsed time
- Count down timer

Menu Mode

The clock’s menu is the starting point for setting both GMT and LT. To access the menu, simultaneously press both the SEL and CTL buttons. This can be done regardless of which mode is currently displayed.

This is the clock menu default display.
Basic Time Set Sequence

The basic time set sequence is:

Pressing SEL sequences the cursor to the next option.

Pressing CTL with the cursor next to an option selects that option.

Pressing CTL with a selected (flashing) digit increments the number (rolls-over at end).

Pressing SEL with a selected (flashing) digit sets the number and selects the next digit to be set.

After all digits are set (stop flashing), pressing SEL returns the display to the menu.

Scrolling to EXIT and pressing CTL exits the menu.

Figure SY109-56 – Clock Menu SET GMT

Figure SY109-57 – Clock Number Set

Figure SY109-58 – Clock Menu Exit
**Setting GMT and LT**

When setting LT, keep in mind that you can only set the first two digits (hours). LT minutes and seconds are synchronized to GMT and cannot be changed in SET Local Time mode.

Minutes and seconds can only be changed in SET GMT mode.

**ET Count Up Function**

To initiate an elapsed time (ET) count up, press the SEL button until the Elapsed Time display appears.

Momentarily pressing the CTL button starts the ET count. The count can continue up to 99 hours 59 minutes 59 seconds.

Pressing the CTL button during the count stops the count. Another CTL press resets the count to zeros.
Count Down Timer 1

You can set count down time using the Count Down Timer (CDT).

With the CDT displayed, pressing and holding the SEL button for at least 3 seconds results in a “Hold to Set CDT” prompt followed in approximately 3 seconds by a “Set Count Down” prompt.

After the “Set Count Down” prompt appears, you can release the SEL button and then set desired CDT numbers using the basic time set steps described earlier.

Count Down Timer 2

With the desired count down time set, pressing the CTL button starts the CDT.

When the count down reaches zero, the display will flash and count up.

Pressing the CTL button deactivates the flashing alarm but the CDT will continue counting up. Pressing the CTL button again will stop the count. Another press resets the CDT to the previous set value.
The time set into the CDT is saved into memory so that you don’t have to re-enter it for each use. To reset the CDT, repeat the steps outlined on the previous page.

Clock Power

The digital clock is hardwired to the hot battery electrical bus. There is no circuit breaker provided in the cockpit for the clock. You will learn information on the hot battery bus in the electrical lesson.

Figure SY109-63 – Clock Power
Flight Data Recorder

<table>
<thead>
<tr>
<th>IDARS ID</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.22.26.0.1</td>
<td>Identify purpose of flight data recorder system</td>
</tr>
<tr>
<td>1.22.26.0.3</td>
<td>Identify flight data recorder system components</td>
</tr>
<tr>
<td>1.22.26.0.4</td>
<td>Match flight data recorder system components to functions</td>
</tr>
<tr>
<td>1.22.26.0.5</td>
<td>Identify characteristics of normal operations for flight data recorder system</td>
</tr>
<tr>
<td>1.22.26.0.8</td>
<td>Interpret flight data recorder instrument displays</td>
</tr>
</tbody>
</table>

IDARS Introduction

The Integrated Data Acquisition Recording System (IDARS) monitors, acquires, and records numerous analog and digital data parameters related to the airframe, engine, flight controls, voice communication systems, and navigation systems.

The IDARS includes these primary components:

- Integrated data acquisition recorder
- Maintenance connector
- Data Transfer Module (DTM)
- Data Transfer Module Receptacle (DTMR)
- Recorder/maintenance annunciator

Figure SY109-64 – IDARS System
Flight Data Recorder

The integrated data acquisition recorder is commonly referred to as the Flight Data Recorder (FDR). It is easily identified as a large orange box in the right avionics bay.

The FDR is the central unit of the IDARS. It acquires and processes all monitored parameters and records data into the internal Crash Protected Memory (CPM) digital storage module and/or the external Data Transfer System (DTS) module. The FDR also provides outputs for status and Built-in Test (BIT) data.

A maintenance connector near the FDR provides test equipment access for system maintenance and stored data download.

Figure SY109-65 – Flight Data Recorder
Data Transfer Module

The Data Transfer Module (DTM) is a portable memory cartridge used for data storage, retrieval, and loading. The data is stored in digital format in non-volatile memory in the cartridge.

A permanently-mounted Data Transfer Module Receptacle (DTMR) provides the interface between the DTM cartridge and the IDARS.

The IDARS system provides power for both the DTM and the DTMR.

FDR Annunciator

An FDR MAINT/FAIL annunciator is installed outboard of the anti-G suit connection near the firewall shutoff handle on the left side of the front cockpit.

Figure SY109-66 – Data Transfer Module and Receptacle

Figure SY109-67 – FDR MAINT/FAIL Annunciator
FDR Annunciator Lights

The FDR annunciator is divided into two halves: an upper maintenance (MAINT) half and a lower FAIL half.

The green MAINT annunciator illuminates when IDARS memory reaches approximately 80% full.

The amber FAIL annunciator illuminates when the IDARS system has failed.

Both annunciator lights illuminate during the lamp test.

IDARS Power

IDARS system power is distributed from the FDR circuit breaker located on the front cockpit battery bus circuit-breaker panel.

Lesson Review Quiz
LESSON QUESTIONS

EMBEDDED QUESTIONS (Ref: Topic/Question)

1. The master warning and master caution switchlights are interconnected with the ______. (B/1/1)
   a. engine/electrical switch panel
   b. crew alerting system (CAS) messages
   c. trim control panel
   d. environmental control pane

2. When a warning or caution message appears on an EICAS in either cockpit, the respective master warning or master caution switchlights will ______. (B/1/2)
   a. illuminate steadily in both cockpits
   b. flash in that same cockpit only
   c. flash in both cockpits
   d. illuminate steadily in the front cockpit

3. Which of these statements is most correct in reference to the warning tones generated by the AMU? (B/1/3)
   a. Volume can be reduced to a minimum level but not turned off.
   b. Volume level is adjustable using the UFCP SYS level 3 page.
   c. Volume level is adjustable using the ICS control panel.
   d. Volume is at a fixed level and cannot be changed.

4. The AOA computer receives inputs from the AOA vane, the flap position microswitch, and from the ______. (B/2/1)
   a. trim position indicator
   b. aircraft control stick
   c. landing gear
   d. elevator trim tab

5. The higher the number on the AOA indicator, the ______. (B/2/2)
   a. greater the approach speed
   b. lower the angle of attack
   c. greater the angle of attack
   d. lower the stall airspeed
6. The red caret at ______ units on the AOA gauge indicates a stall. (B/2/3)
   a. 12
   b. 14
   c. 16
   d. 18

7. The stick shaker activates at approximately ______ knots above stall speed, or ______ units on the AOA indicator. (B/2/4)
   a. 4 to 8; 15
   b. 5 to 10; 15.5
   c. 5 to 10; 18
   d. 6 to 12; 18

8. When the AOA test switch is held at the LO position, the indexer shows a(n) ______ and the AOA indicator reads ______ units. (B/2/5)
   a. red chevron; 7.9
   b. green chevron; 18
   c. amber donut; 10.5
   d. green chevron; 3.6

9. The G meter indicates ______ G when the aircraft is on the ground or in level flight. (B/3/1)
   a. 0
   b. 1
   c. -1
   d. The highest reached
10. How do you reset G load exceedance indications? (B/3/2)
   a. Press and hold line select key (LSK) R4 for at least one second.
   b. Press and hold LSK R5 for at least one second.
   c. Press and hold both LSK R4 and LSK R5 simultaneously for at least one second.
   d. G load exceedance indications can only be reset by maintenance.

11. The SEL button is used to cycle through the clock function options. (B/4/1)
   a. True
   b. False
12. The CTL button is used to set minutes in SET Local Time mode. (B/4/2)

![Image](image.png)

c. True
d. False

13. The Elapsed Time timer can count up to a limit of ______ hours 59 minutes 59 seconds. (B/4/3)

   a. 69  
   b. 79  
   c. 89  
   d. 99  

14. Which of the following statements is most correct regarding the FDR? (B/5/1)

   a. Records data on a tape reel inside the unit 
   b. Must be removed from the aircraft to download the data 
   c. Monitors and records numerous aircraft data parameters 
   d. Transmits recorded data to test equipment via an internal radio data link

15. The FDR is a large _____ box installed ______. (B/5/2)

   a. orange; under the front cockpit glareshield 
   b. black; under the front cockpit glareshield 
   c. orange; in the right avionics bay 
   d. black; in the right avionics bay
16. IDARS power is distributed from the ______ circuit breaker on the front cockpit battery bus circuit-breaker panel. (B/5/3)
   a. DTM
   b. EDM
   c. FDR
   d. UFCP
LESSON QUIZ QUESTIONS

1. The “G” meter gauge and pointer indicates instantaneous normal acceleration in the range from ______ Gs.
   a. –8.5 to +15.0
   b. –4.0 to +10.0
   c. –4.0 to +8.0
   d. –4.0 to +7.5

2. To perform a count up with the digital clock, the display must be set to the ______ function.
   a. Count Down Timer
   b. Elapsed Time
   c. Local Time
   d. Menu

3. The annunciator placarded FDR near the firewall shutoff handle in the front cockpit will light MAINT in the upper half or ______ in the lower half.
   a. RECORDER
   b. 80%
   c. FAIL
   d. FDR

4. Angle of attack (AOA) information is provided on the AOA indexer when ______.
   a. the angle of attack is below 7.9 units on the AOA indicator
   b. airspeed is 5 to 10 knots above stall speed
   c. the landing gear is down and locked
   d. the flaps are set at landing setting

5. When a flashing master caution (MASTER CAUT) or master warning (MASTER WARN) switchlight is reset, the associated message in the Crew Alerting System (CAS) on the Engine Indication and Crew Alerting System (EICAS) display will ______ for as long as the malfunction or failure condition persists.
   a. also reset
   b. begin flashing
   c. remain on steady
   d. extinguish, then relight
6. Which is the default multifunction display (MFD) with the aircraft on the ground (weight on wheels), avionics master switch off, and the battery switch on?
   a. Engine Indicating and Crew Alerting System (EICAS)
   b. Crew Alerting System (CAS) messages only
   c. Primary Flight Display (PFD)
   d. MFD MENU

7. Warning tones generated by the Audio Management Unit (AMU) are routed to the ______.
   a. helmet audio connections
   b. main annunciator panel
   c. cockpit speaker
   d. VHF radio

8. The white triangle at 4.4 units on the AOA indicator designates ______.
   a. maximum endurance angle of attack
   b. maximum range angle of attack
   c. normal approach speed
   d. stall speed

9. The data transfer module (DTM) is a ______ used for digital information storage, loading, and retrieval.
   a. permanently mounted memory chip
   b. portable memory cartridge
   c. fixed data cartridge
   d. fixed tape drive

10. A slow approach speed is indicated by the ______.
    a. upper green chevron on the AOA indexer
    b. lower red chevron on the AOA indexer
    c. white diamond on the AOA indicator
    d. white triangle on the AOA indicator
# TABLE OF CONTENTS

- TABLE OF CONTENTS ................................................................. 10-1
- LIST OF FIGURES .................................................................... 10-2
- OVERVIEW ............................................................................... 10-4
- REFERENCES ........................................................................... 10-4
- STUDENT ASSIGNMENTS ....................................................... 10-4
- LESSON OUTLINE .................................................................... 10-4
- INTRODUCTION ........................................................................ 10-5
- HEAD UP DISPLAY SYSTEM ...................................................... 10-5
  - GENERAL .............................................................................. 10-5
  - COMPONENTS AND CONTROLS .......................................... 10-7
- SYMBOLOGY ............................................................................ 10-9
  - NAV MODE SYMBOLOGY ...................................................... 10-9
  - AIR-TO-AIR MODE SYMBOLOGY ......................................... 10-28
  - AIR-TO-GROUND MODE SYMBOLOGY ............................... 10-30
- LESSON QUESTIONS ................................................................ 10-34
LIST OF FIGURES
Figure SY110-1 – Modes........................................................................................................10-6
Figure SY110-2 – F-18 Display ..........................................................................................10-6
Figure SY110-3 – HUD System.........................................................................................10-7
Figure SY110-4 – Field of View ......................................................................................10-7
Figure SY110-5 – Lighting Controls ...............................................................................10-8
Figure SY110-6 – UFCP Text Control .............................................................................10-9
Figure SY110-7 – HUD Camera ....................................................................................10-9
Figure SY110-8 – Horizon Line ......................................................................................10-10
Figure SY110-8b – Horizon Line Reference ..................................................................10-101
Figure SY110-9 – Flight Path Marker ............................................................................10-11
Figure SY110-10 – Climb Dive Marker .........................................................................10-12
Figure SY110-11 – Climb Dive Ladder .........................................................................10-12
Figure SY110-12 – Climb Dive Ladder Symbology ......................................................10-13
Figure SY110-13 – Climb Example ..............................................................................10-13
Figure SY110-14 – Waterline Pitch Reference ..............................................................10-14
Figure SY110-15 – Altitude Scale ..................................................................................10-15
Figure SY110-16 – Vertical Velocity Indicator ..............................................................10-15
Figure SY110-17 – Airspeed Scale ................................................................................10-16
Figure SY110-18 – Bank Angle Symbology ................................................................10-17
Figure SY110-18b – Full HUD Symbology of a 30° Right Turn .................................10-17
Figure SY110-19 – Slip/Skid Symbology ...................................................................10-17
Figure SY110-20 – Exterior Descending Turn ..............................................................10-18
Figure SY110-21 – Heading Scale ................................................................................10-18
Figure SY110-22 – Steer-To-Points ..............................................................................10-19
Figure SY110-23 – AOA Readout ................................................................................10-19
Figure SY110-24 – AOA Bracket ..................................................................................10-20
Figure SY110-25 – Baro Correction Readout .................................................................10-20
Figure SY110-26 – Course Deviation Indicator .............................................................10-21
Figure SY110-27 – Deviation Dots ...............................................................................10-22
Figure SY110-28 – Localizer/Glideslope Reference .....................................................10-22
Figure SY110-29 – Distance-to Steerpoint .................................................................10-22
Figure SY110-30 – Mach Number ..............................................................................10-23
Figure SY110-31 – Normal G .......................................................................................10-23
Figure SY110-32 – Maximum G ..................................................................................10-24
Figure SY110-33 – Radar Altitude ...............................................................................10-24
Figure SY110-34 – Submode Field ..............................................................................10-25
Figure SY110-35 – System/Elapsed Time ....................................................................10-25
Figure SY110-36 – Declutter Levels ................................................................. 10-26
Figure SY110-37 – Declutter Level 1 ............................................................... 10-26
Figure SY110-38 – Declutter Level 2 ............................................................... 10-26
Figure SY110-39 – A/A LCOS Mode ............................................................... 10-29
Figure SY110-40 – A/A CCIL Mode ............................................................... 10-29
Figure SY110-41 – A/A MSL Mode ............................................................... 10-30
Figure SY110-42 – A/G CCIP Mode (Guns) .................................................... 10-31
Figure SY110-43 – A/G CCIP Mode (Bombs) .................................................. 10-31
Figure SY110-44 – A/G CCRP Mode (Bombs) ................................................ 10-32
Figure SY110-45 – A/G DTOS Mode (Bombs) ................................................. 10-32
Figure SY110-46 – A/G MAN Mode (Bombs) ................................................ 10-33
OVERVIEW
This lesson discusses the purpose, components, controls, functions, and operating principles of the Head Up Display (HUD) system. The lesson is designed to provide you with basic knowledge of the Head Up Display (HUD) in order to provide a foundation for interpreting flight information on the display.

REFERENCES
Personnel: None
Media Facilities: Student CAI Workstation
Support Resources: T-6B Flight Manual; T-6B Systems 1 Student Guide

STUDENT ASSIGNMENTS
Read applicable portions of T-6B Flight Manual, Section I.
Complete CAI lesson SY110, following along with this student guide.
Complete the practice questions provided.

LESSON OUTLINE
Topics in this lesson must be taken in sequential order. All topics must be completed prior to attempting the end of lesson quiz. The estimated time required to complete this lesson is one hour.
Introduction

Head Up Display System

General

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.22.30.0.1</td>
<td>Identify the purpose of the Head Up Display (HUD) (AUP aircraft only)</td>
</tr>
<tr>
<td>1.22.30.0.2</td>
<td>Describe Head Up Display (HUD) operating principles (AUP aircraft only)</td>
</tr>
</tbody>
</table>

Overview

The Head Up Display (HUD) in the T-6B allows the pilot to view altitude, heading, and navigation information “head up” in lieu of looking down at the PFD.

Located above the glareshield, the HUD provides a 25-degree field of view while displaying mission-critical information. Here, the pilot can see all necessary information for aircraft control and navigation while still maintaining vigilance outside.

The advantage of the HUD is that the pilot does not have to divide attention inside and outside the cockpit.
Modes

There are three HUD display master modes; pilot-selectable using the UFCP keys.

Navigation (NAV) for enroute and approach phases of flight

Air-to-air (A/A) for aerial weapons delivery

Air-to-ground (A/G) for ground weapons delivery

This lesson will focus primarily on the NAV mode symbology to provide an introduction to the more common symbology you will see on the HUD. A/A and A/G master modes will be discussed briefly.

F-16/F-18 Displays

The T-6B can also be configured for two model-specific display appearances.

F-16 mode, or “tapes” mode (so called for the altitude and airspeed tapes on the display)

F-18 mode (with the removal of the altitude and airspeed tapes)

Since T-6B training will use the F-18 mode, this lesson will focus on F-18 symbology.
Components and Controls

<table>
<thead>
<tr>
<th>1.22.30</th>
<th>Operate Head Up Display (HUD) (AUP aircraft only)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.22.30.0.3</td>
<td>Identify Head Up Display (HUD) components (AUP aircraft only)</td>
</tr>
<tr>
<td>1.22.30.0.4</td>
<td>Match Head Up Display (HUD) components to functions (AUP aircraft only)</td>
</tr>
</tbody>
</table>

Overview

The HUD system is made up of many components that work together in order to project a real-time image to the pilot. The components consist of:

- An Up Front Control Panel (UFCP).
- A CRT assembly.
- An image projector.
- A camera for external video.
- An optical system with dual combining glass.

Field of View

The HUD display is engineered to be viewed from a particular angle and viewing distance based on pilot sitting position (known as design eye point). When seated properly, the pilot will be able to view all HUD symbology. This is called Total Field of View (TFOV).

If you are seated differently from the design sitting position, the HUD symbology will be obscured or not visible at all.

Let’s look at some of the HUD controls located on the UFCP.
Lighting Controls

The HUD brightness knob, located on the lower portion of the UFCP, adjusts display brightness.

As you recall from the UFCP lesson, The HUD brightness mode switch has three settings.

DAY - The pilot can manually adjust the brightness of the display using the HUD brightness knob.

NIGHT - Intended for use during low light operation, the display brightness is reduced to approximately 20%. The HUD brightness knob will still function, only at a lower luminescence range.

AUTO HUD - The HUD will automatically make brightness adjustments relative to changes in ambient light conditions.
UFCP Text Control

Another HUD control located on the lower UFCP is the HUD TEXT switch.

When selected, this switch projects the current information displayed in the UFCP windows onto the HUD field of view.

Other UFCP controls for the HUD will be discussed in the next segment.

HUD Camera and Repeater

The HUD incorporates a camera for recording real-time flight activities.

HUD symbology is overlayed on the exterior image and displayed on the right MFD. This information, along with cockpit voice recordings, is recorded to the Data Transfer System/Digital Video Recorder (DTS/DVR).

Symbology

**NAV Mode Symbology**

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.22.30</td>
<td>Operate Head Up Display (HUD) (AUP aircraft only)</td>
</tr>
<tr>
<td>1.22.30.0.8</td>
<td>Interpret Head Up Display (HUD) displays (AUP aircraft only)</td>
</tr>
</tbody>
</table>
Overview

The NAV mode provides aircraft information for normal flight and will be the primary mode used during T-6B flight training.

In navigation master mode (NAV), the data displayed on the HUD is used primarily for takeoff, enroute navigation, and landing. Data displayed includes the basic flight data symbology along with additional steering, navigation, landing, and advisory data symbology.

Let’s look at the data displayed on the HUD.

Horizon Line

The horizon line is used to provide a reference point to the horizon. When the landing gear is up, the horizon line is drawn in between the airspeed scale and the altitude scale.

When the landing gear is down, the horizon line widens to cover the entire HUD field of view. This is also known as approach mode.

Figure SY110-8 – Horizon Line
Here is how the horizon line symbol will look in relation to the actual horizon.

Flight Path Marker

The position of the Flight Path Marker (FPM) on the HUD provides the pilot with a visual indication of the flight path of the aircraft.

Note that if strong crosswinds are encountered, the FPM may drift towards the edge of the HUD field of view. Rather than drift off the display in the strongest of winds, the FPM will remain on the edge of the HUD and flash, indicating the limit has been reached.

If this drift is undesirable, the FPM can be caged to the center of the field of view using the FPM CAGE switch on the UFCP.

Think of the FPM as where the aircraft is actually going.
Climb Dive Marker

The Climb Dive Marker (CDM) displays the current climb/dive and roll angle of the aircraft when read against a climb dive ladder. The CDM is free to move along the vertical axis within the limit of the HUD field of view to present the current climb or dive angle.

The CDM accounts for aircraft AOA, Gs, and IRU pitch information.

If the aircraft’s current flight path angle would place the CDM outside the vertical field of view of the HUD, the CDM is caged to remain visible within the HUD display.

Climb Dive Ladder

The Climb Dive Ladder (CDL) is conformal to the outside world and displays current aircraft pitch angle.
Climb Dive Ladder 2

Climb bars are drawn as solid lines in 5° increments.

Dive bars are also drawn in 5° increments; slanted by one half the dive angle they represent a series of chevrons pointing towards the nearest horizon.

A zenith symbol is drawn at the 90° nose up position with an extended leg pointing towards the nearest horizon.

A nadir symbol is drawn at the 90° nose down position with a line pointing towards the nearest horizon.

Climb and Dive Example

Here is a full HUD display of a climb. Notice the horizon line has moved down and the climb ladder indicates a nose-up attitude.

Likewise, in a dive, the horizon line has moved up, and the dive ladder indicates a nose-down attitude.
Waterline Pitch Reference

The waterline pitch reference (WL) is a visual presentation of the extension of the aircraft longitudinal axis or waterline.

The WL is displayed when the landing gear is down or when master mode is NAV and:

The UFCP pitch reference is set to WL; or

When there is no other reference point for the HUD (i.e., CDM is invalid or decluttered).

UFCP Pitch Reference Control

To manually set WL using the UFCP, access the SYS menu.

Select DISPLAY (W3).

Select HUD (W1).

Toggle Pitch (PCH) selection from Climb Dive Marker (CDM) to Waterline (WL) in W1.
Altitude Scale

The altitude scale provides an indication of current aircraft altitude and is located in a box to the right of the horizon line.

The readout provides a numerical readout of the aircraft’s baro-corrected altitude in feet.

Figure SY110-15 – Altitude Scale

Vertical Velocity Indicator

The vertical velocity readout is shown in NAV master mode and is positioned at the right side of the HUD above the altitude scale.

The vertical velocity readout provides a numeric readout of the aircraft’s current vertical velocity in units of feet per minute.

In this example, the aircraft is climbing at 500 feet per minute.

In a descent, the readout will display a negative number.

Figure SY110-16 – Vertical Velocity Indicator
Airspeed Scale

The airspeed scale indicates the aircraft’s current speed measured in knots.

The airspeed source can be displayed next to the airspeed box. Blank represents indicated airspeed, a “T” indicates true airspeed, and a “G” indicates groundspeed. The default airspeed indication is indicated airspeed.

A tick mark below the airspeed box indicates where the airspeed bug is set on the PFD.

