BASICS FOR AIR TRAFFIC CONTROL – PILOT'S ENVIRONMENT

MODULE OVERVIEW

Purpose: The purpose of this module is to introduce you to the types of equipment that pilots use to navigate and physiological factors that pilots may encounter during flight.

MODULE OUTLINE

Lesson: Aircraft Instrumentation

Purpose: The purpose of this lesson is to describe how the pitot-static system and gyroscopic flight instruments are used to help pilots fly their aircraft.

Objectives:

- Define types and characteristics of pitot-static system
- Define operating principles of gyroscopic flight instruments

Topics:

- Pitot-Static System
  - Pitot-Static System Components
  - Pitot Tube
  - Static Air Vents
- Knowledge Check
- Pitot-Static System Instruments
  - Altimeter
  - Altimeter Not Adjusted to Current Altimeter Setting
  - Vertical Speed Indicator (VSI)
  - Airspeed Indicator
  - Types of Airspeed
  - Effects of Altitude on Airspeeds
- Knowledge Check
- Magnetic Compass
  - Compass Error
- Knowledge Check
- Gyroscopic Flight Instruments
  - Instrument Sources of Power
  - Vacuum or Pressure System
  - Gyroscopic Components
  - Gyroscope Within Normal Limits
  - Gyroscope Precession
- Knowledge Check
  - Turn Coordinator
  - Heading Indicator/ Directional Gyro (DG)
  - Attitude Indicator
- Knowledge Check
- Review/Summary

Question and Answer Session – *Parking Lot*

Lesson: Navigational Instruments

Purpose: The purpose of this lesson is to describe how navigational instruments and radio equipment are used to help pilots navigate.

Objectives:

- Define operating principles of navigational instruments
- Identify types and characteristics of radio equipment

Topics:

- Navigational Instruments
  - Automatic Direction Finder (ADF)
  - VOR Instrument
  - NAV Radio Receiver
  - VOR Instrument (Cont.)
- Knowledge Check
  - ILS Receiving Equipment
- Knowledge Check
  - Radio Magnetic Indicator (RMI)
  - Horizontal Situation Indicator (HSI)
- Knowledge Check
  - Distance Measuring Equipment (DME)
  - Global Positioning System (GPS)
- Knowledge Check
- Radio Equipment
  - NAV/COM Radio
  - Transponder
- Knowledge Check
- Review/Summary

Study Aid – Flight Instruments Quick Reference Chart

Lesson: Flight Management and Alert Instrumentation

Purpose: The purpose of this lesson is to identify instrumentation used by pilots that is designed to help navigate and manage routes and alert pilots to prevent airborne collisions.

Objectives:

- Identify instrumentation used to manage aircraft flight
- Identify alert systems used to prevent airborne collisions

Topics:

- Flight Management System (FMS)
  - Glass Cockpit
  - Multifunction Display (MFD)
  - Primary Flight Display (PFD)
  - Navigation Display (ND)
- Traffic Alert and Collision Avoidance System (TCAS)
  - TCAS Functions
  - TCAS Alerting System
  - Responding to Resolution Advisory (RA)
  - Display
  - Limitations

Video –TCAS (3:57 mins.)

- Knowledge Check

- Review/Summary

Question and Answer Session – *Parking Lot*

Lesson: Physiological Factors Affecting Flight

Purpose: The purpose of this lesson is to identify characteristics of physiological factors affecting pilots during flight, which can cause a pilot to perform erratic and unpredictable maneuvers.

Objective:

- Describe characteristics of physiological factors affecting pilots during flight

Topics:

- Physiological Factors Affecting Flight
  - Hypoxia
- Audio File – Hypoxia Scenario
  - Loss of Pitot-Static or Gyroscopic Systems

Video – Pitot-Static or Gyroscopic Systems Failure Scenario (2:12 mins.)

  - Hyperventilation
  - Illusions in Flight
- Knowledge Check
- Review/Summary

Question and Answer Session – *Parking Lot*

End-of-Module (EOM) Test

INTRODUCTION

LESSONS	■ Aircraft Instrumentation ■ Navigational Instruments ■ Flight Management and Alert Instrumentation ■ Physiological Factors Affecting Flight
TOTAL ESTIMATED RUN TIME	4 hrs. 07 mins.
MODULE CONTENT	■ Module Overview ■ Lesson: Aircraft Instrumentation ■ Q&A Session **–** Parking Lot ■ Lesson: Navigational Instruments ■ Study Aid – Flight Instruments Quick Reference Chart ■ Lesson: Flight Management and Alert Instrumentation ■ Q&A Session **–** Parking Lot ■ Lesson: Physiological Factors Affecting Flight ■ Q&A Session – Parking Lot ■ End-of-Module Test

<table>
<tr><th>FACILITATOR INSTRUCTIONS</th><th>DELIVERY METHOD</th></tr>
<tr><td rowspan="3">■ Instruct students to select Pilot’s Environment module link within Blackboard
■ Instruct students to read the module introduction and then wait quietly for additional instructions</td><td>Blackboard</td></tr>
<tr><td>EST. RUN TIME</td></tr>
<tr><td>2 mins.</td></tr>
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How do pilots know they are on an airway?