An arrowhead will move to the right of the tick mark if current aircraft speed is faster than reference speed, and to the left if slower. The tick mark range is +/- 30 knots and the arrowhead will stay full left or right until the aircraft is within 30 knots of reference speed set on the PFD.

UFCP Speed Display Control

To change the airspeed source, access the SYS menu on the UFCP.

Select DISPLAY (W3).

Select HUD (W1).

Select the desired airspeed source in W3.

Local course rules/operating instructions may dictate how the HUD airspeed is displayed.

Figure SY110-17 – Airspeed Scale
Bank Angle Symbology

The bank angle scale and indicator give the pilot reference to current aircraft bank angle.

A ground pointer indicates current bank direction and angle.

Reference marks are continuously displayed at 10°, 20°, 30°, and 45°.

Here is full HUD symbology of a 30° right turn.

Slip/Skid Symbology

A sideslip indicator is displayed below the bank angle indicator.

The symbology consists of a lubber line, a stationary triangular upper arrow, and the sideslip trapezoid.

When the aircraft is in a skid, the indicator moves to the outside of the turn relative to the lubber line. When the
aircraft is in a slip, the indicator moves to the inside of the turn.

Exterior Descending Turn

Bringing together the information that has just been taught, here is a full HUD display of a coordinated 30° left turn descending at approximately 12°.

The aircraft airspeed is 250 knots (above target airspeed), the altitude is 3,450 feet, and the aircraft is descending at 700 feet per minute.

Let’s move on to the supporting symbology available on the HUD.

Heading Scale

The heading scale symbology indicates the aircraft’s current magnetic or true heading and a wind-corrected steering indicator.

The NAV heading scale symbology is comprised of:

- Heading lubber line/true heading indicator
- Heading direction scale
- Heading steer-to-point and target course indicator

Note that the lubber line can be selected as either magnetic or true. If true is selected, the caret will change to a ‘T’.
Heading Scale 2

The heading steer-to point is represented by a line when the steer-to point is an FMS waypoint.

When the wind-corrected steer-to point falls outside the range shown, the line will lay on its side at the edge of the heading display, indicating the shortest direction of turn.

When the steer-to point is a target, it is represented by a diamond.

As with the waypoint line, the diamond will lay on its side when the target falls outside the range shown.

AOA Readout

An angle of attack readout is shown in all modes when the landing gear is up.

The angle of attack readout is located in the lower left portion of the HUD field of view, above the Mach number symbology.

The readout indicates the current aircraft angle of attack in units.

This display indicates an angle of attack of 0.8 units.

Figure SY110-22 – Steer-To Points

Figure SY110-23– AOA Readout
AOA Bracket (Approach Mode)

When the HUD is in approach mode, an angle-of-attack bracket is displayed to the left of the climb dive marker.

The bracket will move linearly up or down in relation to the CDM as AOA increases or decreases.

When AOA is optimal for landing (10.5 units), the CDM will align with the center tick mark of the AOA bracket.

The full range of the AOA bracket is 7.5 units to 13.5 units.

Baro Correction Readout

The baro-correction readout is shown in all modes for five seconds after a change in baro setting. The readout is positioned in the lower right portion of the HUD above the radar altitude symbology.

The baro-correction readout indicates the revised setting that was changed from either front or rear cockpit UFCP and will display for five seconds since last modified.
Course Deviation Indicator

The Course Deviation Indicator (CDI) is displayed in the HUD NAV mode when the navigation selection is FMS or VOR.

The CDI is comprised of the CDI arrow and CDI scale and is drawn relative to the CDM.

The CDI provides an indication of the orientation of the selected course with respect to current heading, and the amount and direction of any lateral deviation from the selected course to the steer-to point (FMS waypoint or VOR).

Course Deviation Indicator 2

When there is lateral deviation from the selected course, deviation dots appear and move left or right relative to the CDI arrow.

The distance of CDI deviation dots from the center of the CDM provides an indication of the magnitude of course deviation.
Localizer/Glideslope Reference

The glideslope and localizer reference is shown in the NAV mode when the navigation source is ILS and an ILS frequency is selected.

The reference is composed of a glideslope deviation bar and a localizer deviation bar.

The glideslope reference is positioned relative to the CDM.

This display indicates the aircraft is below glideslope and to the left of the localizer course.

Distance-to Steerpoint

The distance-to-steerpoint readout is shown in all master modes. The readout is positioned in the lower right portion of the HUD display, on the bottom line.

The distance-to-steerpoint readout indicates the nautical-mile distance to the steerpoint or target.
Mach Number

The Mach number readout is also shown in all modes. The readout is positioned in the lower left portion of the HUD display, above the normal G and below the angle-of-attack symbology.

The Mach number readout indicates the current aircraft Mach number.

Normal G

The normal G readout is shown in all modes. The normal G readout is located above the max G symbology and below the Mach symbology.

The readout indicates the current aircraft body normal acceleration in units of Gs.
Maximum G

The max G readout is positioned in the lower left portion of the HUD display, below the normal G symbology.

The readout indicates the maximum aircraft positive Gs obtained during any one flight. When the maximum G value is greater than 9.9, a value of 9.9 will be displayed.

Radar Altitude

The radar altitude readout is located below the baro correction setting.

The readout consists of the letter R and a boxed four-digit number indicating the current radar altitude when the aircraft is 2,500 feet AGL and below.

If pitch angle is greater than 15 degrees or bank angle is greater than 30 degrees, the display will blank.
Submode Field

The submode field is shown two lines below the radar altimeter symbology. When in NAV master mode, with NAV submode FMS, the submode field will read FMS.

When in the NAV master mode, with NAV submode facilities, and navigation source data is ILS, the submode field will read “nn.n ILS,” where “nn.n” is the distance FROM DME in units of nautical miles.

DME is shown with the ILS if the ILS has an associated DME. VOR, if selected as the current PFD source, will likewise be displayed.

System/Elapsed Time

The elapsed time symbology is shown in all modes when the UFCP-controlled timer is started, otherwise, the system time is shown. System time is set by the GPS.

The system/elapsed time symbology is positioned at the lower left portion of the HUD display. The system time indicates the current UTC (Zulu).

When, in elapsed-time mode, the timer reaches 99 minutes and 59 seconds, the HUD elapsed time readout displays 99:59 until the timer is reset.
Recall setting, starting, and stopping the clock from the UFCP lesson.

Symbology Review

Declutter Levels

Much like the PFD, the HUD can be decluttered. The HUD has three levels of declutter; 0, 1, and 2.

Declutter level 0 represents a full symbol set, whereas 1 and 2 remove specific symbology from the display.

This is level 0.

Declutter Level 1

Declutter level 1 removes the following:

- Altitude
- Mach Number
- Maximum G
- Normal G

Figure SY110-36– Declutter Levels

Figure SY110-37– Declutter Level 1
Declutter Level 2

In declutter level 2, all of the information removed in level 1 applies, with the addition of:

- Bank Scale
- CDM
- Distance-to Steerpoint and steerpoint number
- Distance to target
- Radar Altitude
- Submode Display
- System/Elapsed Time
- Vertical Velocity Indicator

UFCP Declutter Control

To change the declutter level, access the SYS menu on the UFCP.

Select DISPLAY (W3).

Select HUD (W1).

Select DCLTR.

Select the desired declutter level in W2.

Figure SY110-38 – Declutter Level 2
### Air-To-Air Mode Symbology

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.22.30</td>
<td>Operate Head Up Display (HUD) (AUP aircraft only)</td>
</tr>
<tr>
<td>1.22.30.0.8</td>
<td>Interpret Head Up Display (HUD) displays (AUP aircraft only)</td>
</tr>
</tbody>
</table>

### Air-To-Air Overview

The T-6B HUD is capable of displaying additional information for simulated tactical weapons delivery.

The first master mode for weapons is Air-to-Air (A/A). With the aircraft configured in the advanced mode, A/A is selected using the A/A key on the UFCP or HOTAS.

There are three tactical submodes to the A/A master mode. They are:

- Lead Computing Optical Sight (LCOS) for guns
- Continuously Computed Impact Line (CCIL) for guns
- Missile (MSL) for missiles
A/A LCOS Mode

The first submode is the Lead Computing Optical Sight (LCOS) mode for guns. Normal HUD symbology is displayed along with:

- A boresight cross
- An armament readout
- A manual range designator

A/A CCIL Mode

The next A/A submode is the Continuously Computed Impact Line (CCIL) mode for guns.

It shares the features of the LCOS mode, but also includes an impact line for target designation.

Figure SY110-39– A/A LCOS Mode

Figure SY110-40 A/A CCIL Mode
A/A MSL Mode

The last A/A submode on the T-6B is the Missile (MSL) mode.

Standard HUD symbology is presented with the addition of:

- A missile reticle for aiming
- An armament readout

Next we’ll look at the Air-to-Ground mode.

**Air-To-Ground Mode**

**Symbology**

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.22.30</td>
<td>Operate Head Up Display (HUD) (AUP aircraft only)</td>
</tr>
<tr>
<td>1.22.30.0.8</td>
<td>Interpret Head Up Display (HUD) displays (AUP aircraft only)</td>
</tr>
</tbody>
</table>

**A/G Overview**

The Air-to-Ground (A/G) master mode provides the pilot with ground-based weapons delivery information on the HUD. The submodes include:

- Continuously Computed Impact Point (CCIP) for guns
- Continuously Computed Impact Point (CCIP) for bombs
- Continually Computed Release Point (CCRP) for bombs
Dive Toss (DTOS) for bombs

Manual (MAN)

The A/G HUD display is selected using the A/G key on the UFCP and HOTAS.

A/G CCIP Mode (Guns)

The first submode is the Continuously Computed Impact Point (CCIP) mode for guns. Normal HUD symbology is displayed along with:

- An armament readout
- A target designator diamond
- A slant range through piper/reticle

A/G CCIP Mode (Bombs)

The next A/G submode is the Continuously Computed Impact Point (CCIP) mode for bombs.

It shares the features of the guns mode, but also includes an impact line for target designation.
A/G CCRP Mode (Bombs)

Another submode is the Continuously Computed Release Point (CCRP) mode for bombs.

In addition to normal HUD symbology, CCRP includes:

- An aiming reticle
- A target designator
- An armament readout
- A time-to-release readout

A/G DTOS Mode (Bombs)

Dive Toss (DTOS) A/G submode for bombs incorporates:

- An armament readout
- A target designator diamond
- An aiming flight path marker
A/G MAN Mode (Bombs)

The final A/G submode is the Manual (MAN) mode for bombs. It includes standard A/G symbology including a manual aiming reticle.

Lesson Review Quiz

Figure SY110-46—A/G MAN Mode (Bombs)
LESSON QUESTIONS

EMBEDDED QUESTIONS (Ref: Segment/Topic/Question)

1. The primary advantage of the HUD is _____. (B/1/1)
   a. More accurate instrument flight
   b. Complete attention outside the cockpit
   c. Improved collision avoidance
   d. Reduced workload

2. The three HUD display master modes are _____. (B/1/2)
   a. F-16, F-18, and Tapes
   b. F-16, F-18, and Navigation
   c. Navigation, Approach, and Weapons
   d. Navigation, Air-to-Air, and Air-to-Ground

3. True or false? Improper seating position can obscure HUD symbology to the pilot. (B/2/1)
   a. True
   b. False

4. When selected, the AUTO HUD switch on the UFCP is used to _____. (B/2/2)
   a. Automatically power up the HUD when the avionics master switch is turned on
   b. Increase or decrease the HUD symbology brightness over a three second time interval
   c. Automatically make adjustments to brightness relative to changes in ambient light conditions
   d. Set the HUD brightness to 100%
5. Based on this display, the aircraft bank angle is ______. (B/3/1)
   a. 10 degrees
   b. 20 degrees
   c. 30 degrees
   d. 45 degrees

6. Based on this display, the aircraft angle of attack is ______ units. (B/3/2)
   a. 0.22
   b. 1.5
   c. 1.8
   d. 10.5

7. Based on this display, the aircraft is in a ______. (B/3/3)
   a. Climb
   b. Dive
   c. Left turn
   d. Right turn
8. Based on this display, the aircraft is in ______ mode. (B/3/4)
   a. Landing
   b. Angle-of-attack
   c. Approach
   d. Heading

9. Based on this display, the aircraft altitude is ______ feet MSL. (B/3/5)
   a. 120
   b. 250
   c. 1,990
   d. 2,000

10. The three A/A HUD tactical submodes are _______. (B/4/1)
    a. CCIP, CCIL, and MAN
    b. CCIP, CCIL, and MSL
    c. CCIL, MAN, and MAN
    d. CCIL, LCOS, and MSL

11. Which of the following is NOT an A/G submode? (B/5/1)
    a. CCIP
    b. MAN
    c. DTOS
    d. CCIL
LESSON REVIEW QUIZ QUESTIONS

1. The master mode primarily used for flight data, steering, navigation, landing, and advisory information is the ______ mode.
   a. NAV
   b. A/A
   c. A/G
   d. LCOS

2. Which HUD symbol is your best indication of where the aircraft is actually going?
   a. WL pitch reference
   b. CDM
   c. FPM
   d. Steer-to-point indicator

3. When will the glideslope and localizer reference be displayed?
   a. When an ILS frequency is selected
   b. When the navigation source is ILS
   c. When the master mode is NAV
   d. All of the above

4. Based on the display, the aircraft is climbing at _____ feet per minute.
   a. 250
   b. 500
   c. 2,500
   d. 2,992
5. Based on the display, the aircraft is ______ target airspeed.
   a. Slightly above
   b. Slightly below
   c. Well above
   d. Well below

6. Based on the display, what airspeed source is the aircraft using?
   a. Indicated airspeed
   b. True airspeed
   c. Groundspeed
   d. Data not displayed in this mode

7. Bank angle reference marks on the HUD are located at ______ degrees.
   a. 5, 10, 15, and 20
   b. 10, 20, 30, and 40
   c. 10, 15, 30, and 45
   d. 10, 20, 30, and 45
8. Based on the display, the aircraft is heading approximately ______ degrees.
   a. 001
   b. 120
   c. 250
   d. 340

9. Based on the display, what is the maximum G obtained?
   a. 0.45
   b. 0.8
   c. 1.5
   d. 1.8

10. When will the CDM align with the center tick mark of the AOA bracket?
    a. When AOA is optimal for landing
    b. When the aircraft is on glideslope
    c. When the landing gear is down
    d. Both A and C
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>TABLE OF CONTENTS</td>
<td>11-1</td>
</tr>
<tr>
<td>LIST OF FIGURES</td>
<td>11-2</td>
</tr>
<tr>
<td>OVERVIEW</td>
<td>11-4</td>
</tr>
<tr>
<td>REFERENCES</td>
<td>11-4</td>
</tr>
<tr>
<td>STUDENT ASSIGNMENTS</td>
<td>11-4</td>
</tr>
<tr>
<td>LESSON OUTLINE</td>
<td>11-4</td>
</tr>
<tr>
<td>INTRODUCTION</td>
<td>11-5</td>
</tr>
<tr>
<td>COMM/NAV SYSTEMS</td>
<td>11-5</td>
</tr>
<tr>
<td>UHF/VHF RADIOS</td>
<td>11-5</td>
</tr>
<tr>
<td>STANDBY VHF COMM</td>
<td>11-10</td>
</tr>
<tr>
<td>INTERCOMMUNICATIONS SYSTEM (ICS)</td>
<td>11-15</td>
</tr>
<tr>
<td>AUDIO CONTROL PANEL</td>
<td>11-18</td>
</tr>
<tr>
<td>UHF/VHF COMM VIA UFCP</td>
<td>11-22</td>
</tr>
<tr>
<td>UHF/VHF COMM</td>
<td>11-22</td>
</tr>
<tr>
<td>TRANSPONDER</td>
<td>11-28</td>
</tr>
<tr>
<td>COMM VIA FMS</td>
<td>11-31</td>
</tr>
<tr>
<td>FMS INTERFACE</td>
<td>11-31</td>
</tr>
<tr>
<td>LESSON QUESTIONS</td>
<td>11-43</td>
</tr>
<tr>
<td>Figure Number</td>
<td>Description</td>
</tr>
<tr>
<td>---------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>SY111-1</td>
<td>Remote Transceivers</td>
</tr>
<tr>
<td>SY111-2</td>
<td>UFCP and Standby VHF</td>
</tr>
<tr>
<td>SY111-3</td>
<td>UHF Radio</td>
</tr>
<tr>
<td>SY111-4</td>
<td>VHF Radio</td>
</tr>
<tr>
<td>SY111-5</td>
<td>PCL UHF/VHF Key</td>
</tr>
<tr>
<td>SY111-6</td>
<td>VHF Navigation Radio</td>
</tr>
<tr>
<td>SY111-7</td>
<td>UHF Antennas</td>
</tr>
<tr>
<td>SY111-8</td>
<td>COM1 Radio Power</td>
</tr>
<tr>
<td>SY111-9</td>
<td>COM2 Radio Power</td>
</tr>
<tr>
<td>SY111-10</td>
<td>Standby VHF Radio Control Unit</td>
</tr>
<tr>
<td>SY111-11</td>
<td>Standby VHF Radio Display</td>
</tr>
<tr>
<td>SY111-12</td>
<td>Standby VHF Radio Display Components</td>
</tr>
<tr>
<td>SY111-13</td>
<td>Frequency Knobs</td>
</tr>
<tr>
<td>SY111-14</td>
<td>System Number Annunciation</td>
</tr>
<tr>
<td>SY111-15</td>
<td>FAIL 1 Annunciation</td>
</tr>
<tr>
<td>SY111-16</td>
<td>FAIL 2 Annunciation</td>
</tr>
<tr>
<td>SY111-17</td>
<td>Resetting FAIL Annunciations</td>
</tr>
<tr>
<td>SY111-18</td>
<td>ICS</td>
</tr>
<tr>
<td>SY111-19</td>
<td>VOX</td>
</tr>
<tr>
<td>SY111-20</td>
<td>Ground Crew Headset Jack</td>
</tr>
<tr>
<td>SY111-21</td>
<td>Front Engine/Electrical Switch Panel</td>
</tr>
<tr>
<td>SY111-22</td>
<td>Interphone Power</td>
</tr>
<tr>
<td>SY111-23</td>
<td>Audio Control Panel</td>
</tr>
<tr>
<td>SY111-24</td>
<td>Transmit Lights</td>
</tr>
<tr>
<td>SY111-25</td>
<td>Sidetone Control</td>
</tr>
<tr>
<td>SY111-26</td>
<td>Headset Volume Control</td>
</tr>
<tr>
<td>SY111-27</td>
<td>VHF NAV Signals</td>
</tr>
<tr>
<td>SY111-28</td>
<td>EMR/NRM</td>
</tr>
<tr>
<td>SY111-29</td>
<td>Marker Beacon Control</td>
</tr>
<tr>
<td>SY111-30</td>
<td>Audio Control Panel Power</td>
</tr>
<tr>
<td>SY111-31</td>
<td>UFCP</td>
</tr>
<tr>
<td>SY111-32</td>
<td>UFCP Upper Panel</td>
</tr>
<tr>
<td>SY111-33</td>
<td>COM1 UHF Preset</td>
</tr>
<tr>
<td>SY111-34</td>
<td>COM1 UHF Frequency</td>
</tr>
<tr>
<td>SY111-35</td>
<td>COM1 Guard Frequency</td>
</tr>
<tr>
<td>SY111-36</td>
<td>UHF Preset Tuning</td>
</tr>
</tbody>
</table>
Figure SY111-37 – UHF Direct Tuning ................................................................. 11-27
Figure SY111-38 – VHF Display ......................................................................... 11-27
Figure SY111-39 – Standby VHF Radio Power .................................................... 11-28
Figure SY111-40 – VHF Tuning ........................................................................... 11-28
Figure SY111-41 – Transponder Location ............................................................ 11-29
Figure SY111-42 – Transponder Display .............................................................. 11-29
Figure SY111-43 – Field Displays ........................................................................ 11-30
Figure SY111-44 – Transponder Squawk Display ................................................ 11-31
Figure SY111-45 – FMS Frequency Library Page ............................................... 11-33
Figure SY111-46 – FMS Frequency Page ............................................................ 11-34
Figure SY111-47 – FMS UHF Page 1 .................................................................... 11-35
Figure SY111-48 – FMS UHF Page 2 .................................................................... 11-36
Figure SY111-49 – FMS VHF Page ..................................................................... 11-37
Figure SY111-50 – FMS VHF Library Selection .................................................. 11-38
Figure SY111-51 – FMS COM Library Page ....................................................... 11-39
Figure SY111-52 – FMS COM Library Page – Modify Preset ............................... 11-40
Figure SY111-53 – FMS COM Library Page – Delete Record ............................. 11-41
Figure SY111-54 – FMS COM Library Page – Add Record ................................. 11-42
OVERVIEW
This lesson will provide you with information about the T-6B communications systems. You will learn the location and operation of communications systems components, including the following:
UHF radio
VHF radio
Intercommunications System (ICS)
Audio control panel
Communications systems Up Front Control Panel (UFCP) interface

REFERENCES
T-6B Flight Manual
T-6B Systems 1 Student Guide

STUDENT ASSIGNMENTS
Review T-6B Flight Manual, Section I.
Complete CAI lesson SY111, following along with this student guide.
Complete the practice questions provided.

LESSON OUTLINE Segment A
- Introduction Segment B -
Comm/Nav Systems
Segment C - UHF/VHF Comm Via the UFCP
Segment D - Comm Via the FMS
Segment E - Lesson Review Quiz

Topics in this lesson must be taken in sequential order. All topics must be completed prior to attempting the end of lesson quiz. The estimated time required to complete this lesson is one hour.
Introduction

Comm/Nav Systems

UHF/VHF Radios

| 1.22.14.0.1 | Identify purpose of communication/UHF radio system |
| 1.22.14.0.3 | Identify communication/UHF radio system components |
| 1.22.14.0.4 | Match communication/UHF radio system components to functions |
| 1.22.14.0.5 | Identify characteristics of normal operations for communication/UHF radio system |
| 1.22.14.0.8 | Interpret communication/UHF radio instrument displays |
| 1.22.15.0.1 | Identify purpose of communication/VHF radio system |
| 1.22.15.0.3 | Identify communication/VHF radio system components |
| 1.22.15.0.4 | Match communication/VHF radio system components to functions |
| 1.22.15.0.5 | Identify characteristics of normal operations for communication/VHF radio system |
| 1.22.15.0.8 | Interpret communication/VHF radio instrument displays |

Voice Communications

The T-6B has both UHF and VHF radio systems for voice communication. Each radio provides air-to-air and air-to-ground communication.

Remotely mounted transceivers, also known as receiver transmitters or R/Ts, are located in the left and right avionics bays aft of the cockpit.

Figure SY111-1 – Remote Transceivers
These remote units are controlled through the UFCP as follows:

UHF - COM1 button

VHF - COM2 button

The standby VHF radio control unit, located on the right console in the front cockpit, serves as a backup radio in case a malfunction eliminates access to the UHF or VHF radios.

UHF Frequencies

The UHF radio transmits and receives in a frequency range of 225.00 to 399.975 megahertz (MHz) in 25 kilohertz (kHz) increments. This provides 7000 available channels.

When reading a frequency, the numbers to the left of the decimal are megahertz, and the numbers to the right of the decimal are kilohertz.

The UHF transceiver has a dedicated receiver which simultaneously and continuously monitors the UHF GUARD frequency (243.00 MHz). This will be explained further later in the lesson.
VHF Frequencies

VHF COM 2 has both 25kHz and 8.33 kHz increment spacing built in. Note: it is possible to tune a frequency that is not used by Air Traffic Control in the United States (8.33 kHz spacing is standard in Europe).

Unlike the UHF radio, the VHF radio must be tuned (using the UFCP) to the VHF guard frequency (121.50 MHz) in order to monitor that frequency.

Radio Key Switch

The COM 1 / COM 2 key toggle switch located on the inboard face of either PCL is used to transmit over the UHF or VHF radios. Press the toggle switch up to transmit on UHF, and down for VHF. The toggle switch will automatically return to the neutral position when released.
VHF NAV

In addition to voice communications capability, the T-6B also has a VHF navigation receiver for VOR, localizer, glideslope, and marker beacon signals.

These systems will be covered in more detail in SY112, Navigation Systems.

UHF Antennas

There are two UHF antennas, an upper UHF antenna, mounted on the upper fuselage aft of the canopy and a combined VHF/UHF communications antenna on the lower fuselage.

An antenna selector switch, located in the left avionics bay, provides for automatic switching between the upper UHF antenna and the lower VHF/UHF communications antenna. This selector switch provides for optimum UHF transmission and reception. Since the selector switch is totally automatic, the pilot has no capability to manually select an antenna.
Radio Power

Power for the UHF radio is provided through a circuit breaker labeled COM 1, located on the generator bus circuit breaker panel in the front cockpit only.

Power for the VHF primary and standby radio control units is provided through a circuit breaker labeled COM 2, located on the battery bus circuit breaker panel in the front cockpit only.

Power for the standby VHF control unit for emergency operation is also available through the auxiliary battery.
### Standby VHF Comm

<table>
<thead>
<tr>
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<th>Description</th>
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</thead>
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<tr>
<td>1.22.15.0.1</td>
<td>Identify purpose of communication/VHF radio system</td>
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<tr>
<td>1.22.15.0.2</td>
<td>Describe communication/VHF radio system operating principles</td>
</tr>
<tr>
<td>1.22.15.0.3</td>
<td>Identify communication/VHF radio system components</td>
</tr>
<tr>
<td>1.22.15.0.4</td>
<td>Match communication/VHF radio system components to functions</td>
</tr>
</tbody>
</table>

### Overview

The T-6B also has a standby VHF radio control unit located in the right console of the front cockpit.

The standby VHF control unit provides emergency manual radio tuning and use if the UFCP malfunctions.

**Figure SY111-10 – Standby VHF Radio Control Unit**

### Operation

To begin, press the power (PWR) button to turn on the standby VHF radio. Like other avionics systems, a self-test is performed at power-up. When the standby VHF is powered, the UFCP persistent display in both cockpits will read REMOTE in W2.

**Figure SY111-11 – Standby VHF Radio Display**
The frequency currently in use is displayed as the active frequency.

The active frequency is the upper display and immediately below it is the standby frequency. In this example, 124.950 MHz is both the transmit and receive frequency.

To turn the unit off, press and hold the PWR button for 3 seconds.

Display Components

The graphic to the right shows the locations of the following items:

- Volume control (inoperative)
- Mode select control
- Mode annunciator
  - 25k - Standard position allows 25kHz channel tuning
  - 8.33k - Alternative position allows 8.33kHz channel tuning
  - TST - Disables squelch to allow audible verification of receiver operation
- Transmission annunciation
  - TX appears only when radio is keyed

Figure SY111-12 – Standby VHF Radio Display Components
Active COM annunciator
Active COM frequency
Standby COM frequency

Note that standard channel tuning is 25kHz in the US; however, the standby VHF radio is set up to accommodate 25/8.33kHz channel tuning if the aircraft is to deploy overseas.

Standby VHF Tuning 1

When the standby VFH radio is powered up, the 25kHz tuning mode is selected, which is the standard for U.S. operations.

Press the right inner knob to switch between the active and standby frequencies, which are indicated in the left side annunciator. The outer knob tunes the frequency in whole MHz steps while turning the inner knob tunes in 25kHz steps.

Rotating the frequency knob when both frequencies are shown changes just the standby frequency.

Figure SY111-13 – Frequency Knobs
To change the active frequency, press the right inner knob. This will remove the standby frequency so that the active frequency can be tuned using the outer and inner frequency knobs. Notice that the standby frequency window is now blank, and the active frequency window displays 121.500. Now you can tune the active frequency with the frequency control knobs.

Standby VHF Tuning 2

The system number annunciation indicates that this display is for COM system 2 (VHF).

The transmit annunciation (TX) indicates when a transmission is being made and appears when the microphone is keyed.

Rotating the mode knob to TST disables the squelch and permits audible verification of receiver operation.

Figure SY111-14 – System Number Annunciation
Standby VHF Failures

A "FAIL 1" annunciation in the second window indicates a complete system failure. Both receiver and transmitter are inoperative.

A "FAIL 2" annunciation in the second window indicates only a transmitter failure. This annunciation illuminates only when the standby VHF transmitter is keyed. The receiver is still operative on all frequencies.
Resetting the system might clear the fault. To do this, press and hold the power button for 12-15 seconds. This is called a hardware failsafe shutdown. Reapply power to the standby VHF system and check to see if the fail annunciations have cleared. If the fail annunciations remain extinguished, the system should be operative.

**Intercommunications System (ICS)**

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.22.16.0.1</td>
<td>Identify purpose of communications/interphone system</td>
</tr>
<tr>
<td>1.22.16.0.3</td>
<td>Identify communications/interphone system components</td>
</tr>
<tr>
<td>1.22.16.0.4</td>
<td>Match communications/interphone system components to functions</td>
</tr>
<tr>
<td>1.22.16.0.5</td>
<td>Identify characteristics of normal operations for communications/interphone system</td>
</tr>
<tr>
<td>1.22.19.0.1</td>
<td>Identify purpose of communications/ground crew interphone system</td>
</tr>
<tr>
<td>1.22.19.0.3</td>
<td>Identify communications/ground crew interphone system components</td>
</tr>
<tr>
<td>1.22.19.0.4</td>
<td>Match communications/ground crew interphone system components to functions</td>
</tr>
<tr>
<td>1.22.19.0.5</td>
<td>Identify characteristics of normal operations for communications/ground crew interphone system</td>
</tr>
</tbody>
</table>

**Figure SY111-17 – Resetting FAIL Annunciations**
ICS

The Intercommunications System (ICS) allows communication within the cockpit and the ground crew.

There are two rotary switches that control the ICS. The interphone control rheostat, labeled INPH, is located on the audio control panel in both the front and rear cockpits on the front lower panel. This rheostat controls the volume for the interphone portion of the audio system.

The VOX button allows the pilots to choose voice activation of the ICS and the voice-to-noise level where their voices will activate it. With the button depressed, voice activation is turned off. When the button has been released, turning the knob clockwise increases the amount of voice volume required to activate the system.

Ground Crew Interphone Location

A ground crew headset jack is located on the left side of the fuselage, just below the avionics bay. This jack allows communication with the ground crew through the interphone system. Ground crew volume control is provided through the headset control.
Ground Crew Interphone Power

Power is supplied to the ground crew interphone when the battery switch in either cockpit is activated.

ICS Power

Power for the intercommunications system is provided through a circuit breaker labeled AUDIO located on the battery bus circuit breaker panel in each cockpit.

Figure SY111-21 – Front Engine/Electrical Switch Panel

Figure SY111-22 – Interphone Power
Audio Control Panel

| 1.22.17.0.1 | Identify purpose of communications/audio control panel system |
| 1.22.17.0.3 | Identify communications/audio control panel system components |
| 1.22.17.0.4 | Match communications/audio control panel system components to functions |
| 1.22.17.0.5 | Identify characteristics of normal operations for communications/audio control panel system |

Audio Control Panel

An audio control panel is located on the front lower panel in each cockpit. These panels provide for selecting the desired audio source, adjusting volume for each system selected, and selecting alternate audio in case of malfunctions.

The available sources include:
- COM1 (UHF) and COM2 (VHF)
- NAV (VOR/ILS)
- Marker beacon (MKR)
- Distance measuring equipment (DME)
- VOX (control of interphone mic)
- Interphone volume (INPH)

Audio Control Panel Transmit

Green transmit lights, above the COM1 and COM2 control knobs, illuminate when a transmission on the respective radio is made, whether from the forward or aft cockpit.
The transmit lights also illuminate during the LAMP TEST for each cockpit.

Sidetone

Sidetone (feedback audio) is provided whenever the UHF or VHF transceivers are keyed or during interphone communication. Sidetone level is preset, but it can be adjusted using the ST rotary switch.

Overall headset volume is controlled by the rotary HDPH switch.

Audio Source Selection

To select an audio source (except INPH) simply depress the desired control so it extends to the active position. When extended, the white lower half of the base can be seen.

To increase or decrease the volume of the selected source(s), rotate the knobs clockwise or counterclockwise respectively.
VHF NAV Signals

All VHF navigation sources have Morse code (ID) but some also have voice-over (V) capability. A switch on the audio control panel allows you to select which audio to monitor. The switch has the following three positions:

V - voice only
ID - identification (Morse code)
BOTH - both voice and Morse

EMR/NRM

In the event of an audio amplifier failure, a bypass switch is available. This switch is located in the lower section (middle switch) on each control panel and is labeled EMR and NRM.

This switch is usually left in the NRM position. Moving it to the EMR position bypasses the amplifier and provides raw audio (unamplified and no volume control) for COM2 (VHF) and aural warnings.
Marker Beacon

The MRK control provides marker beacon on/off operation and volume control.

In the forward cockpit the audio control panel has a three-position switch placarded HI LO TEST. This switch is used to select the sensitivity level for marker beacon signals (HI and LO positions).

The spring-loaded TEST switch position provides a test of the OM-IM-MM symbols on the PFD if a localizer frequency is tuned and the navigation source is LOC.

Figure SY111-29 – Marker Beacon Control
Audio Control Panel Power

Power for each audio control panel is provided through a circuit breaker labeled AUDIO on the battery bus circuit breaker panel in both cockpits.

Figure SY111-30 – Audio Control Panel Power

UHF/VHF Comm Via UHFCP

UHF/VHF Comm

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.22.29.0.1</td>
<td>Identify purpose of Up Front Control Panel (UFCP)</td>
</tr>
<tr>
<td>1.22.29.0.3</td>
<td>Identify Up Front Control Panel (UFCP) components</td>
</tr>
<tr>
<td>1.22.29.0.4</td>
<td>Match Up Front Control Panel (UFCP) components to functions</td>
</tr>
<tr>
<td>1.22.29.0.5</td>
<td>Identify characteristics of normal operation for the Up Front Control Panel (UFCP)</td>
</tr>
<tr>
<td>1.22.29.0.8</td>
<td>Interpret Up Front Control Panel (UFCP) displays</td>
</tr>
<tr>
<td>1.9.1.15.1b</td>
<td>Recognize UHF COMM setting</td>
</tr>
<tr>
<td>1.9.1.15.2b</td>
<td>Recognize VHF COMM setting</td>
</tr>
</tbody>
</table>
UFCP Purpose

The UFCP interfaces with a number of subsystems on the aircraft and provides the following communications information:

- COM1 (UHF) frequency - Window 1
- COM2 (VHF) frequency - Window 2
- NAV frequency - Window 3
- Transponder Mode and Code - Window 4

The COM1 key on the UFCP allows the pilot to access and modify communications data provided by the single UHF radio installed on the T-6B.

UHF Comm Display

When the COM1 key is pressed, the UFCP automatically displays the following data:

- Radio type - UHF
- Frequency - The last frequency that was tuned in. The UHF frequency range is from 225.000 to 399.975 MHz.
- TR + G - Transmit/Receive, plus Guard
- SQ ON/OFF - Squelch ON or OFF
COM1 Windows 1 and 2

Window 1 (W1) also contains a two-digit number indicating the current COM1 UHF radio preset number (01 in this example). The allowable range is 01 to 99.

If you change the preset number, the UHF radio automatically retunes to the frequency corresponding to that preset.

Window 2 (W2) displays a six-digit decimal number which is the current UHF frequency. The alphanumeric keypad is used to change this frequency.

The digits to the left of the decimal change in 1 MHz increments and the digits to the right of the decimal change in 25 kHz increments.

COM1 Window 2

If the COM1 UHF radio is manually tuned in W2 to a frequency corresponding to a preset, that preset number automatically displays in W1.

If COM1 is tuned to a frequency that does not correspond to a preset, W1 displays ## right justified instead of a preset number.

Figure SY111-33 – COM1 UHF Preset

Figure SY111-34 – COM1 UHF Frequency
COM1 Window 3

Window 3 (W3) controls the COM1 UHF modes. Selections include the following options:

- T/R - Transmit/Receive
- TR + G - Transmit/Receive + Guard Receive
- G - Transmit/Receive on Guard

Pressing the associated window control key toggles through the three available options.

With Guard mode on, the active frequency is replaced with the Guard frequency (243.00 MHz).

COM1 Window 4

Window 4 (W4) controls the COM1 UHF radio squelch setting. The options are either ON or OFF. The squelch setting is normally on.

This value is toggled ON and OFF with the associated window control key.
UHF Preset Tuning

There are two ways to change the UHF frequency using the UFCP. The first and most direct method is to change the preset channel.

From the persistent display, press COM1.

Note that W1 is already an active edit.

Use the DATA ENTRY knob to scroll through available presets.

If the desired preset is selected using the data entry knob, it is ready for use as data entry knob inputs are immediate changes.

When W1 is active for data edit you may also type in a one- or two-digit preset using the alphanumeric keyboard and then press ENT. Entry of a leading zero is not required.
UHF Direct Tuning

You can also change the UHF frequency directly in W1 from the persistent display.

Press the W1 window control key to make the UHF frequency active for data entry.

Enter the desired frequency using the alphanumeric keyboard and press ENT to make it active.

VHF Display

The COM2 key on the UFCP allows the pilot to access VHF radio information.

When COM2 is pressed, the VHF page displays the last data used. The format is as follows:

- Radio frequency type (VHF)
- The frequency that was last tuned.
- W3 is blank
- SQ ON/OFF - Squelch ON or OFF

Notice that presets for VHF frequencies operate in the same manner as those discussed under COM1
Standby VHF Power

Power for the Standby VHF control head is provided thru the AUX BAT BUS.

VHF Tuning

Frequency changes for COM2 (VHF) are accomplished in the same manner as described under COM1 (UHF).

Transponder

<table>
<thead>
<tr>
<th>ID</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.22.24.0.1</td>
<td>Identify purpose of transponder system</td>
</tr>
<tr>
<td>1.22.24.0.2</td>
<td>Describe transponder system operating principles</td>
</tr>
<tr>
<td>1.22.24.0.3</td>
<td>Identify transponder system components</td>
</tr>
<tr>
<td>1.8.1.14.3b</td>
<td>Recognize transponder setting</td>
</tr>
</tbody>
</table>
System Overview

The T-6B is equipped with an altitude-reporting Mode S transponder that responds to both ground and airborne interrogations.

The transponder is located in the left avionics bay and is controlled through the UFCP.

Persistent Display

When power is first applied to the aircraft, the persistent display comes up. The fourth window (W4) displays the last used parameters for the transponder.

The transponder code is displayed on the left in octal (0000 to 7777) and the operation mode is displayed on the right.

The operation modes available are

ALT - automatic reply for Mode S, Mode A, and Mode C with altitude information
SBY – standby
Accessing the transponder settings is done by pressing W4 or through the NAV TUNE pages.

Field Displays

Pressing the NAV TUNE key repeatedly, accesses the VOR (or LOC), DME, and XPDR pages. The following settings on the transponder (XPDR) page may be viewed and changed:

W1 - Status options include ACT (active) or SBY (standby)

W2 - Four-digit octal transponder code for Mode 3 IFF. The filled triangle indicates the transponder code is active for data edit via the alphanumeric keyboard.

W3 - Mode C altitude encoding (ALT) options: ALT ON or ALT OFF.

Settings Modification

Changing the transponder status options is done by toggling the W1 window control key.

Once the code is changed using the alphanumeric keyboard and the ENT key pressed, the new setting is displayed in both cockpits.
If entered in error, the previous code can be retrieved in the same manner as is done with COM1, COM2, and NAV - via the FREQ page of the FMS.

**ID Key**

The UFCP identification (ID) key allows the aircrew to initiate an ID squawk from the IFF transponder, and to also view the information contained within the transmission. The transponder information display and squawk last for 5 seconds.

If you wish to select another display before the 5 seconds has elapsed, simply select any of the master mode or page navigation keys.

**Comm Via FMS**

**FMS Interface**

| 1.22.23b.0.1 | Identify purpose of flight management system (FMS)/GPS system |
| 1.22.23b.0.3 | Identify flight management system (FMS)/GPS system components |
| 1.22.23b.0.4 | Match flight management system (FMS)/GPS system components to functions |
| 1.22.29.0.1 | Identify purpose of Up Front Control Panel (UFCP) |
| 1.22.29.0.3 | Identify Up Front Control Panel (UFCP) components |
| 1.22.29.0.4 | Match Up Front Control Panel components to function |
| 1.22.23b.0.5 | Identify characteristics of normal operations for flight management system (FMS)/GPS system |
| 1.22.23b.0.8 | Interpret flight management system (FMS)/GPS instrument displays |
| 1.9.1.15.1b | Recognize UHF COMM setting |
| 1.9.1.15.2b | Recognize VHF COMM setting |
FMS Databases

There are three databases in the FMS that are used for storing radio presets and waypoints. These can all be loaded onto the FMS at the aircraft, or via maintenance action with the appropriate data loading equipment.

The three databases are as follows:

- Radio and radio navigation aid presets, 1 to 99 (read/write)
- User-defined waypoints, up to 460 (read/write)
- Navigation - Primary waypoint database (read only)

The radio and radio navigation aid presets can be created and modified directly on the FMS.

The FMS also offers backup frequency tuning of navigation and communication radios such as:

- Single DMEs
- Single or dual NAVs
- Single or dual COMs
- Single ATC transponders
FMS Tuning

FMS tuning capabilities include active and standby frequency entry, and control of all radio modes including self-test.

The FMS provides library pages for UHF, VHF, and NAV radio frequencies or channels. Each library allows up to 99 entries.

Library parameters include:

- Preset number (mandatory)
- Identifier and data (optional)
- Frequency or channel (mandatory)

Making changes to a library is a ground operation only. All libraries are locked and password protected and must be unlocked before making changes. Library pages may be scanned and viewed at any time.

Figure SY111-45 – FMS Frequency Library Page
FMS Interface

The FMS provides control and display of the active and standby frequencies and settings for all of the radios accessed through the frequency page.

To access the frequency page, press LSK R1 on the MFD menu 1/2 page.

The frequency page provides tuning entries and access to more detailed frequency control pages, where self-test and radio modes can be selected.

When power is applied, the FMS retrieves the current valid tuned frequencies and settings from the radios. If airborne, the FMS automatically tunes them to the frequencies and settings used prior to the last power interruption.

Figure SY111-46 – FMS Frequency Page
From the FREQ page, select UHF. Press LSK L1 to navigate to the UHF 1/2 page.

Using this page, you can tune the UHF radio by library preset, frequency, or library identifier entry.

The UHF active/standby frequencies are stored in non-volatile memory (NVM) and automatically restore after the FMS is restarted.

The selectable functions of the UHF radio are as follows:

- Transmit Receive (TR) - Main receiver and transmitter are enabled and tuned to the indicated frequency/guard receiver is inactive
- Transmit Receive-Guard (TR-G) - TR mode active and the guard receiver enabled and tuned to the guard channel
- Guard (GD) - Guard mode selected, main receiver set to 243.000 MHz
LSK L1 displays and allows you to modify the active and standby frequencies and library presets.

Selecting LSK L1 when the scratchpad is empty toggles between the active and standby frequencies.

LSK L2 activates the call tone. The TONE selection will not be displayed if the radio is not tuned to the indicated frequency or if guard mode is selected.

LSK L3 allows you to select the operating mode TR, TR-G, or GD.

LSK L4 toggles the squelch on or off.

LSK L6 provides access to the frequency top level page for a list of all the radios and their tuned frequencies.

LSK R6 provides access to the UHF library.

Let’s go back to the Frequency 1/4 page to review the VHF 1/2 page.
FMS VHF Page 1

To get to the VHF 1/2 page, press LSK L2 on the FREQUENCY 1 / 4 page.

The VHF 1/2 page provides access to the VHF controls in the event of UFCP failure.

FMS VHF Page 2

LSK L3 toggles squelch on or off.

LSK L6 provides access to the frequency top level page and a list of all radios.

LSK R6 provides access to the VHF library.

Be aware that the VHF radio does not monitor the guard frequency like the UHF radio. In order to receive or transmit on guard, the pilot must tune the VHF radio to 121.50 MHz.
The FMS allows the pilot to store up to 99 presets in each of the NAV and COM libraries.

Since setting the preset numbers in the VHF and UHF radios are very similar, we will only discuss the VHF preset function.

The libraries are accessed through the COM library 1/N page specific to the radio you are using. In this case, we used the following path:

LSK R1 on the MFD Menu 1/2 page to access the FREQUENCY LIBRARY 4/4 page
LSK L2 on the FREQUENCY LIBRARY 4/4 page to select the VHF radio
From here you want to select LIBRARY (LSK R6).
FMS Library Presets 2

This COM library I/N page allows the pilot to view and modify the preset numbers, identifiers, and frequencies that are stored in the VHF COM library.

As we stated earlier, the maximum number of COM library entries is 99. However, the maximum number of COM library pages is only 20. This means that 5 library entries are available on each page.

LSKs L1 through L5 are used to display and modify the COM library entries.

The NEXT and PREV keys allow you to scroll forward and backwards through the COM library pages.

FMS Library Presets 3

You can also enter an existing preset number, followed by a slash (example, 11/), and press any LSK associated with a library record to display the entered preset (without changing its identifier or frequency).
FMS Library Presets 4

Existing preset records can be modified through the COM LIBRARY screen as well. Let’s say we want to change preset 04 (standby) from ABC/111.050 to ABC/112.075.

The most expedient way to do this is to enter //112.075 into the scratchpad and press LSK L2. After the LSK is pressed the 04 standby preset updates.

Another way to do this starts with pressing LSK L2 first to transfer the current library record into the scratchpad. Once that is done, press the CLR key 5 times to erase the last 5 characters of the frequency. Now enter the new frequency (example, 2.075), and press LSK L2 again to enter the modified record into the library.

FMS Library Presets 5

If you wish to transfer a library record to the active or standby field of the COM library page, first press the LSK that corresponds to the library record.

This places the preset number, identifier, and frequency in the scratchpad.
You may have to scroll through the record sets using the PREV and NEXT selections (LSKs LL and LR) to find the preset number you want to transfer. Then press the applicable right LSK (LSK R1 through R5) to transfer the contents of the scratchpad.

The identifier will not display on the frequency page field even though it displayed in the scratchpad.

FMS Library Presets 6

Records can also be deleted from the library as follows:

Use the PREV and NEXT LSKs to find the record you wish to delete.

Press the CLR key on the UFCP (displays DELETE in the scratchpad on the UFCP).

Press the LSK corresponding to the record you wish to delete.

Figure SY111-53 – FMS COM Library Page – Delete Record
FMS Library Presets 7

To add a new record in the library, use the UFCP to key in a new preset number, identifier, and frequency into the scratchpad. Each element must be separated by a slash, for example: 04/DEF/120.900.

Then press the LSK associated with the library record (L2 for this example). The new record will be added to the library.

If the record identified by the preset number already exists in the library, then that record will be overwritten. In this example, preset 04 will be overwritten with the new identifier and frequency.

Lesson Review Quiz
LESSON QUESTIONS

EMBEDDED QUESTIONS (Ref: Segment/Topic/Question)

1. The VHF transceiver has a separate radio for monitoring VHF Guard. (B/1/1)
   a. True
   b. False

2. Click on the highlighted box that contains the COM 1 / COM 2 key toggle. (B/1/2)

3. What is UHF Guard frequency? (B/1/3)
   a. 121.50 MHz
   b. 143.00 MHz
   c. 243.00 MHz
   d. 263.00 MHz

4. Where is the standby VHF control unit located? (B/2/1)
   a. Right console, front cockpit
   b. Right console, rear cockpit
   c. Left console, front cockpit
   d. Left console, rear cockpit

5. When you power up the backup VHF radio, what frequencies appear in the display windows? (B/2/2)
   a. 121.500 MHz in active window and 124.900 in teh standby window
   b. 124.900 MHz in active window and 121.500 in the standby window
   c. The last frequencies selected prior to system shutdown
   d. The frequency currently entered in system
6. Which annunciator (if any) appears on the control unit when the standby VHF radio is keyed for transmission? (B/3/3)
   a. T only
   b. TX only
   c. TX and RX
   d. No indication

7. The ICS control is located ____ (B/3/1)
   a. on the UFCP.
   b. on the audio panel on the right side of the front cockpit.
   c. on the PCL.
   d. on the audio panel on the front lower panel in each cockpit.

8. The ground crew interphone headset jack is located _____. (B/3/2)
   a. in the left avionics bay
   b. in the right avionics bay
   c. on the left side of the fuselage, below the avionics bay
   d. on the right side of the fuselage, below the canopy

9. To set VHF radio volume _____. (B/4/1)
   a. rotate the COM1 knob on the audio control panel
   b. rotate the COM2 knob on the audio control panel
   c. use the VHF COM knob on the VHF control head
   d. rotate the VHF knob on the left hand console

10. The audio control panel is located in the front cockpit only. (B/4/2)
    a. True
    b. False

11. What effect will rotating the bypass switch to the EMR position have on the UHF radio? (B/4/3)
    a. You will not be able to hear the audio.
    b. The audio will be unamplified, raw audio.
    c. Radio control will revert to backup control unit.
    d. The active frequency will switch to the alternate frequency.
12. UHF frequency information is displayed in _____ on the UFCP. (C/1/1)
   a. W1
   b. W2
   c. W3
   d. W4

13. When the ______ key on the UFCP is pressed, the VHF page automatically display with the following data: (C/1/2)
   a. SYS
   b. COM1
   c. COM2
   d. NAV TUNE

14. With the transponder mode set to SBY, what information is being transmitted? (C/2/1)
   a. None
   b. The transponder code
   c. The transponder code and altitude
   d. Aircraft altitude

15. How many seconds is the ID page displayed after pressing the ID squawk key on UFCP? (C/2/2)
   a. 3
   b. 5
   c. 10
   d. 15
16. If you wish to modify an existing VHF library record (preset 05), identifier FOX, and frequency 114.000 MHz (05/FOX/114.00) to a new frequency, 115.000 MHz, what would you enter into the scratchpad? (C/4/1)
   a. //115.000
   b. 115.000//
   c. /115.000/
   d. 115.000

LESSON REVIEW QUIZ QUESTIONS

1. The audio control panel is located in the _________ in each cockpit.
   a. left console
   b. lower left corner of the instrument panel
   c. lower right corner of the instrument panel
   d. front lower panel, between the pilot’s legs

2. The ground crew interphone is activated ______.
   a. when the aircraft engine is started
   b. anytime a headset is plugged in to the jack
   c. when the GPU is plugged in
   d. when the battery switch in either cockpit is switched on

3. The UFCP controls the UHF and VHF as follows:
   a. UHF (COM1 button), VHF (COM2 button)
   b. VHF (COM1 button), UHF (COM2 button)
   c. UHF1 (COM1 button), UHF2 (COM2 button), VHF (COM3 button)
   d. VHF1 (COM1 button), VHF2 (COM2 button), UHF (COM3 button)

4. Where is the standby VHF radio located?
   a. Right console in the front cockpit
   b. Left console in the front cockpit
   c. Right console in the rear cockpit
   d. Left console in the rear cockpit
5. When you select COM1 on the UFCP, which of the windows allows you to select T/R, TR + G, or G for the UHF radio?
   a. W1
   b. W2
   c. W3
   d. W4

6. UHF radio direct tuning is accomplished by _____.
   a. pressing the W2 arrow key, then using the UFCP DATA ENTRY knob to scroll through the frequencies
   b. pressing the W1 arrow key, then using the UFCP DATA ENTRY knob to scroll through the presets
   c. pressing the W2 arrow key, then using the keypad to manually enter the preset
   d. pressing the W1 arrow key, then using the keypad to manually enter the desired frequency

7. The FMS allows the T-6B aircraft to store up to ________ presets in the COM library for the VHF or the UHF radios.
   a. 20
   b. 40
   c. 77
   d. 99

8. Which of the following units control the tuning of the UHF, VHF and VOR?
   a. ICS
   b. HUD
   c. UFCP
   d. Each individual control unit

9. The UHF squelch setting is normally _________ (initial and cold start default value).
   a. ACTIVE
   b. STBY
   c. OFF
   d. ON
10. How is the standby VHF radio channel tuned?
   a. Normally 5 kHz (US) or 5 kHz and 3.33 kHz tuning (aircraft deployed overseas)
   b. Normally 25 kHz (US) or 25 kHz and 8.33 kHz tuning (aircraft deployed overseas)
   c. Normally 5 kHz (US) or 5 kHz and 8.33 kHz tuning (aircraft deployed overseas)
   d. Normally 25 kHz (US) or 25 kHz and 3.33 kHz tuning (aircraft deployed overseas)

11. What is the main operational difference between the UHF radio and the VHF radio?
   a. The VHF radio doesn’t have a Guard frequency.
   b. You cannot transmit over VHF Guard frequency.
   c. The VHF radio doesn’t have a standby frequency.
   d. The VHF radio doesn’t monitor Guard frequency; you must dial it up manually.

12. What is range of the transponder/IFF Mode 3 code?
   a. 0000-4444
   b. 0000-5555
   c. 0000-6666
   d. 0000-7777
TABLE OF CONTENTS

TABLE OF CONTENTS ......................................................................................... 12-1
LIST OF FIGURES ............................................................................................... 12-2
OVERVIEW .......................................................................................................... 12-4
REFERENCES ...................................................................................................... 12-4
STUDENT ASSIGNMENTS .................................................................................. 12-4
LESSON OUTLINE ............................................................................................... 12-4
  INTRODUCTION ................................................................................................. 12-5
  T-6B NAVIGATION SYSTEMS .......................................................................... 12-5
    VOR/ILS .......................................................................................................... 12-5
    DME .............................................................................................................. 12-23
  TRANSPONDER ................................................................................................. 12-29
  TCAS ................................................................................................................. 12-38
LESSON QUESTIONS ............................................................................................ 12-54
**LIST OF FIGURES**

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>SY112-1</td>
<td>VOR Systems</td>
<td>12-6</td>
</tr>
<tr>
<td>SY112-2</td>
<td>VOR Antennas</td>
<td>12-7</td>
</tr>
<tr>
<td>SY112-3</td>
<td>VOR Types</td>
<td>12-11</td>
</tr>
<tr>
<td>SY112-4</td>
<td>Radials</td>
<td>12-11</td>
</tr>
<tr>
<td>SY112-5</td>
<td>VOR Tuning</td>
<td>12-12</td>
</tr>
<tr>
<td>SY112-6</td>
<td>PFD Source-VOR Tuned</td>
<td>12-14</td>
</tr>
<tr>
<td>SY112-7</td>
<td>ILS PFD Source-LOC Tuned</td>
<td>12-14</td>
</tr>
<tr>
<td>SY112-8</td>
<td>Course Pointer</td>
<td>12-15</td>
</tr>
<tr>
<td>SY112-9</td>
<td>TO/FROM</td>
<td>12-16</td>
</tr>
<tr>
<td>SY112-10</td>
<td>UFCP Course Page</td>
<td>12-17</td>
</tr>
<tr>
<td>SY112-11</td>
<td>ILS Signals</td>
<td>12-17</td>
</tr>
<tr>
<td>SY112-12</td>
<td>ILS Instrument Displays</td>
<td>12-19</td>
</tr>
<tr>
<td>SY112-13</td>
<td>LOC Deviation-CDI</td>
<td>12-19</td>
</tr>
<tr>
<td>SY112-14</td>
<td>PFD With ILS Selected-GS</td>
<td>12-20</td>
</tr>
<tr>
<td>SY112-15</td>
<td>Bearing Pointers</td>
<td>12-20</td>
</tr>
<tr>
<td>SY112-16</td>
<td>Bearing Pointer OFF Selected</td>
<td>12-21</td>
</tr>
<tr>
<td>SY112-17</td>
<td>Bearing Pointer VOR Selected</td>
<td>12-21</td>
</tr>
<tr>
<td>SY112-18</td>
<td>Bearing Pointer LOC Selected</td>
<td>12-22</td>
</tr>
<tr>
<td>SY112-19</td>
<td>Bearing Pointer FMS Selected</td>
<td>12-22</td>
</tr>
<tr>
<td>SY112-20</td>
<td>Nav System Power</td>
<td>12-23</td>
</tr>
<tr>
<td>SY112-21</td>
<td>DME Operation</td>
<td>12-23</td>
</tr>
<tr>
<td>SY112-22</td>
<td>DME Distance</td>
<td>12-24</td>
</tr>
<tr>
<td>SY112-23</td>
<td>DME on PFD</td>
<td>12-25</td>
</tr>
<tr>
<td>SY112-24</td>
<td>DME on NAV Display</td>
<td>12-26</td>
</tr>
<tr>
<td>SY112-25</td>
<td>DME Hold 1</td>
<td>12-27</td>
</tr>
<tr>
<td>SY112-26</td>
<td>DME Hold 2</td>
<td>12-28</td>
</tr>
<tr>
<td>SY112-27</td>
<td>Primary Radar</td>
<td>12-29</td>
</tr>
<tr>
<td>SY112-28</td>
<td>Transponder Operation</td>
<td>12-29</td>
</tr>
<tr>
<td>SY112-29</td>
<td>Transponder Standby (SBY)</td>
<td>12-31</td>
</tr>
<tr>
<td>SY112-30</td>
<td>XPDR Page</td>
<td>12-32</td>
</tr>
<tr>
<td>SY112-31</td>
<td>Mode A</td>
<td>12-33</td>
</tr>
<tr>
<td>SY112-32</td>
<td>ID Priority Function PFB</td>
<td>12-34</td>
</tr>
<tr>
<td>SY112-33</td>
<td>UFCP IDENT Page</td>
<td>12-34</td>
</tr>
<tr>
<td>SY112-34</td>
<td>Mode C</td>
<td>12-35</td>
</tr>
<tr>
<td>SY112-35</td>
<td>Transponder</td>
<td>12-37</td>
</tr>
<tr>
<td>SY112-36</td>
<td>Transponder Power</td>
<td>12-37</td>
</tr>
<tr>
<td>SY112-37</td>
<td>TCAS System</td>
<td>12-38</td>
</tr>
</tbody>
</table>
Figure SY112-38 – TCAS Warnings 1 and 2................................. 12-40
Figure SY112-39 – TCAS Warnings 3 and 4................................. 12-40
Figure SY112-40 – TCAS NAV Display ........................................ 12-41
Figure SY112-41 – Note 1......................................................... 12-42
Figure SY112-42 – Volume Limits ............................................... 12-42
Figure SY112-43 – Note 2......................................................... 12-43
Figure SY112-44 – Range Select 2............................................. 12-44
Figure SY112-45 – Note 3......................................................... 12-44
Figure SY112-46 – TCAS Processor and Mode S............................ 12-45
Figure SY112-47 – TCAS Antennas............................................. 12-45
Figure SY112-48 – TCAS Symbology .......................................... 12-46
Figure SY112-49 – TCAS Symbology 3...................................... 12-47
Figure SY112-50 – TCAS Symbology 4...................................... 12-48
Figure SY112-51 – TCAS Symbology 5...................................... 12-49
Figure SY112-52 – Other Traffic ................................................ 12-51
Figure SY112-53 – Off Scale Traffic........................................... 12-51
Figure SY112-54 – Pilot-Initiated Self Test................................. 12-52
OVERVIEW
This lesson discusses the various components and indicators of the T-6B navigation systems, including VOR/ILS, DME, transponder, and TCAS. The lesson is designed to provide you with an understanding of basic operation and interpretation of these components so they can be used effectively in-flight.

REFERENCES
Personnel: None
Media Facilities: Student CAI Workstation
Support Resources: T-6B Flight Manual; T-6B Systems 1 Student Guide

STUDENT ASSIGNMENTS
Read applicable portions of T-6B Flight Manual, Section I.
Complete CAI lesson SY112, following along with this student guide.
Complete the practice questions provided.

LESSON OUTLINE
Topics in this lesson must be taken in sequential order. All topics must be completed prior to attempting the end of lesson quiz. The estimated time required to complete this lesson is 1.7 hours.
Introduction

T-6B Navigation Systems

VOR/ILS

<table>
<thead>
<tr>
<th>ID</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.8.1.14.4b</td>
<td>Recognize VHF NAV setting</td>
</tr>
<tr>
<td>1.22.21.0.1</td>
<td>Identify purpose of navigation/VOR/ILS system</td>
</tr>
<tr>
<td>1.22.21.0.3</td>
<td>Identify navigation/VOR/ILS system components</td>
</tr>
<tr>
<td>1.22.21.0.4</td>
<td>Match navigation/VOR/ILS system components to functions</td>
</tr>
<tr>
<td>1.22.21.0.5</td>
<td>Identify characteristics of normal operations for navigation/VOR/ILS system</td>
</tr>
<tr>
<td>1.22.21.0.8</td>
<td>Interpret navigation/VOR/ILS instrument displays</td>
</tr>
</tbody>
</table>

T-6B VOR/ILS Introduction

Radio navigation systems were introduced in the lesson Flight Instruments, Part 1. This lesson (Navigation Systems) provides additional details about these systems. Let’s start with a review of basic radio navigation terms.

Very High Frequency (VHF)

VHF Omnidirectional Range (VOR)

Instrument Landing System (ILS)

Localizer (LOC)

Marker Beacon (MB)
Glideslope (GS)

Distance Measuring Equipment (DME)

Navigation Aid (navaid)

The abbreviation “GS” is used in this lesson only where there is no risk of confusion with “ground speed.”

VOR/ILS Components

The principal components of the VOR/ILS radio navigation systems are the integrated navigation (NAV) receiver, DME transmitter/receiver (transceiver), Up Front Control Panel (UFCP) and the Multifunction Displays (MFDs), in particular the Primary Flight Display (PFD).

Both pilots can control the radio navigation systems using the UFCP and Flight Management System (FMS) in each cockpit.

Recall that the NAV receiver processes VOR and ILS signals. ILS is a combination of LOC, GS, and MB signals.

In this lesson segment we’ll primarily discuss VOR/ILS and the association between DME and VOR/ILS. We’ll discuss DME in more detail in the next segment.

Figure SY112-1 – VOR Systems
VOR/ILS Antennas

The NAV receiver is connected to VOR/LOC/GS antennas on the vertical fin and a MB antenna on the bottom of the fuselage.

The DME transceiver is connected to a small DME antenna on the bottom of the fuselage.

Frequency Pairing

VOR, ILS, and DME frequencies are tuned in groups according to permanently-assigned frequency-pairing arrangements as follows:

A DME transmit frequency is always paired with a DME receive frequency.

Each VOR frequency is associated (paired) with a DME frequency pair.

Each LOC frequency is associated (paired) with a GS frequency and also with a DME frequency pair.
When you tune a VOR, the “hardcoded” NAV tuning system automatically sets the associated DME frequencies.

For example, when you tune 112.30 MHz (VOR), the system automatically tunes the DME transceiver to 1,094 MHz (transmit) and 1,157 MHz.

When you tune a LOC (ILS) frequency, the NAV tuning system automatically sets the associated GS and DME frequencies.

VOR/LOC Frequencies

Two hundred VOR/ILS frequencies are assigned in the 108.00 MHz to 117.95 MHz frequency range. There are 40 LOC and 160 VOR frequencies with 50 kHz frequency spacing. As a result, the hundredths digit is always 0 or 5; i.e., xxx.10, xxx.15, xxx.20, xxx.25 and so on.

From 108.00 to 111.95 MHz

Frequencies with an odd number in the tenths digit are assigned to LOC.

Frequencies with zero or an even number in the tenths digit are VOR.

For example:
108.00 VOR
108.05 VOR
108.10 LOC
108.15 LOC
108.20 VOR
108.25 VOR

//\\\\\\

111.90 LOC
111.95 LOC

VOR Frequencies

From 112.00 to 117.95 MHz

All frequencies in this range are assigned to VOR.

112.00
112.05
112.10
112.15
112.20
112.25
112.30
Recall that each ILS and VOR broadcasts a Morse code audio identifier unique to that station. Each DME also broadcasts its own Morse code station identifier.

VOR Types

There are three primary types of VOR stations:

- VOR - VOR azimuth signals only
- VOR/DME - VOR signals paired with DME
- VORTAC - VOR station and Tactical Air Navigation (TACAN) station collocated

Recall that TACAN includes both azimuth and DME signals.
While the T-6B is not equipped with a TACAN radio and cannot receive TACAN azimuth signals, the DME signal component of TACAN is usable by the T-6B DME radio.

This chart shows the symbols that represent the three types of VOR facilities.

VOR Radials

A VOR ground station transmits two different azimuth signals on the same frequency. One, omnidirectional or omni, is the same all around the station, like ripples in a pond. The other rotates around the station like a tower beacon.

The NAV receiver compares the azimuth signals from the tuned station to determine the bearing (azimuth) from the station to the aircraft, relative to magnetic north at the station. This azimuth is the radial from the station.

A radial always points away from its originating station. Radials are resolved to 1° increments for a total of 360 radials, numbered 000 to 359. The 000 radial indicates magnetic north. Radials appear on the charts as compass lines that “radiate” from the center of the VOR, like spokes on a
VOR signals are subject to line-of-sight restrictions that vary with terrain and the altitude of the receiving aircraft. Maximum usable range varies from 25 to 130 NM.

VOR Tuning

To tune to a VOR station, use standard UFCP procedures to enter the published frequency.

As previously discussed, the VOR/ILS tuning system sets the NAV receiver to the VOR frequency and simultaneously sets the DME transceiver to the paired DME frequencies.

The tuned VOR frequency appears on the Horizontal Situation Indicator (HSI). In this example, the station is a VOR/DME so DME distance to the station also appears. If the station does not have DME or if DME is inoperative, the DME data line is blank.

Note that the Primary Flight Display (PFD) navigation source (PFD SOURCE) is VOR. We’ll discuss this later in the lesson.

ILS Tuning
To tune an ILS, use standard UFCP procedures to enter the published localizer frequency.

When the LOC frequency is entered, the VOR/ILS tuning system simultaneously sets the LOC, GS, and DME frequencies.

The tuned LOC frequency displays on the HSI. DME distance also appears if available. The DME line is blank if DME is not available.

If the chart shows a TACAN channel with the LOC frequency, the ILS is equipped with DME.

If the ILS installation has DME, keep in mind that the DME transmitter is not necessarily positioned at the same spot as the localizer.
PFD Source - VOR Tuned

The navigation data displayed on the PFD depends on the PFD SOURCE and the tuned VOR/ILS frequency.

With VOR/ILS tuned to a VOR frequency, each press on LSK L4 toggles the PFD SOURCE through these options:

- VOR
- OFF
- FMS
- VOR

PFD Source - LOC Tuned

With VOR/ILS tuned to a LOC frequency, the options are

- LOC
- OFF
- FMS
- LOC
PFD With VOR Selected

When the PFD SOURCE is VOR, the course deviation indicator provides navigation information relative to the radial selected.

The selected course is indicated by the course pointer and Course Deviation Indicator (CDI).

The course pointer has three parts: head, tail, and TO/FROM arrow. The head points to the compass direction of the selected course (radial). The tail forms a line with the head. We’ll look at TO/FROM on the next slide.

The CDI is in the center of the course pointer. The NAV receiver determines the position of the selected radial and drives the CDI toward that radial. The CDI indicates course position relative to the aircraft. The CDI centers when the desired course equals the selected radial.

In this example the CDI indicates that the selected course is to the left of the aircraft and parallel to the heading.

Figure SY112-8 – Course Pointer
TO/FROM

When the TO/FROM arrow is pointing to the course pointer head, it is the TO arrow.

When the arrow is pointing to the course pointer tail, it is the FROM arrow.

The FROM arrow indicates that if the selected course is flown, it will take the aircraft away from the VOR station.

The TO arrow indicates that if the selected course is flown, it will take the aircraft toward the VOR station.

Setting Course Direct to Station

The course is set by using the course select option at LSK LL and by using the UFCP.

Pressing and holding LSK LL for one second or more sets a course that leads directly to the tuned facility; i.e., selects a course that sets the CDI to center and shows the TO flag.

Let’s look at another course selection method on the next slide.
Link to UFCP Course Page

Momentarily pressing LSK LL automatically changes the UFCP to the VOR select course page.

W4 is activated and ready for course entry. The currently-set course appears in W4.

Note that this is the same UFCP page that is displayed when the NAV master mode button is pressed on the UFCP.

Regardless of source, the course setting that appears in W4 always refers to the VHF NAV Course Deviation Indicator (CDI) setting.

ILS Signals

Let’s do a quick review of the ILS system.

The minimum ILS installation is LOC only. Depending on the airport, an ILS installation for any given runway may also include GS, DME, and MB.

Localizer (LOC) signals provide lateral course guidance to the runway centerline. LOC tuning was covered earlier in this lesson.
Glideslope (GS) signals provide vertical guidance to establish the proper runway approach angle.

Marker beacons (MBs) provide approach path progress indications at fixed points. There are three basic MB types: Inner Marker (IM), Middle Marker (MM), and Outer Marker (OM). An airport may have all or none of these.

All MBs operate on 75 MHz. This frequency is permanently fixed in the NAV receiver MB module; no tuning is required.

PFD With ILS Selected

With the VOR/ILS tuned to an ILS (LOC) frequency and with LOC selected as the PFD SOURCE, the localizer deviation scale and the glideslope deviation scale appear on the Attitude Deviation Indicator (ADI) section of the PFD.
PFD With ILS Selected - LOC

The localizer deviation pointer only appears when the NAV receiver detects a valid localizer signal.

The pointer is not displayed when a valid localizer signal is not detected, such as the wrong LOC frequency is tuned, out-of-range, aircraft position is out of the localizer signal capture envelope, or equipment malfunction.

When the pointer is left of scale center, the localizer is to the left of the aircraft.

When the pointer is right of scale center, the localizer is to the right of the aircraft.

When the pointer is centered on the scale, the aircraft is centered on the runway approach.

LOC Deviation - CDI

With the course selected to the runway heading, the CDI accurately indicates localizer deviation left, right, and center in the same manner as the localizer pointer.

Notice that there is not a TO or FROM arrow on the course pointer.

Figure SY112-12 – ILS Instrument Displays

Figure SY112-13 – LOC Deviation-CDI
PFD With ILS Selected - GS

The glideslope deviation pointer appears when the NAV receiver detects a valid glideslope signal.

The pointer is not displayed when a valid glideslope signal is not detected.

When the pointer is above scale center, the aircraft is below glideslope.

When the pointer is below scale center, the aircraft is above glideslope.

When the pointer is centered, the aircraft is on glideslope.

Bearing Pointers

Bearing pointers indicate the absolute bearing to the navigation source the pointer is slaved to. Each bearing pointer has a head and tail with the head indicating the bearing.

Bearing pointer source options depend on the frequency the VHF NAV radio is tuned to.

With the NAV radio tuned to a VOR, the source options are OFF, VOR, and FMS.

Figure SY112-14 – PFD With ILS Selected-GS

Figure SY112-15 – Bearing Pointers
With the NAV radio tuned to a LOC, the source options are OFF, LOC, and FMS.

If a slaved navaid is not producing a valid bearing (out of range, wrong tuned frequency, etc.), the associated pointer is not displayed and the pointer data block shows only the pointer head and label.

Bearing Pointer OFF

If a bearing pointer is selected OFF, the pointer data block label displays OFF and the pointer is not displayed.

Pressing LSK L6 or R6 toggles the adjacent bearing pointer options between OFF, VOR or LOC (depending on tuned NAV frequency), and FMS.

Bearing Pointer VOR Selected

When a bearing pointer is selected to VOR, the pointer data block shows the following:

First line - Pointer head symbol and VOR label

Second line - Tuned VOR frequency

Third line - DME distance to the station if available, blank if DME is not available
Bearing Pointer ILS Selected

When a bearing pointer is selected to LOC, the bearing pointer is not displayed and the pointer head is not displayed in the data block.

In this configuration, the pointer data block shows the following:

First line - LOC

Second line - Tuned LOC frequency

Third line - DME distance to station if available, blank if DME is not available

Bearing Pointer FMS Selected

When a bearing pointer is selected to FMS, the pointer indicates the absolute bearing to the nearest point on the FMS-generated desired track.

The pointer data block shows the following:

First line - Pointer head symbol and FMS label

Second line - Waypoint identifier

Third line - FMS-computed distance to the waypoint

Figure SY112-18 – Bearing Pointer LOC Selected

Figure SY112-19 – Bearing Pointer FMS Selected
Nav System Power

Electrical power for the radio navigation systems is distributed from the DME and VHF NAV circuit-breakers on the generator bus circuit-breaker panel in the forward cockpit.

Figure SY112-20 – Nav System Power

DME

| 1.22.22.0.1 | Identify purpose of navigation/DME system |
| 1.22.22.0.3 | Identify navigation/DME system components |
| 1.22.22.0.4 | Match navigation/DME system components to functions |
| 1.22.22.0.5 | Identify characteristics of normal operations for navigation/DME marker beacon system |
| 1.22.22.0.8 | Interpret navigation/DME instrument displays |

DME Operation

DME operates in the UHF frequency range. Each DME transceiver repetitively transmits a pulse-pair signal that forms a unique signature, like two notes on a piano.

Randomization logic in every DME transceiver establishes the specific signature for that DME. This ensures that each DME system in each aircraft has its own signature. Recall that the T-6B only has one DME system.

Figure SY112-21 – DME Operation
The DME sends its signature to the ground station on one frequency and the ground station retransmits the signature on a different frequency. This two-way communication continues hundreds of times per second as long as the ground station is tuned and in range.

The aircraft DME continuously attempts communication even if the selected ground station is not DME-equipped.

DME Distance

When the aircraft DME system recognizes its own signature back from the ground station, it measures the round-trip time and calculates a slant range distance in nautical miles from the aircraft to the ground station. Remember that DME range is NOT actual horizontal (ground) distance.

The error between the DME display (slant range) and the horizontal distance to the station increases as the aircraft gets closer to the station. This error is more pronounced with higher aircraft altitudes. This is evidenced by the fact that the minimum DME as the aircraft directly overflies a station is its AGL altitude (slant range = altitude) expressed in nautical miles, even though the horizontal distance is zero.
DME is a line-of-sight signal, reliable up to 199 nautical miles depending on aircraft altitude.

DME on the HSI

As seen earlier in the lesson, when the PFD SOURCE is selected to VOR or LOC and the selected station is DME-equipped, DME slant-range distance appears in the PFD SOURCE data block.

When a bearing pointer is selected to VOR or LOC, DME range also appears in the third line of the bearing pointer data block.

The DME data lines in the PFD SOURCE and bearing pointer data blocks are blank if DME is not available.

In this example, bearing pointer #2 is selected to FMS. Note that the data in this block is cyan. This indicates that the data is generated by the FMS, not by the DME system.
DME on the NAV Display

In this example, note that the PFD SOURCE is FMS. In this configuration, data at the top of the display is generated by the FMS, not by the DME.

The FMS waypoint (WPT) labeled THX is a coordinate that coincides with the tuned VOR station. In this case the FMS-computed distance to the active waypoint (DIST) is the same (or nearly the same) as the DME distance, allowing for system error and slant-range variations. Otherwise, these values are completely unrelated.

Time-To-Go (TTG) and Estimated Time Of Arrival (ETA) are also computed by the FMS and have nothing to do with the DME.

Figure SY112-24 – DME on NAV Display
DME Hold 1

Recall that DME HOLD lets you tune the DME transceiver to one navigation station, hold that frequency, and then tune the NAV receiver to a different station.

The HOLD feature is used when required by approach procedures, such as when flying a DME arc transition to intercept a localizer.

The procedure for setting DME HOLD was covered in the UFCP lesson. Let’s briefly review the steps.

Press the NAV TUNE Priority Function Button (PFB) until DME appears in W1.

Press the W2 window control key to select the HOLD (H) option.

Figure SY112-25 – DME Hold 1
DME Hold 2

With DME HOLD selected, these indications appear on the PFD and NAV displays.

On the PFD SOURCE data block:

- Bearing or localizer source tuned frequency
- DME distance to held source (amber)
- DME source tuned frequency preceded by “H” (amber)

On the bearing pointer data blocks:

- Bearing or localizer source frequency
- *** in place of DME distance

DME Power

DME system power is distributed through the DME circuit breaker on the generator bus circuit-breaker panel in the front cockpit.
## TRANSPONDER

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.8.1.14.3b</td>
<td>Recognize transponder setting</td>
</tr>
<tr>
<td>1.22.24.0.1</td>
<td>Identify purpose of transponder system</td>
</tr>
<tr>
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</tr>
<tr>
<td>1.22.24.0.8</td>
<td>Interpret transponder instrument displays</td>
</tr>
</tbody>
</table>

**Primary Radar**

Primary, radar operates by transmitting microwave signals which are reflected from the aircraft then back to the ground antenna. These “skin paint” signals are affected by terrain, distance, and atmospheric phenomena such as heavy precipitation.

**Figure SY112-27 – Primary Radar**

**Transponder Operation**

The transponder enhances the reflected skin paint signal to help controllers to identify various aircraft. The transponder is the airborne portion of the Air Traffic Control Radar Beacon System (ATCRBS) known as secondary radar.

**Figure SY112-28 – Transponder Operation**
Ground radar stations and airborne systems transmit interrogation signals which trigger the transponders to reply to the interrogations. Transponder-equipped aircraft within line of sight of the interrogation signals automatically respond by sending back coded signals determined by the interrogation mode request.

Mode A, Mode C, Mode S

The T-6B transponder is a “Mode S” transponder. It incorporates three basic modes. These are:

- Mode A, sometimes referred to as “4096” code
- Mode C, altitude reporting
- Mode S, “Select” mode assigned to individual aircraft

Interrogation systems can send requests for any of these mode replies.
When the interrogating station receives an aircraft’s Mode A reply signal, a distinct position indicator appears on the controller’s scope to positively identify the aircraft. If Mode C was also requested and replied, the aircraft’s altitude information appears with the Mode A code and highlighted position indicator.

We’ll look at each of these modes later.

Operational Modes

The transponder modes are integrated into the UFCP and FMS).

There are three operational modes: standby (SBY), altitude reporting (ALT), and active (ACT).

With SBY selected, the transponder is on and warmed-up but will not respond to ground or airborne interrogations.

With altitude reporting ON (ALT), the transponder is active and responds to Mode A, Mode S, and Mode C interrogations. ALT is the default.

Figure SY112-29 – Transponder Standby (SBY)
When set to active with altitude reporting OFF, the transponder responds to Mode A and Mode S interrogations, but does provide Mode C altitude. ACT does not appear on the persistent display and the right side of W4 is blank.

Transponder Operation, UFCP

You can use the NAV TUNE - XPDR page to view and change the transponder operational status (SBY, ACT, and ALT), and Mode A code.

Pressing the W1 window control key toggles the options between XPDRACT and XPDRSBY.

The Mode A code is changed using standard UFCP data entry procedure.

Pressing the W3 window control key toggles the options between ALT ON and ALT OFF.

Keep in mind that if XPDRSBY is selected, the transponder will not reply to interrogations even if ALT ON is selected.

Figure SY112-30 – XPDR Page
Mode A

Mode A is the basic identification mode. ATC assigns a Mode A code to each flight. There are 4096 possible Mode A codes with each of the four digits assigned 0 through 7 (octal, 0000 - 7777). Mode A is equivalent to military Mode 3.

With the persistent display present, pressing the W4 window control key activates the window for code entry. Use standard UFCP data entry procedures to enter the code.

When a secondary radar transmits a Mode A request, all Mode A-enabled aircraft in the coverage area automatically reply. The controller sorts-out the replies and assigns them to the appropriate aircraft symbols on the scope.

Ident Function

In heavy air traffic environments, controllers will sometimes request pilots to “SQUAWK IDENT.”
Pressing the ID priority function button (PFB) on the UFCP (to the right of W4) commands the transponder to transmit the Mode A code and an embedded ident code. This action generates distinct IDENT symbology on the controller’s screen. The controller is then able to quickly and easily identify that airplane’s location among the traffic on the screen.

Pressing the ID PFB changes the UFCP to the IDENT page for 5 seconds.

Figure SY112-32 – ID Priority Function PFB

Figure SY112-33 – UFCP IDENT Page
Mode C

Mode C is the altitude reporting mode. Mode C altitude reporting is enabled when ALT appears in W4 on the UFCP persistent display.

With altitude reporting enabled, Mode C data automatically transmits when a secondary radar interrogation includes a Mode C request, when interrogated by TCAS, and when you squawk ident.

The Air Data Computer (ADC) provides altitude data to the transponder.

Mode C always reports altitude at the standard altitude setting (29.92 inHg or 1013 mb). The barometric altitude setting used for the altimeters has no bearing on Mode C. The Mode C reply is automatically converted to current local conditions by the receiving station equipment. And since every aircraft reports altitude on the same standard setting, this simplifies the TCAS relative altitude computations. We’ll discuss TCAS later.

Mode S

Mode S is the “select” mode.
Each aircraft is assigned a unique 24-bit Mode S address based on the aircraft registration number. The Mode S address cannot be changed in flight and it is not displayed anywhere except on a specific FMS page.

Unlike Mode A interrogations where all Mode A-enabled aircraft always replay at the same time, Mode S can interrogate Mode S-equipped aircraft only (all-call) or can interrogate an individual aircraft using the assigned Mode S address. A Mode S reply actually contains a great deal of information about the host aircraft; for example, it contains coding that identifies the type of aircraft it is installed in.

Mode S is required for the Traffic Collision Avoidance System (TCAS). If the transponder is OFF or in standby, TCAS does not work.

In TCAS operation, TCAS processors in other aircraft transmit Mode S interrogations. When a Mode S transponder detects this interrogation, it broadcast a Mode S reply, just like when interrogated by a ground station. We’ll see more about this in the next segment.
T-6B Transponder Components

The transponder, located in the left avionics bay, sends and receives signals through a lower transponder antenna located on the bottom of the fuselage just in front of the wing.

The transponder also uses a transponder antenna element embedded in upper UHF/transponder antenna. This antenna also includes a UHF antenna element used by the UHF radio.

The transponder automatically switches between the upper and lower antennas for optimum transmission and reception.

Transponder Power

The transponder is powered through a circuit breaker labeled “XPDR” on the generator bus circuit breaker panel in the front cockpit.
TCAS

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.22.25.0.1</td>
<td>Identify purpose of collision warning system</td>
</tr>
<tr>
<td>1.22.25.0.3</td>
<td>Identify collision warning system components</td>
</tr>
<tr>
<td>1.22.25.0.4</td>
<td>Match collision warning system components to functions</td>
</tr>
<tr>
<td>1.22.25.0.5</td>
<td>Identify characteristics of normal operations for collision warning system</td>
</tr>
<tr>
<td>1.22.25.0.8</td>
<td>Interpret collision warning instrument displays</td>
</tr>
</tbody>
</table>

TCAS Introduction

The T-6 is equipped with a Traffic Collision Avoidance System (TCAS). There are two different TCAS systems: TCAS I and TCAS II. The primary difference between these is that TCAS II provides vertical avoidance maneuver guidance while TCAS I does NOT provide avoidance maneuver guidance.

The T-6B is equipped with the TCAS I system.

TCAS displays detected traffic (intruders) on the NAV displays in both cockpits.

When TCAS detects other aircraft, distinctive TCAS symbology appears on the NAV display and aural advisories are triggered.

Figure SY112-37 – TCAS System
TCAS Operation

The TCAS processor incorporates its own transmitter and receiver closely interfaces with the Mode S transponder. TCAS detects and tracks other aircraft by transmitting interrogations and then analyzing their transponder replies to determine range, bearing, and relative altitude (if the intruding aircraft is reporting altitude).

The TCAS processor/transmitter interrogates Mode A, Mode C, and Mode S. To be detected by TCAS, an aircraft must have an operating transponder but does not need to be equipped with Mode S or TCAS.

TCAS IS NOT RADAR.

TCAS CANNOT DETECT AIRCRAFT THAT DO NOT HAVE OPERATING TRANSPONDERS.
SY0112 NAVIGATION SYSTEMS

Warnings 1 and 2

- Do not use TCAS as the primary means of avoiding traffic conflicts.
- TCAS is only an aid to detecting other aircraft as a means to visually acquire and avoid aircraft that may pose a collision threat. It is not a replacement for ATC or see-and-avoid procedures. Pilots must still visually scan the surrounding airspace.

Figure SY112-38 – TCAS Warnings 1 and 2

Warnings 3 and 4

- TCAS may be unreliable or traffic may disappear from the NAV display during stalls, aggressive maneuvering or aerobatic flight. During inverted flight, traffic will be displayed as if the aircraft were upright.
- TCAS provides symbols to indicate the altitude differential between the traffic and the T-6B aircraft, as well as an indication of whether the traffic is climbing or descending.

Figure SY112-39 – TCAS Warnings 3 and 4
TCAS Functions Using UFCP

The UFCP provides TCAS functional control. With the NAV display present, momentarily pressing LSK R2 changes the UFCP to the TCAS page.

The SYS DISPLAY TCAS page provides the following:

W1 - TCAS ON or TCAS SBY (standby)

W2 - Look angle (ABOVE, NORMAL, BELOW)

W3 - Flight level setting: relative altitude (FL REL) and absolute altitude (FL ABS)

W4 - No display or functionality

Default TCAS Functions

FL REL is the default setting in W3. This display option means that the intruder symbology displays the relative altitude between the intruder and your own altitude. We’ll see this symbology later.
Selecting FL ABS temporarily displays the absolute (Mode C reported) altitude of the targets on the NAV display. After 15 seconds, the target displays return to normal and W3 reverts to FL REL.

Note 1

Volume Limits

In NORMAL mode, traffic between 2700 feet above and 2700 feet below own aircraft is displayed. This mode is normally used in the enroute phase.

In ABOVE mode, traffic between 8700 feet above and 2700 feet below own aircraft is displayed.

In BELOW mode, traffic between 2700 feet above and 8700 feet below own aircraft is displayed.
Range Select 1

TCAS range information is based on the compass rose (or compass arc) range setting on the NAV display. Pressing LSK R3 increases the NAV display range (RNG) and LSK R4 decreases the NAV display range in nautical mile increments as follows:

- 5
- 10
- 20
- 40
- 80
- 160
- 320
Range Select 2

In this example, the current range setting on the NAV display is 20 nm and you have a traffic advisory of an aircraft 2500 feet above your altitude and climbing.

The arrow adjacent to the traffic symbol indicates climbing traffic, not direction of flight. A down arrow indicates descending traffic. We’ll discuss symbology later.

As the relative position between own aircraft and the intruder aircraft changes, the intruder symbol moves in the direction of the changing position.

Keep in mind that this is only a representative example. TCAS display interpretation is actually critically important and requires in-depth discussion.

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Note 3

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**NOTE**

The range setting on the NAV display is not a tandem function and must be independently selected from each cockpit.

**NOTE**
TCAS Processor and Mode S

The TCAS processor is located on a lower shelf in the left avionics bay. The processor performs receiver, transmitter, and computer functions. It receives altitude and airspeed data from the ADC, and heading and present position data from the GPS.

As previously mentioned the TCAS processor closely interfaces with the Mode S transponder. While the TCAS processor on your aircraft interrogates the transponders of other aircraft and listens for their replies, the Mode S transponder on your aircraft replies to other TCAS interrogations and provides datalink capability to share information between your TCAS system and the TCAS system on another aircraft.

TCAS Antennas

The TCAS processor uses two antennas. The upper TCAS antenna is mounted to the top of the engine cowl, while the lower TCAS antenna is mounted on the bottom of the fuselage ahead of the speed brake.
TCAS Symbology 1

Information from the TCAS system displays as Traffic Advisories (TAs) on the NAV display using standard TCAS symbology.

Traffic is identified as follows:

- Non-threat traffic - Unfilled white diamond
- Proximity intruder traffic - Filled white diamond
- Traffic advisory (TA) - Filled yellow circle

A TA means that you need to actively be doing something to see and avoid the traffic.

TCAS Symbology 2

When an intruder aircraft is reporting Mode C, TCAS symbol altitude labels indicate the altitude differential between the traffic and own aircraft as well as whether the traffic is climbing or descending.

The altitude differential is indicated by a two digit readout representing the altitude difference in hundreds of feet.
A + or - next to the digital readout indicates whether the traffic is above or below own aircraft.

The digital readout displays either above or below the traffic symbol to indicate if the traffic is above or below own aircraft.

If the traffic is at the same level as own aircraft, the altitude differential readout displays “00” with no sign.

TCAS Symbology 3

An arrow to the right of the traffic symbol indicates whether the traffic is climbing or descending.

An arrow pointing upwards indicates that the traffic is climbing, and an arrow pointing downwards indicates that the traffic is descending.

Figure SY112-49 – TCAS Symbology 3
TCAS Symbology 4

TCAS traffic symbols display at the appropriate bearing and distance from the own aircraft symbol, based on the selected display range and current aircraft heading.

A circle of blue dots appears when the display range is set to 10 nm or less. This circle indicates 2 nm from own aircraft symbol. Each dot is an “o’clock” position, with 12:00 o’clock at top center.

When TCAS issues a TA, the TFC advisory annunciator appears in the top left corner of the NAV display and the PFD.

When TCAS reports a TA and the NAV display is not selected, the NAV display will pop-up automatically on an MFD, as long as PFD and EICAS both appear. The NAV range scale will automatically set to 10 nm.
TCAS Symbology 5

If TCAS cannot determine the intruder bearing, the traffic information displays in text format to the right of the heading readout.

The text displays in yellow as “TA XX YY”.

- TA - Traffic advisory
- XX - Distance to the traffic in nautical miles
- YY - Altitude differential between traffic and aircraft in hundreds of feet

This example shows a traffic advisory at 10 nm and 2500 foot altitude differential between the aircraft.

The TCAS text display can only provide data for up to two aircraft.

Sensitivity Levels

TCAS separates the airspace surrounding the aircraft into two altitude layers with different sensitivity levels for issuing TAs.

Figure SY112-51 – TCAS Symbology 5
TCAS is in Sensitivity Level A when the landing gear is extended. A TA will be issued when one of the following conditions is met:

TCAS calculates that if current closing rate with intruder aircraft is maintained, vertical separation of less than 600 feet will occur in 20 seconds;

Vertical separation from intruder is less than 600 feet and horizontal separation is less than 0.2 NM;

Horizontal separation from non-altitude reporting intruder is within 15 seconds or 0.2 NM.

Sensitivity Levels 2

TCAS is in Sensitivity Level B when the landing gear is retracted. A TA will be issued when one of the following conditions is met:

TCAS calculates that if current closing rate with intruder aircraft is maintained, vertical separation of less than 800 feet will occur in 30 seconds;

Vertical separation from intruder is less than 800 feet and horizontal separation is less than 0.55 NM;
Horizontal separation from non-altitude reporting intruder is within 20 seconds or 0.55 NM.

Other Traffic

Other traffic is displayed as an open white diamond indicating the intruder’s relative altitude is greater than ±1200 relative altitude, or its distance is beyond 5 NM.

Off Scale Traffic

Intruders beyond the selected display range are indicated by a traffic half-symbol at the edge of the display. The position of the half-symbol represents the bearing to the intruder.
Pilot-Initiated Self Test

The TCAS Built-In Test is initiated by pressing and holding LSK R2 for one second. This test only works when the aircraft is on the ground.

Test indications are as follows:

A traffic advisory annunciator (yellow filled circle) appears at the 9 o’clock position at 2 NM range, 200 feet below and climbing.

A proximity traffic annunciator (solid white diamond) appears at the 1 o’clock position at 3.6 NM, 1000 feet below, descending.

Another traffic annunciator (open white diamond) appears at the 11 o’clock position, 3.6 NM range, 1000 feet above and in level flight.

Self Test Pass Audio Message

If the self test passes, an audible “TAS SYSTEM TEST OK” is heard on the audio system.
Self Test Fail Audio Message

“TAS SYSTEM TEST FAIL” is heard if the test fails.

Lesson Review Quiz
LESSON QUESTIONS

EMBEDDED QUESTIONS (Ref: Segment/Topic/Question)

1. Select the VOR frequency. (B/1/1)
   a. 109.30
   b. 109.35
   c. 109.40
   d. 111.95

2. Select the LOC frequency. (B/1/2)
   a. 109.05
   b. 109.15
   c. 114.90
   d. 114.95

3. Radials_____. (B/1/3)
   a. are oriented to true north
   b. are numbered from 001 to 360
   c. always point toward the originating VOR station
   d. always point away from the originating VOR station

4. Which indicator shows the position of the selected radial relative to aircraft position? (B/1/4)
   a. Course pointer
   b. TO/FROM arrow
   c. Course Deviation Indicator (CDI)
   d. Attitude Direction Indicator (ADI)

5. If you want to select VOR as the navigation source (PFD SOURCE), press LSK ______ with a ______ frequency currently tuned. (B/1/5)
   a. LL; VOR
   b. L4; VOR
   c. LL; VOR or ILS
   d. L4; VOR or ILS
6. The ILS _____ provides course guidance to the runway centerline. (B/1/6)
   a. localizer
   b. glideslope
   c. marker beacon
   d. course indicator

7. Which of these statements is most correct regarding glideslope? (B/1/7)
   a. Glideslope can be inhibited using the UFCP.
   b. Glideslope signals are always broadcast on 75MHz.
   c. Glideslope signals are broadcast on the same frequencies as LOC signals.
   d. Glideslope signals provide vertical guidance for the appropriate runway approach angle.

8. The localizer and glideslope deviation scales are displayed ______. (B/1/8)
   a. when a LOC frequency is currently tuned and the PFD SOURCE is OFF or LOC
   b. only when the NAV receiver detects valid localizer and glideslope signals
   c. when a LOC frequency is currently tuned and the PFD SOURCE is LOC
   d. anytime LOC is selected in the bearing pointer #1 data box at LSK L6

9. What happens to bearing pointer #1 if a valid VOR signal is not present? (B/1/9)
   a. The pointer “parks” at the 270° position and the frequency line in the pointer data block
      is replaced with yellow dashes.
   b. The pointer “parks” at the 090° position and turns yellow and all data in the data block
      blanks.
   c. The pointer is not displayed and the pointer data block shows only the pointer head and
      label.
   d. The pointer is not displayed and all lines in the pointer data block are blank.

10. The DME system measures the time required for the transmitted signal to reach the ground
    station and return, and calculates a ______ distance in nautical miles from the aircraft to the
    ground station. (B/2/1)
    a. lateral
    b. vertical
    c. horizontal
    d. slant range
11. When a DME-equipped navigation facility is tuned, the DME distance to that facility is displayed in ______. (B/2/2)
   a. the PFD SOURCE data block if the source is selected to VOR or LOC
   b. the bearing pointer data blocks on the PFD and NAV displays if VOR or LOC is the selected bearing source
   c. the DIST data field at the top of the NAV display
   d. Both A and B

12. The Distance To Go to the active waypoint (DIST), Time To Go to the active waypoint (TTG) and Estimated Time of Arrival (ETA) are computed by the ______. (B/2/3)
   a. FMS
   b. DME system
   c. DME using FMS input data
   d. FMS using DME input data

13. To set the DME HOLD frequency, use the ______. (B/2/4)
   a. LSK adjacent to the PFD SOURCE to toggle through the HOLD options
   b. LSK adjacent to bearing pointer #1 to toggle through the HOLD options
   c. UFCP to enter the frequency for the distance source and the associated FMS waypoint identifier
   d. NAV TUNE button on the UFCP to select the DME page then press the window control key adjacent to the DME frequency to select the HOLD option

14. Controllers will assign the same Mode A transponder code to all aircraft under their control. (B/3/1)
   a. True
   b. False

15. Which mode allows a transponder to automatically reply to an interrogation addressed to a specific aircraft? (B/3/2)
   a. Mode A
   b. Mode C
   c. Mode S
   d. Both Mode A and Mode C
16. With UFCP configured as shown in this example, the transponder will reply with what mode(s) when interrogated by a Mode A and Mode C request? (B/3/3)
   a. Mode A only
   b. Mode C only
   c. Both Mode A and Mode C
   d. The transponder will not respond to interrogations

17. With the UFCP configured as shown in this example, the transponder will reply with what mode(s) when interrogated by a Mode A and Mode C request? (B/3/4)
   a. Mode A only
   b. Mode C only
   c. Both Mode A and Mode C
   d. The transponder will not reply to interrogations

18. TCAS traffic warnings and advisories display on the EICAS in both cockpits. (B/4/1)
   a. True
   b. False

19. TCAS range selections are ______ selectable on the ______. (B/4/2)
   a. 5, 10, 20, 40, 80, 160, 320; NAV display
   b. 15, 30, 60, 120, 240; NAV display
   c. 5, 10, 20, 40, 80, 160, 320; EICAS
   d. 15, 30, 60, 120, 240; EICAS

20. TCAS threats are identified as follows: (B/4/3)

   Non-threat traffic - Unfilled white diamond

   Proximity intruder traffic - Filled white diamond

   Traffic advisory traffic - Filled yellow circle

   a. True
   b. False

21. In Above mode, traffic from 9000 feet above to 2700 feet below the aircraft is displayed. (B/4/4)
   a. True
   b. False
LESSON REVIEW QUIZ QUESTIONS

1. The Distance Measuring Equipment (DME) system displays _____ from the aircraft to the ground station.
   a. slant range distance in statute miles
   b. horizontal distance in statute miles
   c. slant range distance in nautical miles
   d. horizontal distance in nautical miles

2. The localizer (LOC) and Glideslope (GS) deviation scales appear on the Attitude Direction Indicator (ADI) when the Primary Flight Display source (PFD SOURCE) is set to LOC and _____.
   a. a LOC frequency is tuned
   b. Distance Measuring Equipment (DME) HOLD is selected
   c. Navigation (NAV) display PFD SOURCE is selected to ILS
   d. the Flight Management System (FMS) is in the approach mode of flight

3. The 000° radial of each VOR station is oriented to _____.
   a. grid north
   b. true north
   c. magnetic north
   d. magnetic north minus local magnetic variation

4. Automatic altitude reporting is provided by transponder mode _____.
   a. A
   b. B
   c. C
   d. D

5. When you tune a localizer (LOC) frequency using the Up Front Control Panel (UFCP), the navigation radio tuning system automatically set the associated _____.
   a. communication radio frequencies
   b. Flight Management System (FMS) waypoint
   c. Very High Frequency (VHF) Omnidirectional Range (VOR) frequency
   d. Distance Measuring Equipment (DME) and Glideslope (GS) frequencies
6. The TCAS non-threat traffic symbol is a _____ and the traffic advisory traffic symbol is a _____.
   a. unfilled white circle; filled yellow diamond
   b. unfilled white circle; filled yellow circle
   c. unfilled white diamond; filled yellow diamond
   d. unfilled white diamond; filled yellow circle

7. The frequency 110._____ is a localizer (LOC) setting.
   a. 00
   b. 20
   c. 25
   d. 30

8. Pressing the _____ button on the UFCP transmits a special pulse to aid in immediate identification on a controller’s scope.
   a. NAV TUNE
   b. MRK
   c. NAV
   d. ID

9. The Traffic Collision Avoidance System (TCAS) detects and tracks other aircraft by interrogating their transponders and then analyzing the replies to determine range, bearing, and relative _____.
   a. airspeed
   b. heading
   c. altitude
   d. size
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>TABLE OF CONTENTS</td>
<td>14-1</td>
</tr>
<tr>
<td>LIST OF FIGURES</td>
<td>14-2</td>
</tr>
<tr>
<td>OVERVIEW</td>
<td>14-4</td>
</tr>
<tr>
<td>REFERENCES</td>
<td>14-4</td>
</tr>
<tr>
<td>STUDENT ASSIGNMENTS</td>
<td>14-4</td>
</tr>
<tr>
<td>LESSON OUTLINE</td>
<td>14-4</td>
</tr>
<tr>
<td>INTRODUCTION</td>
<td>14-5</td>
</tr>
<tr>
<td>FMS</td>
<td>14-5</td>
</tr>
<tr>
<td>FMS BASICS</td>
<td>14-5</td>
</tr>
<tr>
<td>FMS ON NAV AND PFD</td>
<td>14-11</td>
</tr>
<tr>
<td>FMS MANAGEMENT</td>
<td>14-18</td>
</tr>
<tr>
<td>FMS PAGE OVERVIEW</td>
<td>14-38</td>
</tr>
<tr>
<td>LESSON QUESTIONS</td>
<td>14-48</td>
</tr>
</tbody>
</table>
## LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>SY114-1</td>
<td>NAV Display With FMS Selected</td>
<td>14-5</td>
</tr>
<tr>
<td>SY114-2</td>
<td>Integrated Avionics Computer (IAC) Integration</td>
<td>14-9</td>
</tr>
<tr>
<td>SY114-3</td>
<td>FMS User Interfaces</td>
<td>14-9</td>
</tr>
<tr>
<td>SY114-4</td>
<td>FMS Progress Page</td>
<td>14-10</td>
</tr>
<tr>
<td>SY114-5</td>
<td>NAV Display FMS Data</td>
<td>14-11</td>
</tr>
<tr>
<td>SY114-6</td>
<td>NAV Display FMS Symbols</td>
<td>14-12</td>
</tr>
<tr>
<td>SY114-7</td>
<td>Rose Map and Arc Map</td>
<td>14-13</td>
</tr>
<tr>
<td>SY114-8</td>
<td>NAV Display Range (RNG)</td>
<td>14-13</td>
</tr>
<tr>
<td>SY114-9</td>
<td>Rose Plan Display</td>
<td>14-14</td>
</tr>
<tr>
<td>SY114-10</td>
<td>Active Waypoint Display</td>
<td>14-15</td>
</tr>
<tr>
<td>SY114-11</td>
<td>ICAO Symbols</td>
<td>14-16</td>
</tr>
<tr>
<td>SY114-12</td>
<td>PFD FMS Data</td>
<td>14-17</td>
</tr>
<tr>
<td>SY114-13</td>
<td>DTK Deviation</td>
<td>14-17</td>
</tr>
<tr>
<td>SY114-15</td>
<td>UFCP FMS Functions</td>
<td>14-18</td>
</tr>
<tr>
<td>SY114-16</td>
<td>FMS Data Modification</td>
<td>14-19</td>
</tr>
<tr>
<td>SY114-17</td>
<td>FMS Pages</td>
<td>14-19</td>
</tr>
<tr>
<td>SY114-18</td>
<td>Basic FMS Pages</td>
<td>14-20</td>
</tr>
<tr>
<td>SY114-19</td>
<td>Basic Page Functionality</td>
<td>14-21</td>
</tr>
<tr>
<td>SY114-20</td>
<td>FMS Copying Data</td>
<td>14-21</td>
</tr>
<tr>
<td>SY114-21</td>
<td>FMS General Layout</td>
<td>14-22</td>
</tr>
<tr>
<td>SY114-22</td>
<td>Field Types</td>
<td>14-23</td>
</tr>
<tr>
<td>SY114-23</td>
<td>FMS Page Text Sizes</td>
<td>14-24</td>
</tr>
<tr>
<td>SY114-24</td>
<td>Color Conventions - Green</td>
<td>14-24</td>
</tr>
<tr>
<td>SY114-25</td>
<td>Color Conventions - White</td>
<td>14-25</td>
</tr>
<tr>
<td>SY114-26</td>
<td>Data Fields With Two Items</td>
<td>14-25</td>
</tr>
<tr>
<td>SY114-27</td>
<td>Data Display Fields</td>
<td>14-26</td>
</tr>
<tr>
<td>SY114-28</td>
<td>Active Waypoint-Magenta</td>
<td>14-26</td>
</tr>
<tr>
<td>SY114-29</td>
<td>Cyan Inactive Route</td>
<td>14-27</td>
</tr>
<tr>
<td>SY114-30</td>
<td>ERASE</td>
<td>14-27</td>
</tr>
<tr>
<td>SY114-31</td>
<td>Downselect to Scratchpad</td>
<td>14-28</td>
</tr>
<tr>
<td>SY114-32</td>
<td>Upselect From Scratchpad</td>
<td>14-29</td>
</tr>
<tr>
<td>SY114-33</td>
<td>Downselect Highlighted Data</td>
<td>14-29</td>
</tr>
<tr>
<td>SY114-34</td>
<td>Other Waypoint Lists</td>
<td>14-30</td>
</tr>
<tr>
<td>SY114-35</td>
<td>Access the MFD Menu</td>
<td>14-30</td>
</tr>
<tr>
<td>SY114-36</td>
<td>MFD MENU 1/2 Page</td>
<td>14-31</td>
</tr>
<tr>
<td>SY114-37</td>
<td>MFD MENU 2/2 Page</td>
<td>14-31</td>
</tr>
<tr>
<td>SY114-38</td>
<td>FREQUENCY 1/4 Page</td>
<td>14-32</td>
</tr>
</tbody>
</table>
Figure SY114-39 – UHF 1/2 Page ................................................................. 14-33
Figure SY114-40 – Peer Pages ................................................................. 14-34
Figure SY114-41 – Single Page ................................................................. 14-35
Figure SY114-42 – Index Pages ................................................................. 14-35
Figure SY114-43 – NAV Display ARC MAP .............................................. 14-36
Figure SY114-44 – Sub Page ................................................................. 14-37
Figure SY114-45 – Data Prompt ................................................................. 14-37
Figure SY114-46 – FMS Top-Level Pages .................................................. 14-38
Figure SY114-47 – Frequency Page .......................................................... 14-39
Figure SY114-48 – Route Page 1 ............................................................... 14-39
Figure SY114-49 – DEP-ARR Page .......................................................... 14-41
Figure SY114-50 – LEGS Page ................................................................. 14-41
Figure SY114-51 – HOLD Page ................................................................. 14-42
Figure SY114-52 – INIT REF Page .......................................................... 14-43
Figure SY114-53 – PROG Page ................................................................. 14-43
Figure SY114-54 – FIX Page ................................................................. 14-44
Figure SY114-55 – Nearest Page ............................................................... 14-45
Figure SY114-56 – Nearest Airport Page .................................................. 14-46
Figure SY114-57 – Nearest VHF NAV Page .............................................. 14-46
OVERVIEW
The FMS CAI lesson discusses the operation of the T-6B Flight Management System. This lesson is designed to provide you with an understanding of basic operation and interpretation of this system so it can be used effectively in-flight. You may want to review this lesson again when you progress into instrument and navigation training.

REFERENCES
Personnel: None
Media Facilities: Student CAI Workstation
Support Resources: T-6B Flight Manual; T-6B Systems 1 Student Guide

STUDENT ASSIGNMENTS
Read applicable portions of T-6B Flight Manual, Section I.
Complete CAI lesson SY114, following along with this student guide.
Complete the practice questions provided.

LESSON OUTLINE
Topics in this lesson must be taken in sequential order. All topics must be completed prior to attempting the end of lesson quiz. The estimated time required to complete this lesson is 1.0 hour.
Introduction

FMS

FMS Basics

<table>
<thead>
<tr>
<th>Task ID</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.22.23b.0.1</td>
<td>Identify purpose of flight management system (FMS)/GPS system</td>
</tr>
<tr>
<td>1.22.23b.0.2</td>
<td>Describe flight management system (FMS)/GPS system operating principles</td>
</tr>
<tr>
<td>1.22.23b.0.3</td>
<td>Identify flight management system (FMS)/GPS system components</td>
</tr>
<tr>
<td>1.22.23b.0.4</td>
<td>Match flight management system (FMS)/GPS system components to functions</td>
</tr>
<tr>
<td>1.22.23b.0.7</td>
<td>Locate flight management system (FMS)/GPS system components</td>
</tr>
</tbody>
</table>

FMS Introduction

The CMA-9100 Flight Management System (FMS) installed in the T-6B is a navigation computer system that integrates and manages these primary functions:

- Flight plan storage and management
- Global Positioning System (GPS) position determination
- Area Navigation (RNAV) solutions for en-route, terminal, and approach operations
- Communication and navigation radio tuning management

Figure SY114-1 – NAV Display With FMS Selected
GPS may be also referred to as Global Navigation Satellite System (GNSS). We'll limit the terminology to GPS for this lesson.

FMS Overview

The FMS provides the capability to create, manage, and view flight plans and routes. A controlled-subscription navigation database stored in FMS non-volatile memory contains most of the information that appears on the navigation charts. This includes extensive searchable information on waypoints, navaids, airports, and existing routes such as departures, approaches, hold patterns, special operations areas, and remain-within boundaries. Once loaded into the FMS, the navigation database is read-only. The navigation database is loaded using a data loader.
A separate user database stores user-defined waypoint and route data. A frequency database stores communication and navigation radio frequency presets and channel assignments; however, the FMS is not configured to autotune the frequencies. Frequency/channel tuning must be user-initiated. Both the user database and the frequency database accept data from the data loader and both can be updated directly on the FMS.

Complete pre-programmed flight plans and routes can be loaded into the databases, and new flight plans and routes can be built from scratch using the stored data. These flight plans and routes can be accessed, viewed, and modified as needed during flight planning and in flight.

FMS Capabilities

FMS capabilities include:

- Standard Instrument Departure (SID)
- Standard Terminal Arrival Routes (STAR)
- GPS instrument approaches
Direct-to/intercept navigation, holding patterns, procedure turns, arcs, and offset tracks

Automatic waypoint sequencing, with and without turn anticipation

Required and Actual Navigation Performance (RNP/ANP)

Required Time of Arrival (RTA)

Required Time Enroute (RTE)
FMS Components

The FMS core unit is a circuit-card assembly that integrates functional components, programming, and memory for both FMS and GPS. There are two identical FMS/GPS core units, one in each Integrated Avionics Computer (IAC).

IAC 1 provides the FMS for the forward cockpit and IAC 2 provides the FMS for the aft cockpit. Recall that either IAC can support both cockpits if required.

Each FMS interfaces with the communication and navigation radio systems and with external sensors via the host IAC.

Unless otherwise stated, FMS represents FMS/GPS throughout this lesson.

FMS User Interface

FMS system operation is accomplished using the

Navigation (NAV) display

Primary Flight display (PFD)

FMS pages (alphanumeric FMS data displays)
Position and Tracking

The FMS determines aircraft position by combining GPS position data, Inertial Reference System (IRS) heading data, and Air Data Computer (ADC) true airspeed and altitude reference data. GPS is the primary navigation position reference.

Because FMS-derived position is not dependent on ground-based nav aids, FMS navigation is usable in remote areas.

The FMS uses aircraft position to continuously track, update, and project flight progress. Using a programmed flight plan, the FMS sequentially plots the desired track from waypoint to waypoint and automatically updates required navigation parameters as the flight progresses.

Figure SY114-4 – FMS Progress Page
FMS on NAV and PFD

| 1.22.23b.0.8 | Interpret flight management system (FMS)/GPS instrument displays |

NAV Display FMS Data

When the navigation source is FMS, the NAV display provides a map-like representation of the active FMS flight plan and provides alphanumeric waypoint and track data.

There are three different NAV display format options.

- Rose map
- Arc map
- Rose plan

Rose map and arc map may be referred to as map displays.

Rose plan may be referred to as the plan display.

Figure SY114-5 – NAV Display FMS Data
NAV Display FMS Symbols

The active flight plan route is shown as a series of waypoints connected by legs. A star with a label is a waypoint. A solid straight line is a leg. A curved leg is displayed as a series of short straight lines joined together in a "connect-the-dot" manner.

The aircraft symbol represents current aircraft position. On the map displays, the wing-fuselage cross point is the center of the compass rose. On the plan display, the selected waypoint is at rose center and the aircraft symbol position is relative to the selected waypoint.

The current leg is the active leg. The next waypoint on the active leg is the active waypoint. When the navigation source is FMS, the active leg and active waypoint are magenta. All other waypoints and legs are white.

Figure SY114-6 – NAV Display FMS Symbols
Rose Map and Arc Map

The map displays are primarily used for following flight progress and for navigation orientation. The aircraft symbol is fixed in the center of the compass rose and always points to the heading pointer at the top of the rose. As the flight progresses the rose rotates as heading changes and the FMS symbology moves in relation to aircraft position.

Arc map is nearly identical to rose map. The main difference is that route data does not appear behind the aircraft. The advantage of this display is that the "magnified" 90° arc expands the map scale of the area ahead of the aircraft. This is useful when the area is cluttered.

Notice that the display range (RNG) does not change when changing between NAV displays. Range is changed separately.
Rose Plan Display

The third NAV display is rose plan.

The active waypoint appears in the center of the rose. The plan display is used to review the flight plan, waypoint by waypoint, using the PREV and NEXT keys to step through the programmed route one waypoint at a time. This mirrors the waypoints on the FMS ROUTE page, seen later in the lesson.

The plan display deletes most map data. The compass rose is fixed at True North (NT) top and does not rotate as aircraft heading changes.

The aircraft symbol is positioned at the appropriate bearing and distance from the selected waypoint and rotates as heading changes so that it always points to aircraft heading. If off-scale, the symbol maintains the correct bearing and heading and appears at rose edge.

Figure SY114-9 – Rose Plan Display
Active Waypoint Data

Active waypoint information appears at the top of the map displays. As previously seen, magenta labels indicate active FMS data. The data parameters are:

- **WPT** - Active waypoint identifier label
- **DIST** - Distance-to-go to the active waypoint
- **TTG** - Time-to-go to the active waypoint
- **ETA** - Estimated time of arrival at the active waypoint

DIST, TTG, and ETA continuously change as the flight progresses.

When the aircraft passes the current active waypoint, the next leg becomes the active leg and the next waypoint becomes the active waypoint. When this occurs, the FMS transitions all active waypoint indications and data to the new active leg and new active waypoint.
ICAO Symbols

Off-route waypoints may also appear on the map displays. These waypoints can include user-defined waypoints and ICAO waypoints.

This chart shows International Civil Aviation Organization (ICAO) waypoint symbols that may be displayed. Note that these symbols are the same as on the navigation charts.

Up to 10 ICAO waypoint symbols can be displayed at a time. If more than 10 ICAO waypoints are within the current display range, the 10 nearest to the aircraft will be displayed. These are displayed at the appropriate bearing and distance from the aircraft symbol based on the selected display range and the current aircraft heading.

A user-defined waypoint is displayed as a standard waypoint symbol.
PFD FMS Data

Active leg, active waypoint, and FMS phase-of-flight data are displayed in magenta on the PFD when FMS is the navigation source.

The data block below PFD SOURCE shows:

- Active leg desired track (DTK) in degrees
- Active waypoint identifier (in reverse video)
- Distance to the active waypoint.

DTK is the FMS-computed course (leg) to a waypoint.

DTK deviation is represented by the course deviation indicator (CDI) and CDI scale.

The current phase of flight is shown by a magenta label. The three phases of flight are enroute (ENR), terminal (TRM), and approach (APR).

The magenta heading bug and heading bug data block are not related to the FMS data.
FMS Management

| 1.22.23b.0.2 | Describe flight management system (FMS)/GPS system operating principles |
| 1.22.23b.0.4 | Match flight management system (FMS)/GPS system components to functions |
| 1.22.23b.0.8 | Interpret flight management system (FMS)/GPS instrument displays |

UFCP and FMS Pages

FMS data and system management is accomplished using the Up Front Control Panel (UFCP) and FMS pages.

UFCP FMS Functions

The UFCP provides the primary means for manually entering and editing FMS data. FMS functions of the UFCP include:

- Making navigation waypoint entries
- FMS display control functions
- Selecting stored waypoints
- Communication and navigation system selection and tuning
- FMS data entered on the UFCP is sent to the associated IAC.

Figure SY114-14 – UFCP and FMS Pages

Figure SY114-15 – UFCP FMS Functions
FMS Data Modification

Two methods are used to modify FMS data.

Use the UFCP to enter data into the scratchpad and then upselect the scratchpad data to an FMS page.

Downselect (copy) field data from an FMS page to the scratchpad and then upselect the copied data to an FMS page.

We’ll show how to downselect and upselect FMS page data later in the lesson.

FMS Pages

An FMS page is an alphanumeric display which provides an organized set of data that is specific to a function or closely-related group of functions.

FMS pages provide the means to manage flight plans, FMS control functions, database entries, and communication, navigation, and display systems settings and status.

FMS page data comes from FMS databases, computations, and system interfaces, and from the scratchpad.

Figure SY114-16 – FMS Data Modification

Figure SY114-17 – FMS Pages
SY0114
FLIGHT MANAGEMENT SYSTEM (FMS)

In case of UFCP failure, some FMS pages provide limited back-up data entry functions for redundancy.

Basic Page Conventions

There are dozens of different FMS pages. To look at each one would require several lessons. For now, we will focus on these items:

- Basic functionality
- Data fields
- Page layout
- Font size and color
- Usage conventions
- Page access
- Page hierarchy

Figure SY114-18 – Basic FMS Pages
Basic Page Functionality

FMS management functionality depends on the ability to navigate to FMS pages and examine and manipulate the data on the pages.

The FMS generates the page data and assigns different functions on each page to the adjacent LSKs (soft keys). These "soft keys" provide the capability to execute functions and manipulate data.

For example, this page displays user-controllable functions associated with the UHF radio. Using the appropriate LSKs, you can change a frequency, set TONE, and set SQUELCH.

Downselect and Upselect

As previously stated, you can manipulate FMS data by downselecting (copying) field data to the scratchpad and then upselecting the copied data to another field.

Copying does not erase the data. The data remains in the field until erased or overwritten.

Figure SY114-19 – Basic Page Functionality

Figure SY114-20 – FMS Copying Data
You can upselect the scratchpad data to another field on the same page or navigate to another page and upselect the data there.

Scratchpad data does not erase or change when navigating between pages or displays.

We'll work through this example later in the lesson.

FMS Page General Layout

Let's look at the basic FMS page layout.

FMS page data is arranged into 14 rows with up to 24 characters per row.

Row 1 is reserved for the page title, page number, and prefixes (if present). FMS page titles are always cyan.

Rows 2 through 13 contain the working data.

Row 14 is reserved for the scratchpad.

The top row appears on all MFD displays (PFD, EICAS, NAV, STS/BIT, MENU, and FMS). Except for specific advisory messages, this row is not unique to FMS data.

Figure SY114-21 – FMS General Layout
Likewise, when present, the functions in the bottom row are not unique to FMS data.

Field Types

FMS pages include several field types which provide most of the FMS system functionality. The standard field types are

Data display fields (can be copied but not edited)

Data entry fields (can be copied and edited)

Option selection fields (selects available options)

Function activation fields (performs listed function)

Boxes in data entry field indicate required data needed

Dashed lines in data entry field indicate optional data entry

Page navigation fields (page prompts)

Figure SY114-22 – Field Types
Text Size Conventions

FMS page text appears in large, medium, and small font.

Small font is reserved for data units (NM, TTG, KT, GMT, DTG, ETA, ETE, etc.).

Medium font displays computed or system generated data, retrieved data, and field labels.

Large font displays page titles, page prompts, function activation fields, navigation fields, user-entered data (from scratchpad), and scratchpad content.

Color Conventions - Green

Green is used on the LEGS pages for

- Waypoint identifiers
- Option selection field titles
- Option prompts
- Data display field titles
Color Conventions - White

White applies to:
- Standardized messages
- Computed data and units
- Scratchpad
- Data entry field highlight (cursor)
- Data field
- Data field description
- Slashed data field

Slashed data field:
Data fields are justified adjacent to the associated LSKs. On condition, some data fields contain two items separated by a slash.

Data appears in medium font if automatically entered by the FMS and in large font if user-entered.

Data Display Fields:
Data Display fields contain actual performance or status information.
While data display fields are not user-editable, this data is usually available for downselection to the scratchpad.

Attempted data entry into one of these fields will result in a data entry error message in the scratchpad.

Active Waypoint

Magenta in inverse video identifies the active TO waypoint on ACT RTE LEGS 1/X, and PROGRESS pages.

Figure SY114-27 – Data Display Fields

Figure SY114-28 – Active Waypoint-Magenta
Cyan - Inactive Route

When an inactive route is selected, the ACT prefix is not present in the page title and all data appears in cyan.

Figure SY114-29 – Cyan Inactive Route

ERASE

During a route modification (MOD), green inverse video highlights the ERASE function on the ROUTE (RTE) and LEGS pages.

ERASE is an activation field that acts like "undo." Pressing the ERASE soft key before a MOD is executed removes any changes or insertions and returns the page to the previous condition.

Keep in mind that ERASE cannot undo a modification after the MOD has been executed.

Figure SY114-30 – ERASE
If you want to return to the previous condition after MOD execution, you will have to create and execute another route modification.

Downselect to Scratchpad

When the scratchpad is empty, pressing an LSK adjacent to a waypoint identifier downselects the identifier to the scratchpad. This function applies whether the identifier is white or green.

Let's use a route discontinuity example.

Recall that you can also use the UFCP to enter the desired waypoint identifier into the scratchpad.

Upselect From Scratchpad

Open boxes in a data field indicate that a data entry is required before the MOD can be executed. While required entry boxes are green on the RTE and LEGS pages, they are white on other pages.

With properly-formatted data in the scratchpad, pressing the LSK adjacent to a data entry field upselects the scratchpad data to that field.
Notice that the remaining legs in the flight plan (ACGET, HADKI, WAXEL) shifted up a row in sequence.

This "copy and paste" process works on all waypoint and data entry fields. This is generally faster and easier than using the UFCP to insert the same information.

Let's look at another example.

Downselect Highlighted Data

Waypoint identifiers include airports and navaids.

This example shows a NEAREST AIRPORT list. The first identifier is automatically highlighted when the page is first accessed. Pressing the LSK adjacent to a highlighted identifier downselects the identifier to the scratchpad.

If you want a different airport identifier, clear the scratchpad, find the desired identifier, then press the adjacent LSK. This will highlight the new identifier and downselect it to the scratchpad.
Other Waypoint Lists

This example shows NEAREST VHF NAV (navaids location) data retrieved from the databases. Notice that the second identifier on the list has been selected and downloaded to the scratchpad.

The FMS also generates pages for user waypoints (USER WPTS) and custom waypoints (CUSTOM WPTS) where you can downselect and upselect waypoints.

A waypoint identifier can be downselected from any page where the identifier is displayed adjacent to an LSK.

Access the MFD Menu

Anytime that MENU appears at the bottom edge of the display heading box below LSK UL, pressing the LSK takes you directly to the MFD MENU.

The MFD MENU lists the top-level FMS pages.

Let's take a look the menu functions.

Figure SY114-34 – Other Waypoint Lists

Figure SY114-35 – Access the MFD Menu
NEXT Function

There are two MFD MENU pages: MFD MENU 1/2 and MFD MENU 2/2.

Navigation back and forth between these pages is accomplished using the previous (PREV) and NEXT soft keys.

This is the MFD 2/2 page.

PREV Function

The PREV and NEXT page functions work the same way.

Figure SY114-36 – MFD MENU 1/2 Page

Figure SY114-37 – MFD MENU 2/2 Page
on any page where they appear.

Page Prompts 1

Pressing an LSK adjacent to an FMS page prompt provides direct access to that page. An FMS page prompt is a cyan label with a cyan arrowhead. The arrowhead indicates that the selection is enabled. The page is not selectable if the arrowhead is not present.

White-labeled prompts are display formats. Only prompts with a chevron can be selected. If the chevron is missing, the prompt is not enabled and the display is not available in the current system configuration.

Selecting an FMS page prompt or a display prompt changes the current display to the selected FMS page or display format.

Notice that this FMS page also includes enabled page prompts. Let's look at this next.
Page Prompts 2

FMS page prompts on an FMS page work exactly the same way as they do on the MFD MENU.

Where provided, this functionality lets you access one FMS page directly from another FMS page without the need to go through the MFD MENU.

Return to MFD Menu

Keep in mind that if you get lost, you can always return to the MFD MENU and start from there.

As you can see, the techniques used to access the FMS pages and navigate between these pages are relatively straightforward.
Peer Pages

Peer pages exist when the FMS or display system assigns more than one page to a title or when differently-named pages are grouped by related functions. "X/X" indicates the number of pages in a set. For example, 1/13 shows that there are 13 pages in this set, numbered successively as 1/13, 2/13, 3/13, and so on.

The number of peer pages may be fixed or conditional. For example, MFD MENU always has two pages while other sets have as many pages as needed to accommodate the data.

The first page (1/X) in a set is the main page. The main page appears when a peer page set is accessed by a page prompt. Navigation between peer pages is accomplished using the PREV and NEXT soft keys.

Figure SY114-40 – Peer Pages
Single Page

If 1/1 follows a page title, only one page exists. A single page is always a main page.

In some examples, such as the one shown here, there will never be more than one page.

In other examples, current conditions provide only enough information to fill one page but the FMS may assign more pages as conditions change.

The PREV and NEXT soft key functions do not appear whenever there is only a single page.

Index Pages

FMS index pages are lists of FMS page prompts. The exact selections available on the index pages are conditional.

For example, DEP/ARR INDEX selections depend on the departure and arrival airports on the flight plans.

INIT REF INDEX page selections and options depend on whether the aircraft is on the ground or in flight.

NAV STATUS INDEX options depend on equipment configuration.
In the NEAREST index, you can specify the runway minimum length and runway surface conditions that the FMS will use when retrieving page data from the databases.

**NAV Display Page Prompts**

The NAV display includes direct access page prompts (shortcuts) for the FMS pages most commonly used during flight. These are:

- NRST - NEAREST 1/1
- LEGS - RTE x LEGS 1/X
- ROUTE - RTE 1/X
- DEP/ARR - DEP/ARR INDEX 1/1

The prompts are the same on both the ROSE MAP and ARC MAP displays when FMS is the PFD SOURCE. NRST (LSK L1) is presented on ROSE MAP and ARC MAP regardless of PFD SOURCE.

Figure SY114-43 – NAV Display ARC MAP
Sub Page

When accessed directly from the NAV display, an FMS page becomes a sub-page of the NAV display. Another way to view this is that the NAV display is the parent and the sub-page is the child.

In this situation, the display heading and prompt below LSK UL change from FMS/MENU to NAV and the box changes from solid to dashed. This indicates that pressing the NAV prompt soft key (LSK UL) bypasses the MFD MENU and returns you directly back to the parent display.

DATA Prompt

The DATA prompt accompanied by an outward-pointing arrow indicates a shortcut to the selective map display declutter DATA page.

Notice that this prompt is white, not cyan. This indicates that the DATA page is not an FMS page.

This page provides declutter options for the NAV display. Since this is a display page, not an FMS page, the page name is white. Also note that this is a sub-page.
While this page allows you to selectively turn FMS-generated data ON and OFF on the NAV display, use of these options has no effect on the data in the FMS databases.

FMS Page Overview

1.22.23b.0.2 Describe flight management system (FMS)/GPS system operating principles
1.22.23b.0.8 Interpret flight management system (FMS)/GPS system displays

Top Level Page Overview

The sheer number of FMS pages and page access combinations can be overwhelming.

As you gain experience, you will learn many "tricks" and shortcuts to learning your way around these pages. For now, keep in mind that almost all page access paths wind through the top level pages at some point. If you get lost trying to find a particular page, starting at the top level pages provides a logical starting point.

As you have seen, some top-level pages are accessible directly from the NAV display. If the page you want can't be reached from here, go to the MFD MENU.

Recall that all FMS top-level pages are listed on the MFD MENU.
FREQ Page

Let's look at each of the top-level pages to get an idea of the scope of the FMS capabilities.

Unless otherwise stated, assume that these pages are accessed directly using the FMS page prompts on the MFD MENU.

The FREQUENCY (FREQ) page provides access to communication and navigation radio tuning, frequency management, and testing.

Distance Measuring Equipment (DME) system and ATC transponder system management and testing are also included.

ROUTE Page 1

The ROUTE page prompt selects the active ROUTE (RTE) 1/X page. The page has an ACT prefix when the route is active.

RTE pages provide the primary means for managing FMS routes. These pages are used to search for pre-programmed routes, select a route and make it the active route, modify routes, build a new route, and other related functions. Page 1/1 data includes...
<table>
<thead>
<tr>
<th>Origin and destination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flight number (optional)</td>
</tr>
<tr>
<td>Route name (if loaded)</td>
</tr>
</tbody>
</table>

**Selectable pre-programmed routes stored in CO ROUTES and USER ROUTES**

| OFFSET value |

**ROUTE Page 2**

Route page 2/X and subsequent pages (if any) include the route procedures and the list of jet routes, airways, applicable airway intersections, and route turnpoints from the flightplan.
DEP-ARR Page

The departure/arrival (DEP/ARR) page prompt accesses the DEP/ARR INDEX 1/1 page.

This page provides access to departure and arrival information for the origin and destination airports listed in the FMS flight plans for both route 1 (RTE1) and RTE 2.

The selected airport ID becomes part of the FMS page name. The arrivals and departures pages are nearly identical except that the departure page lists SIDS and the arrivals page lists STARS and available approaches.

Note that these identifiers are all data fields. Pressing the LSK adjacent to any identifier downselects the identifier to the scratchpad.

LEGs Page

The LEGS page prompt selects the active route LEGS page, ACT RTE LEGS 1 (or 2) 1/X.

ACT RTE x LEGS pages provide the primary means to display and modify the active flight plan.

Waypoints can be created, inserted, and deleted.
A holding pattern can be defined on any waypoint.

Waypoints can be converted from fly-by (with turn anticipation) to fly-over (with no turn anticipation).

These pages have numerous format options depending on the function being performed.

Recall that the waypoint list can be reviewed graphically using the NAV display ROSE PLAN option.

HOLD Page

This page is used to review and/or revise the details of either an existing or proposed holding pattern.

A manually exited holding pattern can be defined by the pilot.

A holding pattern termination at an altitude or after one full circuit is the result of the departure/arrival procedures in the database.

Figure SY114-51 – HOLD Page
INIT REF Page

The INIT REF page prompt selects the INIT REF INDEX 1/2 page. FMS 1 (or 2) is determined by the FMS currently associated with the cockpit position.

As you can see the entire contents of this page is a list of FMS page prompts.

As mentioned earlier in the lesson, the exact listings on these pages are conditional on current conditions and configuration.

PROG Page

The PROG page prompt selects the active (ACT) PROGRESS 1/X page.

The PROGRESS pages allow you to monitor current dynamic data along the active route.

Two display formats are possible: ETA and ETE. The default is ETA as determined by the "LEGS ETA" prompt on the active LEGS pages. If ETA appears, pressing LSK R1 changes the format to ETE and changes the "LEGS ETA" prompt on the LEGS page to "LEGS ETE."
If the PROGRESS page is accessed with "LEGs ETE" on the active LEGS page, the LEGS ETE format appears.

**FIX Page**

The FIX page prompt selects the active FIX INFO 1/1 page.

The FIX page provides bearing or course and distance information relative to an entered FIX. Distance-to-go (DTG) and ETA are displayed for radial, distance and abeam intersections.

The FIX entry must be a valid waypoint or navaid in the databases or in the active route. Radial/Distance (RAD/DIS) entries can be radials or distances from the entered FIX.

Radial or distance or abeam intersection data may be entered as waypoints in the route by downselecting into the scratchpad and transferring to the RTE LEGS 1/X page.

**NRST Page**

While not on the MFD MENU, the NEAREST index page is frequently used. Recall that this page is accessible from the NAV display.
This index lists pages that contain categorized navigation data. Accessing a NEAREST page commands the FMS to generate a sorted list on the selected page. The list is ordered by proximity to the center reference identifier. The center reference identifier may be a waypoint or aircraft present position (PPOS). PPOS is the default.

RUNWAY MIN LENGTH defines the minimum runway length required for inclusion in the nearest airport list. The default is 5,000 ft.

RUNWAY SURFACE options are HARD_SOFT (default) and HARD. HARD_SOFT selects both hard and soft runway types meeting the runway length criteria to appear in the nearest airport list. HARD selects only hard surfaces meeting the runway length criteria to appear in the nearest airport list.

NEAREST AIRPORT Page

Let's look at NEAREST AIRPORT.

Airports that meet the FMS search criteria are listed, with up to 50 airports within a radius of 640 NM from the center reference identifier. The nearest airport is at the top with the rest sorted in order by distance.
The first airport identifier (ID) is highlighted. Pressing the adjacent LSK places the highlighted ID in the scratchpad. Selecting a different airport ID moves the highlight to that ID and replaces the airport ID in the scratchpad.

The center reference identifier (REF ID) is adjacent to LSK R5. Pressing LSK R5 replaces the REF ID with a valid entry from the scratchpad. Valid entries are PPOS or a waypoint ID from the FMS databases. Changing the REF ID reorders the list.

NEAREST VHF NAV Page

Now let's look at NEAREST NAV.

NEAREST VHF NAV page criteria is the same as NEAREST AIRPORT page criteria except that navigation aids (NAVAIDS) are listed instead of airports.

Figure SY114-56 – Nearest Airport Page

Figure SY114-57 – Nearest VHF NAV Page
Summary

This lesson has presented only the very basic operations of the FMS.

As you can see by looking at the numerous pages and the features available on these pages, there is a considerable amount of flight data and many functions available to you. You will learn many of these more advanced functions as you progress to actual navigation lessons.

Lesson Review Quiz
LESSON QUESTIONS

EMBEDDED QUESTIONS (Ref: Segment/Topic/Question)

1. The core GPS/FMS unit is located in the ______. (B/1/1)
   a. Integrated Avionics Computer (IAC)
   b. Up Front Control Panel (UFCP)
   c. left Multifunction Display (MFD)
   d. Head Up Display (HUD)

2. The FMS uses the _____ as the primary position-determining reference. (B/1/2)
   a. Air Data Computer (ADC)
   b. Inertial Reference System (IRS)
   c. Global Positioning System (GPS)
   d. magnetic sensor unit in the right wing

3. The FMS in the T-6B is configured to automatically tune the appropriate navigation aid (NAVAID) radio as the flight progresses. (B/1/3)
   a. True
   b. False

4. Which display provides the ability to review the flight plan waypoint by waypoint. (B/2/1)
   a. ARC MAP configuration on the NAV display b. ROSE MAP configuration on the NAV display c. ROSE PLAN configuration on the NAV display
d. Horizontal Situation Indicator (HSI) on the Primary Flight Display (PFD)

6. On the map displays, the _____ represents the aircraft position in the center of the compass rose. (B/2/2)
   a. center of the active waypoint symbol
   b. tip of the nose of the aircraft symbol
c. tail-fuselage cross-point on the aircraft symbol
d. wing-fuselage cross-point on the aircraft symbol
7. On the NAV display, the active waypoint is displayed in ______ when the navigation source is FMS. (B/2/3)
   a. magenta
   b. green
   c. white
   d. cyan

8. When you downselect (copy) a waypoint from a data field to the scratchpad, the ______. (B/3/1)
   a. FMS deletes the field and the remaining waypoints resequence their positions on the page
   b. copied waypoint identifier turns from normal video to inverse video
   c. FMS deletes the waypoint from the copied field
   d. copied waypoint remains in the data field

9. FMS page titles are always displayed in ______. (B/3/2)
   a. cyan
   b. white
   c. green
   d. magenta

10. The ERASE activation field is used to______. (B/3/3)
    a. clear the scratchpad
    b. delete a flight plan from the user database
    c. "undo" a modification (MOD) after executing a MOD
    d. "undo" a modification (MOD) prior to executing the MOD
11. How do you downselect a waypoint to the scratchpad? (B/3/4)
   a. Turn the data entry knob on the UFCP until the desired waypoint appears.
   b. Press the PREV LSK until the desired waypoint appears in the scratchpad.
   c. Press the NEXT LSK until the desired waypoint appears in the scratchpad.
   d. Press the LSK adjacent to the desired waypoint.

12. Which of these FMS pages is NOT directly accessible from the NAV display? (B/3/5)
   a. INIT REF
   b. DEP/ARR
   c. ROUTE
   d. LEGS
13. Which of these pages consists entirely of FMS page prompts? (B/4/1)
   a. LEGS  
   b. PROG  
   c. ROUTE  
   d. INIT/REF

14. Which of these FMS pages provides the waypoint list information that can also be viewed on the NAV display ROSE PLAN format? (B/4/2)
   a. INIT REF  
   b. DEP/ARR  
   c. ROUTE  
   d. LEGS
15. With the PROGRESS page as shown, pressing LSK _____ changes the page from the ETA format to the ETE format. (B/4/3)
   a. LL
   b. LR
   c. R1
   d. UL

16. Which of these FMS pages is not listed on the MFD MENU? (B/4/4)
   a. FIX
   b. HOLD
   c. NRST
   d. PROG
LESSON QUIZ QUESTIONS

1. Read-only navigation chart information is stored in the Flight Management System (FMS) ______ database.
   a. user
   b. frequency
   c. navigation
   d. inertial reference system (IRS)

2. The Flight Management System (FMS) determines aircraft position by combining data from ______.
   a. Global Positioning System (GPS), VHF Navigation (VOR), and Distance Measuring Equipment (DME)
   b. GPS, Inertial Reference System (IRS), and Air Data Computer (ADC) true airspeed and altitude
   c. GPS, IRS, and the magnetic sensor in the right wing
   d. GPS, IRS, and VOR

3. As shown on this display, the aircraft is ______ nm from the active waypoint.
   a. 2.32
   b. 3.0
   c. 5
   d. 33
4. As shown on this display, what is the Flight Management System (FMS) current phase of flight?
   a. Enroute
   b. Terminal
   c. Approach
   d. Cannot be determined from this display

5. Flight Management System (FMS) data and management functions are controlled using the ________.
   a. Up Front Control Panel (UFCP) and Multifunction Display (MFD) FMS pages
   b. MFD FMS pages and Primary Flight Display (PFD) prompts
   c. Head Up Display (HUD) and UFCP
   d. MFD FMS pages and HUD
6. As shown on this display, which Line Select Key (LSK) would you press to upselect the waypoint in the scratchpad to the required entry prompts?
   a. L2
   b. L3
   c. R2
   d. R3

7. The waypoint identifier "OS" is _____.
   a. an invalid waypoint not stored in the databases
   b. selected for deletion
   c. an inactive waypoint
   d. the active waypoint
8. As shown on this display, which Line Select Key (LSK) would you press to change the display to the MFD MENU?
   a. UL
   b. L5
   c. L6
   d. R6

9. What is the primary page used to display and modify the flight plan?
   a. FIX
   b. LEGS
   c. PROG
   d. INIT REF

10. Which page provides access to communication and navigation radio system management?
    e. INIT REF
    f. HOLD
    g. FREQ
    h. FIX
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>TABLE OF CONTENTS</td>
<td>15-1</td>
</tr>
<tr>
<td>LIST OF FIGURES</td>
<td>15-3</td>
</tr>
<tr>
<td>OVERVIEW</td>
<td>15-4</td>
</tr>
<tr>
<td>REFERENCES</td>
<td>15-4</td>
</tr>
<tr>
<td>STUDENT ASSIGNMENTS</td>
<td>15-4</td>
</tr>
<tr>
<td>LESSON OUTLINE</td>
<td>15-4</td>
</tr>
<tr>
<td>INTRODUCTION</td>
<td>15-5</td>
</tr>
<tr>
<td>FLIGHT INSTRUMENTS</td>
<td>15-5</td>
</tr>
<tr>
<td>INTEGRATED AVIONICS SYSTEM</td>
<td>15-5</td>
</tr>
<tr>
<td>PRIMARY FLIGHT DISPLAY (PFD)</td>
<td>15-5</td>
</tr>
<tr>
<td>BACKUP FLIGHT INSTRUMENT</td>
<td>15-5</td>
</tr>
<tr>
<td>SYSTEMS INSTRUMENTATION</td>
<td>15-5</td>
</tr>
<tr>
<td>COMMUNICATION SYSTEMS</td>
<td>15-6</td>
</tr>
<tr>
<td>UHF/VHF RADIOS</td>
<td>15-6</td>
</tr>
<tr>
<td>ICS AND AUDIO CONTROL PANEL</td>
<td>15-6</td>
</tr>
<tr>
<td>RMU</td>
<td>15-6</td>
</tr>
<tr>
<td>NAVIGATION SYSTEMS</td>
<td>15-6</td>
</tr>
<tr>
<td>VOR/ILS/DME</td>
<td>15-6</td>
</tr>
<tr>
<td>TRANSPONDER</td>
<td>15-6</td>
</tr>
<tr>
<td>COLLISION WARNING</td>
<td>15-6</td>
</tr>
<tr>
<td>GLOBAL POSITIONING SYSTEM</td>
<td>15-6</td>
</tr>
<tr>
<td>ABNORMAL OPERATIONS</td>
<td>15-7</td>
</tr>
</tbody>
</table>
LIST OF FIGURES

Figure SY115-1 – Communications Failure Indications..............................................7
Figure SY115-2 – Audio Control Panels........................................................................8
Figure SY115-3 – Navigation System Failures.................................................................8
Figure SY115-4 – FMS Failure Indications....................................................................9
Figure SY115-5 – UFCP Transponder Failure Indication ..............................................9
Figure SY115-6 – EICAS Transponder Failure Indication ............................................10
Figure SY115-7 – TCAS Failure Indications..................................................................10
OVERVIEW
This lesson is designed to provide a review of the T-6B systems covered in SY107 – Up Front Control Panel, SY108 - Flight Instruments Part 1; SY109 – Flight Instruments Part 2; SY110 – Head Up Display, SY111 - Communications Systems; SY112 – Navigation Systems; and SY114– FMS. The lesson then covers characteristics of abnormal operation and failure indications for these systems.

REFERENCES
Personnel: MIL Instructor
Media Facilities: MIL Equipped Classroom
Support Resources: T-6B Flight Manual; T-6B Systems 2 Student Guide

STUDENT ASSIGNMENTS
Review SY107, SY108, SY109, SY110, SY111, SY112, and SY114 student guides.
Read T-6B Flight Manual, Section I.
Complete lesson review questions for SY115.

LESSON OUTLINE
This lesson provides you a review of the normal operation of the T-6B flight instruments, communication systems, and navigation systems, then covers the characteristics of abnormal operation and failure indications for these systems. Topics in this lesson will be presented in sequential order. Follow along with the instructor using this student guide and the student guides provided for SY107 - SY115. The estimated time to complete this lesson is 3 hours.
Introduction

Flight Instruments

Integrated Avionics System
1.22.b1.0.2 Identify MFDU system components location and functions
1.22.29.0.1 Identify purpose of Up Front Control Panel (UFCP)
1.22.29.0.3 Identify Up Front Control Panel (UFCP) components

Primary Flight Display (PFD)
1.22.1b.0.2 Identify MFDU system components location and functions
1.22.3b.0.2 Describe PFD VSI normal operating principles
1.22.4b.0.2 Describe PFD CAS, TAS, and GS normal operating principles
1.22.6b.0.2 Describe PFD AOA normal operating principles
1.22.7b.0.2 Describe PFD accelerometer normal operating principles

Backup Flight Instrument
1.22.9b.0.2 Describe backup flight instrument operating principles (AUP aircraft only)
1.22.9b.0.6 Identify backup flight instrument operating limits (AUP aircraft only)

Systems Instrumentation
1.22.6b.0.2 Describe PFD AOA normal operating principles (AUP aircraft only)
1.22.6b.0.6 Describe PFD AOA abnormal/emergency operating principles (AUP aircraft only)
1.22.7b.0.2 Describe PFD accelerometer normal operating principles (AUP aircraft only)
1.22.8.0.2 Describe clock system operating principles
1.22.8.0.6 Identify clock system operating limits
1.22.13.0.2 Describe caution/warning system operating principles
1.22.13.0.6 Identify caution/warning system operating limits
1.22.20.0.2 Describe communication/aural warning system operating principles
1.22.20.0.6 Identify communication/aural warning system operating limits
1.22.26.0.2 Describe flight data recorder system operating principles
1.22.26.0.6 Identify flight data recorder system operating limits

For lesson topics Integrated Avionics System, Primary Flight Display (PFD), and Backup Flight Instrument, please refer to your student guide for SY107 – Flight Instruments, Part 1.

For lesson topic Systems Instrumentation, please refer to your student guide for SY108 – Flight Instruments, Part 2.
### Communication Systems

#### UHF/VHF Radios
- 1.22.14.0.2 Describe communication/UHF radio system operating principles
- 1.22.14.0.6 Identify communication/UHF radio system operating limits
- 1.22.15.0.2 Describe communication/VHF radio system operating principles
- 1.22.15.0.6 Identify communication/VHF radio system operating limits

#### ICS and Audio Control Panel
- 1.22.17.0.2 Describe communications/audio control panel system operating principles
- 1.22.17.0.6 Identify communications/audio control panel system operating limits
- 1.22.16.0.2 Describe communications/interphone system operating principles
- 1.22.16.0.6 Identify communications/interphone system operating limits
- 1.22.19.0.2 Describe communications/ground crew interphone system operating principles
- 1.22.19.0.6 Identify communications/ground crew interphone system operating limits

#### RMU
- 1.22.29.0.2 Describe up front control panel (UFCP) operating principles (AUP aircraft only)
- 1.22.29.0.6 Identify up front control panel (UFCP) operating limits (AUP aircraft only)

Fore lesson topics **UHF/VHF Radios, ICS and Audio Control Panel, and RMU**, please refer to your student guide for SY109 – Communications Systems.

### Navigation Systems

#### VOR/ILS/DME
- 1.22.21.0.2 Describe navigation/VOR/ILS system operating principles
- 1.22.21.0.6 Identify navigation/VOR/ILS system operating limits
- 1.22.22.0.2 Describe navigation/DME system operating principles
- 1.22.22.0.6 Identify navigation/DME system operating limits

#### Transponder
- 1.22.24.0.2 Describe transponder system operating principles
- 1.22.24.0.6 Identify transponder system operating limits

#### Collision Warning
- 1.22.25.0.2 Describe collision warning system operating principles
- 1.22.25.0.6 Identify collision warning system operating limits

#### Global Positioning System
- 1.22.23b.0.2 Describe flight management system (FMS)/GPS system operating principles (AUP aircraft only)
- 1.22.23b.0.6 Identify flight management system (FMS)/GPS system operating limits (AUP aircraft only)

Abnormal Operations

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.1.2.0.1</td>
<td>Describe aircraft components affected</td>
</tr>
<tr>
<td>6.1.2.0.2</td>
<td>Describe the symptoms of systems failure</td>
</tr>
<tr>
<td>1.22.14.0.9</td>
<td>Identify characteristics of abnormal operations of the communications/UHF radio system</td>
</tr>
<tr>
<td>1.22.15.0.9</td>
<td>Identify characteristics of abnormal operations of the communications/VHF radio system</td>
</tr>
<tr>
<td>1.22.16.0.8</td>
<td>Identify characteristics of abnormal operations of the communications/interphone system</td>
</tr>
<tr>
<td>1.22.21.0.9</td>
<td>Identify characteristics of abnormal operations of the navigation/VOR/ILS system</td>
</tr>
<tr>
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</tr>
<tr>
<td>1.22.23b.0.9</td>
<td>Identify characteristics of abnormal operations of the flight management system (FMS)/GPS system</td>
</tr>
<tr>
<td>1.22.24.0.9</td>
<td>Identify characteristics of abnormal operations of the transponder system</td>
</tr>
<tr>
<td>1.22.25.0.9</td>
<td>Identify characteristics of abnormal operations of the collision warning system</td>
</tr>
</tbody>
</table>

Communications Failure

UFCP blank -

Figure SY115-1 – Communications Failure Indications
ICS/Audio Failure

Inability to communicate

Lack of audio signals

Navigation System Failures Pitch

or attitude failure Glideslope

and localizer faults Invalid or

missing heading data UFCP

malfunciton

MFD unit malfunction

Overheat indications

FAN

HOT

Figure SY115-2 – Audio Control Panels

Figure SY115-3 – Navigation System Failures
FMS Failure

Self test failure

Messages

Transponder Failure

Transponder failure is indicated by:

An X in the first character position of UFCP persistent display W4.

The amber XPDR FAIL advisory on the EICAS with the associated master caution and aural tone.
Inoperative TCAS

TCAS failure is indicated by:

A red X through the TFC alert in the upper left corner of the NAV and TSD

A loss of traffic symbols on the NAV and TSD

TCAS FAIL in white letters on a red background at R2

A red X through the TFC alert in the upper left corner of the PFD

Avionics Failures
Confirm indications in both cockpits

Reference alternate data sources

Check applicable circuit breakers

Lesson Review Questions
LESSON QUESTIONS

EMBEDDED QUESTIONS (Ref: Segment/Topic/Question)

1. What information does the airspeed indicator display? (B/2/1)
2. What do white chevrons display on the ADI? (B/2/2)
3. What information is displayed by the altimeter? (B/2/3)
4. What type of heading is indicated by a ° symbol? (B/2/4)
5. What elements are displayed by the CDI? (B/2/5)
6. What items are removed from the PFD by DCLR1? (B/2/6)
7. What information is displayed by the VSI? (B/2/7)
8. How is the Backup Flight Instrument (BFI) powered? (B/3/1)
9. How is the airspeed indicator operated? (B/3/2)
10. The backup attitude indicator can be powered for a limited time in the event of a battery bus failure by what source? (B/3/3)
11. The stick shaker is activated approximately how many knots above stall speed? (B/4/1)
12. What information does the EICAS display? (B/4/2)
13. When will either the MASTER WARN or MASTER CAUTION switchlights illuminate? (B/4/3)
14. What information is shown in the AOA display? (B/4/4)
15. How can you tell if the IDARS has failed or its data is invalid? (B/5/1)
16. True or false? Both UHF and VHF systems have dedicated receivers for Guard. (C/1/1)
17. What frequencies are displayed when the Standby UHF radio is powered up? (C/1/2)
18. True or false? The UHF backup control unit will automatically activate in the event of a failure of the RMU. (C/1/3)
19. How do you turn on voice activation of the ICS? (C/2/1)
20. True or false? With the audio control panel identifier select switch in the ID position, the VHF NAV radio will receive both voice and Morse signals. (C/2/2)
21. What indication do you get on the audio control panel when the mic is keyed? (C/2/3)
22. What information is displayed on the UFCP persistent page? (C/3/1)
23. What are the steps for changing the UHF frequency using presets? (C/3/2)
24. What are the steps for making numeric frequency entries in COM1 and COM2? (C/3/3)

25. What is the UHF preset entry range available through COM1? (C/3/4)

26. True or false? The VHF Guard frequency can be set using a preset? (C/3/5)

27. What are the indications that the UFCP in the forward cockpit has failed or is no longer communicating with IAC1 or IAC2? (C/3/6)

28. What are the three types of VOR facilities? (D/1/1)

29. What information does the ILS localizer provide? (D/1/2)

30. True or false? During a localizer approach, localizer course information is displayed on both the ADI and HSI. (D/1/3)

31. What happens to DME display error at a higher aircraft altitude? (D/1/4)

32. True or false? The pilot must press the ID button on the UFCP for the transponder to reply to a Mode A interrogation signal. (D/2/1)

33. If you are on approach, when will you get a TA? (D/3/1)

34. True or false? The TCAS system installed on the T-6B provides avoidance maneuver guidance. (D/3/2)

35. How is the TCAS range selected? (D/3/3)

36. True or false? The targets displayed on this TAS display represent “other” traffic. (D/3/4)

37. Which key would you press to change your view to Rose Plan? (D/4/1)

38. Which top level FMS page is used to change UHF parameters? (D/4/2)

39. True or false? The data in the scratchpad is erased when the information is pasted into an active field. (D/4/3)

40. How many flight plans can be stored in memory? (D/4/4)

41. You notice that the EHSI course indication cannot be changed by rotating the CRS knob on the EFIS control panel. What indication on the EHSI might confirm your problem? (E/1/1)

42. True or false? The HSI at right indicates that the DME system has failed. (E/1/2)

43. A TCAS failure notification will appear on what instrument? (E/1/3)

**LESSON REVIEW QUESTIONS**

1. What are the three phases of flight when FMS is selected as the navigation source?

2. The VSI displays vertical velocity from 0 to ______ feet per minute.

3. From what component does the airspeed indicator receive its data?
4. What indication on the UFCP will alert you to a possible failure of the transponder?

5. The backup flight instruments are normally powered by the ______.

6. When showing, what does the red indication in the standby turn and bank indicator mean?

7. When should a reading be taken from the magnetic compass?

8. When does the AOA amber donut illuminate?

9. What is the purpose of the two resettable needles on the accelerometer?

10. What is the first component you should check when you suspect an avionics failure?

11. What happens anytime the FIRE warning annunciator illuminates?

12. What indications can be illuminated on the flight data recorder annunciator?

13. How are the VHF tuning functions controlled?

14. What are the four fields on the UFCP persistent page?

15. What is the purpose of the ICS KEY/MUTE button?

16. How is the range display changed on the NACWS traffic display?

17. How is the range display changed on the TCAS display?

18. Where are the VOR antennae located on the T-6B?

19. Which ILS component operates at 75 MHz and indicates your location along the approach path?

20. What is the range of the DME?

21. What should you do if the controller directs you to squawk altitude?
### APPENDIX A
### ANSWER KEY

#### A100. ANSWERS

<table>
<thead>
<tr>
<th>SY0101– Flight Controls</th>
<th>Embedded Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Elevator</td>
<td>The TAD senses torque, altitude, airspeed, and pitch rate and computes a desired rudder trim tab position.</td>
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<tr>
<td>2. True. Exhaust gases are ejected rearward providing thrust which augments that produced by the propeller.</td>
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<tr>
<td>3. The generator function of the starter/generator.</td>
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<tr>
<td>4. UFCP</td>
<td>False. The VHF system provides VOR, ILS, Localizer and glideslope capability.</td>
</tr>
<tr>
<td>5. Horizontal Situation Indicator (HSI)</td>
<td></td>
</tr>
<tr>
<td>6. The Backup Flight Instrument (BFI)</td>
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</table>

#### Lesson Review Quiz Questions

| 1. Hydraulic            | False. The auxiliary battery will power the BFI for approximately 30 minutes |
| 2. Ailerons             | 24 volt battery |
| 3. Rocket Motor         | Environment control system |
| 4. False. The canopy is hinged along the right side and opens to that side |
| 5. Up Front Control Panel (UFCP) |

The Emergency Locator Transmitter (ELT) senses impact loads and generates a signal on 121.5, 243.0 and 406.0 MHz with a unique downward sweeping audio tone.
### SY0103 – Flight Controls

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#### Lesson Review Quiz Questions

<table>
<thead>
<tr>
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</tr>
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<tbody>
<tr>
<td>2. B</td>
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<td>3. A</td>
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<tr>
<td>4. D</td>
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<td>5. D</td>
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### SY0104 – Hydraulic System 1

<table>
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<tr>
<th>Embedded Questions</th>
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<tbody>
<tr>
<td>1. B</td>
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<td>6. A</td>
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#### Lesson Review Quiz Questions

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<td>4. B</td>
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<td>6. D</td>
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### SY0105 – Hydraulic System 2

#### Embedded Questions

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<td>B</td>
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<tr>
<td>5.</td>
<td>A</td>
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<td>6.</td>
<td>B</td>
</tr>
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<td>7.</td>
<td>D</td>
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<td>C</td>
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<td>D</td>
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#### Lesson Review Quiz Questions

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### SY0106 – Systems Review 1

#### Embedded Questions

1. Longitudinal (roll)
2. 20° up and 11° down
3. Small weights are placed along the leading edge at the point where the ailerons pivot. These weights ensure the center of gravity for each aileron is at the pivot point. This is necessary because the mass of each aileron is rearward of the hinge line.
4. Provides heavier stick force when G-load is increasing; Helps prevent overstressing of aircraft frame
5. It controls the pitch angle of the aircraft around the lateral (pitch) axis.
6. Elevator trailing edge deflects downward and aircraft nose pitches down
7. It controls the aircraft’s yaw movement around the vertical (yaw) axis
8. Moves tail left and causes aircraft nose to yaw right
9. By rotating the pedal adjustment hand crank
10. The ailerons
11. The elevator/aileron trim switch located at the top of each control stick, the rudder trim switch located on the PCL in each cockpit
12. It removes power from the trim system and disengages the Trim Aid Device.
13. The green TRIM OFF and TAD OFF advisories will illuminate.
14. Through a circuit breaker placarded AIL/EL TRIM located on the battery bus circuit breaker panel in the front cockpit
15. Pitch rate, airspeed, altitude and engine torque
16. The ailerons and rudder will be in a neutral position and the elevator will be in a nose-down position.
17. Landing gear and main gear inboard doors, flaps, speed brake, nose wheel steering
18. The engine-driven pump
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<tr>
<td>19.</td>
<td>White</td>
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<tr>
<td>20.</td>
<td>The fluid level in the reservoir has dropped below one quart.</td>
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<td>21.</td>
<td>It provides a one-time lowering of the landing gear, main gear inboard doors and flaps.</td>
</tr>
<tr>
<td>22.</td>
<td>Pressure at 2880-3120 psi on the EICAS, FULL AC (accumulator charged) or FULL AD (accumulator discharged) displayed on the green indicating rod in the reservoir level window</td>
</tr>
<tr>
<td>23.</td>
<td>150 KIAS</td>
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<td>24.</td>
<td>Loss of either primary hydraulic system or battery bus power, or in the event of an engine failure</td>
</tr>
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<td>25.</td>
<td>Lower the landing gear selector handle and pull the emergency landing gear extension handle</td>
</tr>
<tr>
<td>26.</td>
<td>150 KIAS</td>
</tr>
<tr>
<td>27.</td>
<td>Yes, after the landing gear has been lowered using the emergency system.</td>
</tr>
<tr>
<td>28.</td>
<td>The speed brake allows you to decelerate. It also allows you to increase descent rate without increasing your airspeed.</td>
</tr>
<tr>
<td>29.</td>
<td>On the front cockpit generator bus circuit breaker panel</td>
</tr>
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<td>30.</td>
<td>It can result in directional control problems due to increased sensitivity.</td>
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<td>31.</td>
<td>Nose wheel steering</td>
</tr>
<tr>
<td>32.</td>
<td>Uncommanded pitch, roll or yaw movements and a sluggish response to control inputs</td>
</tr>
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<td>33.</td>
<td>Perform runaway trim checklist procedures</td>
</tr>
<tr>
<td>34.</td>
<td>Emergency landing gear and flap extension</td>
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</table>
| 35. | 1) Indicator lights  
2) Lack of noticeable drag  
3) Lack of noticeable noise  
4) AOA indexer not active  
5) Inability to turn on landing or taxi lights  
6) Tendency to roll (main gear) |
| 36. | Two green mains, two red mains, red gear handle light |
| 37. | The flaps might extend only partially and they can take longer to extend. |
| 38. | 1) Inability to maintain directional control  
2) Inability to decelerate  
3) “Spongy” or soft brake pedal  
4) The aircraft pulls to one side |

**Lesson Review Questions**

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<td>The lateral (pitch) axis</td>
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<td>2.</td>
<td>The longitudinal (roll) axis</td>
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<td>3.</td>
<td>Vertical (yaw)</td>
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<td>4.</td>
<td>the ailerons</td>
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<tr>
<td>5.</td>
<td>Engine torque, altitude, airspeed and pitch rate</td>
</tr>
<tr>
<td>6.</td>
<td>the aircraft accelerates to 80 KIAS and there is no weight on the wheels</td>
</tr>
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<td>7.</td>
<td>3000 ± 120 psi</td>
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<td>8.</td>
<td>It creates hydraulic pressure that is transferred to the primary system and to the emergency accumulator.</td>
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<td>9.</td>
<td>The landing gear, main gear inboard doors and flaps, for a one-time extension</td>
</tr>
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<td>10.</td>
<td>The main gear inboard doors</td>
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<td>11.</td>
<td>The gear doors are not closed, or the PCL is approaching IDLE with the gear handle UP.</td>
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<td>12.</td>
<td>NWS will not operate because it is serviced by the primary hydraulic system.</td>
</tr>
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</table>
13. The speed brake will not operate.
14. 150 KIAS
15. Nose wheel steering should be turned off prior to the turn since the NWS will try to limit the nose wheel castor.
16. If the emergency accumulator pressure is less than 2400 psi (plus or minus 150 psi)
17. No, the emergency system services only the landing gear, the main gear inboard doors and flaps.
18. Yes, because the wheel brake system is separate from the primary and emergency hydraulic systems.

**SY0107 – Up Front Control Panel**

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<td>12. A</td>
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<td>13. A</td>
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<tr>
<td>14. All are correct responses</td>
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<td>15. E</td>
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**Lesson Review Quiz Questions**

| 1. B               |
| 2. E               |
| 3. B               |
| 4. B               |
| 5. E               |
| 6. C               |
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| 10. D              |

**SY108- Flight Instruments 1**

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**Lesson Quiz Questions**

| 1. C               |
| 2. A               |
| 6. B               |
| 7. D               |
### SY109 – Flight Instruments 2

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**Lesson Review Quiz Questions**

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### SY110 – Head Up Display

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### SY111 – Communications Systems

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<td>A (NATOPS Note on page 3-28)</td>
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#### Lesson Review Quiz Questions

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### SY112 Navigation Systems

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### SY114 – FMS

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#### Lesson Review Quiz Questions

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### SY115 – Systems Review 2

#### Embedded Questions

1. Indicated airspeed
   - Airspeed tape
   - Digital airspeed readout
   - Airspeed bug (set using the UFCP)
   - Airspeed bug digital readout
   - Flap extension speed band
   - Mach number
   - Airspeed trend vector
2. When pitch attitude exceeds 30° nose down or 50° nose up.

3. Current barometric-corrected altitude

- Altitude scale
- Digital altitude readout
- Altitude bug
- Altitude bug setting readout
- Altimeter barometric setting

4. Magnetic

5.

- CDI Head and Tail
- Deviation bar
- Deviation scale
- TO/FROM arrow
- CDI Annunciations

6.

- Airspeed trend vector
- True airspeed
- Wind speed and direction
- Ground track pointer
- Groundspeed

7.

- Indicates climbs or descents in FPM
- Scale range 0 to ± 6000
- Digital readout range 0 to ± 9900

8.

- Battery bus (normally)
- Auxiliary battery (backup)

9. BFI airspeed indicator is powered by pitot and static pressure from the secondary pitot/static system
10. Auxiliary battery

11. 5 to 10 knots

12.
- Fuel, electrical, and environmental
- Engine performance
- Crew Alerting System (CAS)

13.
- Anytime a warning or caution annunciator illuminates in either cockpit
- The MASTER WARN switchlight will illuminate with the FIRE light.

14.
- Approach angle target range (green band from 10 to 11 units)
- Red caret at 18 units, red band above stall 18 units indicates stall
- Max endurance (white diamond caret at 8.8 units)
- AOA pointer
- Max range (white triangle caret at 4.4 units)
- AOA digital readout

15. The amber FAIL annunciator illuminates on the lower half of the FDR annunicator

16. False. Only UHF has a dedicated Guard receiver.

17. The frequencies currently entered in the system.*** Question should read backup VHF control head

18. False. The standby VHF control unit must be turned on with the PWR knob

19. Ensure the VOX button is depressed to the active position (When extended, the white lower half of the base can be seen.

20. False. Only the NAVAID recognition (Morse) signal will be selected for monitor.

21. The green lights above the respective comm controls illuminate.
## STUDENT GUIDE

### 22.
- Window 1 = COM1 - UHF
- Window 2 = COM2 - VHF
- Window 3 = VHF NAV
- Window 4 = Transponder mode and code

### 23.
- Rotate the UFCP DATA ENTRY knob to the desired preset
- Press the knob to enter the preset
  or
- Enter the desired preset using the keypad
- Press the ENT to enter the preset

### 24.
- Press the appropriate window control key to make the window active
- Enter digits using the alphanumeric keypad
  - Trailing zeros are not required
  - The decimal point is not required when followed by zeros
- Press the ENT key

### 25. 01 to 99

### 26. False. The guard frequency has to be set manually using the alphanumeric keys.

### 27. The UFCP goes blank and a yellow UFCP 1 FAIL caution advisory appears on the CAS display.

### 28.
- VOR
- VOR/DME
- VORTAC

### 29. Course guidance to runway centerline

### 30. True
### Lesson Review Questions

1. Enroute ENR, Terminal TERM, and Approach APR
2. ±6000
3. Air data computer
4. An X displays in the first character position of the UFCP persistent display in W4.
5. Battery bus
6. **DELETED QUESTION** from review
7. **DELETED QUESTION** from review
8. When you have achieved the optimum angle of attack range for landing (on-speed).
<table>
<thead>
<tr>
<th>Student Guide</th>
</tr>
</thead>
<tbody>
<tr>
<td>9. Record maximum deviation above and below +1G experienced during flight</td>
</tr>
<tr>
<td>10. Circuit breaker</td>
</tr>
<tr>
<td>11.</td>
</tr>
<tr>
<td>• MASTER WARN switchlight flashes</td>
</tr>
<tr>
<td>• MASTER WARN tone sounds</td>
</tr>
<tr>
<td>12.</td>
</tr>
<tr>
<td>• MAINT (green)</td>
</tr>
<tr>
<td>• FAIL (yellow)</td>
</tr>
<tr>
<td>13. Primarily through the UFCP</td>
</tr>
<tr>
<td>14.</td>
</tr>
<tr>
<td>• UHF comm</td>
</tr>
<tr>
<td>• VHF comm</td>
</tr>
<tr>
<td>• VHF NAV</td>
</tr>
<tr>
<td>• Transponder</td>
</tr>
<tr>
<td>15. Mutes all incoming audio while allowing inter-cockpit communication</td>
</tr>
<tr>
<td>16. DELETED QUESTION from review</td>
</tr>
<tr>
<td>17. UP/DN range LSKs on the NAV display</td>
</tr>
<tr>
<td>18. Vertical stabilizer</td>
</tr>
<tr>
<td>19. Marker beacons</td>
</tr>
<tr>
<td>20. It is reliable up to 199 miles slant range depending upon aircraft altitude.</td>
</tr>
<tr>
<td>21. Set the transponder to ALT on the UFCP and press the ID PFB.</td>
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</tbody>
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