When an aircraft is cleared “direct OKC,” how does the pilot find OKC?

What does a pilot mean by saying, “My DG isn’t working”?

As a controller, having basic knowledge of the instruments the pilots use and the environment in which they work will help you to effectively work with pilots.

The purpose of this module is to introduce you to the types of equipment that pilots use to navigate, and physiological factors that pilots may encounter during flight.

FACILITATOR INSTRUCTIONS	DELIVERY METHOD
■ **ENABLE *Aircraft Instrumentation*** lesson in Blackboard ■ Instruct students to navigate to the ***Aircraft Instrumentation*** lesson in Blackboard ■ Instruct students to work individually through the lesson content ■ Upon completion of the lesson, students should review previously introduced content or wait quietly until other students have completed	Blackboard **EST. RUN TIME** 40 mins.

AIRCRAFT INSTRUMENTATION

Purpose: The purpose of this lesson is to describe how the pitot-static system and gyroscopic flight instruments are used to help pilots fly their aircraft.

Objectives:

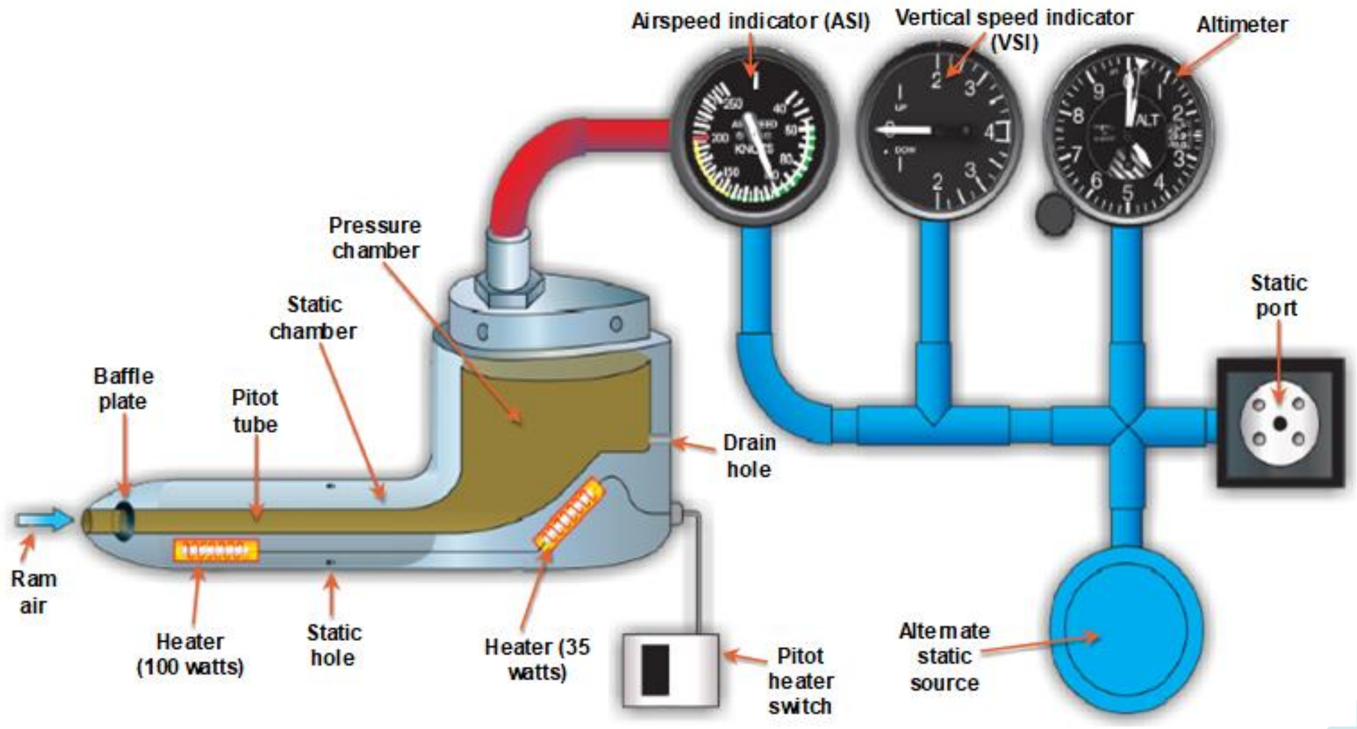
- Define types and characteristics of pitot-static system
- Define operating principles of gyroscopic flight instruments

References for this lesson are as follows:

- FAA-H-8083-25, Pilot's Handbook of Aeronautical Knowledge

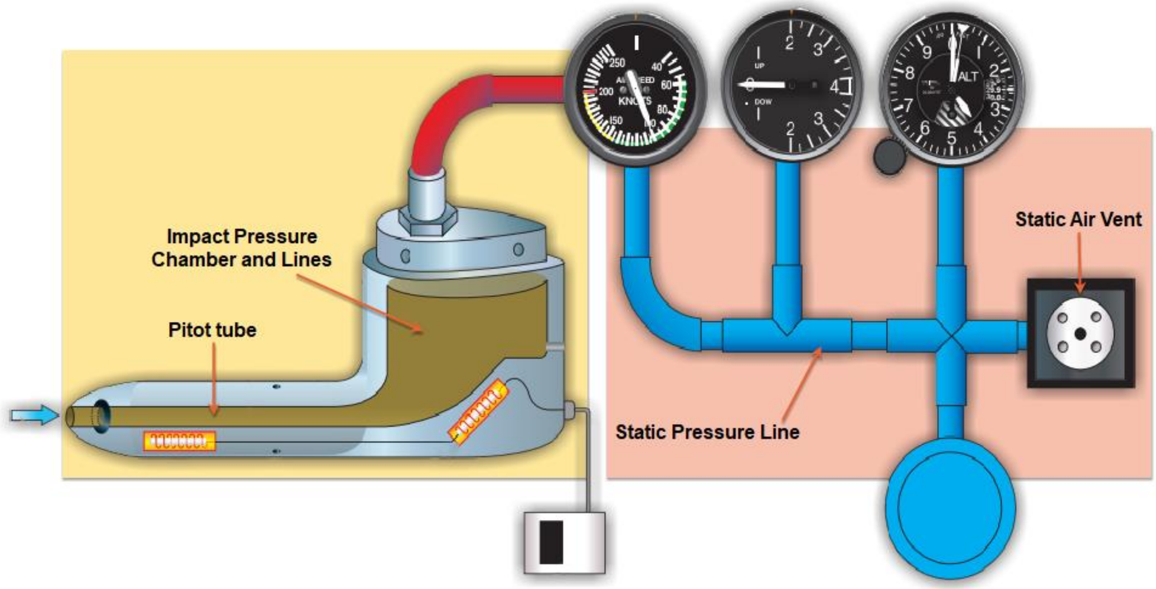
Pitot-Static System

The pitot-static system provides the sources of air pressure for the operation of the **altimeter**, **vertical speed**, and **airspeed**.

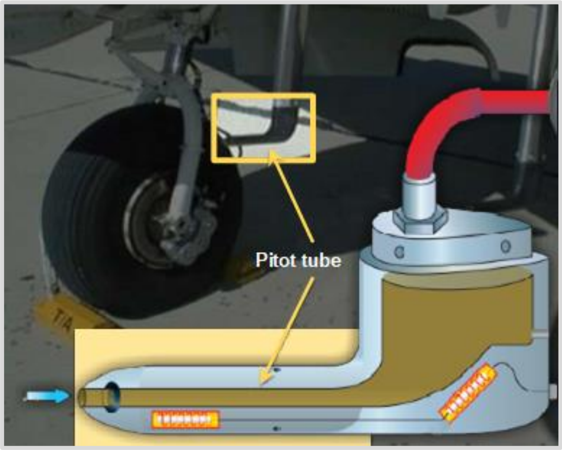


Pitot-Static System Components

There are two major parts of the pitot-static system: the **pitot tube**, with impact pressure chamber and lines, and the **static air vents**, with a static pressure line.



Pitot Tube



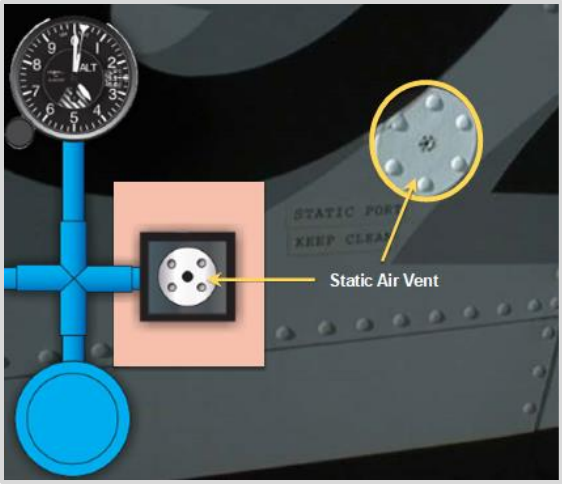
The pitot tube is the source of impact pressure, which is the result of the aircraft's motion through the air. Some aircraft have two pitot systems.

A pitot tube:

- Has an opening in the front of the tube
- Is usually mounted on the leading edge of the wing, on the nose section, or on the vertical stabilizer
- Is connected to the airspeed indicator

Blockage of the pitot tube opening adversely affects the airspeed readout.

Static Air Vents



Static air vents are the source of external atmospheric pressure and consist of a small hole or group of holes connecting outside air pressure to the pitot-static instruments. All three pitot-static system instruments are vented to the static vent openings.

Static air vents are normally mounted flush on the side of the fuselage or behind the pitot tube.

Blockage of static air vents creates erroneous readings by all three pitot-static system instruments.

Knowledge Check A

REVIEW what you have learned so far about aircraft instrumentation. ANSWER the question listed below.

1. Which instrument is the pitot tube connected to? *(Select the correct answer.)*
   - ❑ **Airspeed indicator**
   - ❑ Vertical speed indicator
   - ❑ Altimeter

Pitot-Static System Instruments

The instruments affected by the pitot-static system include:

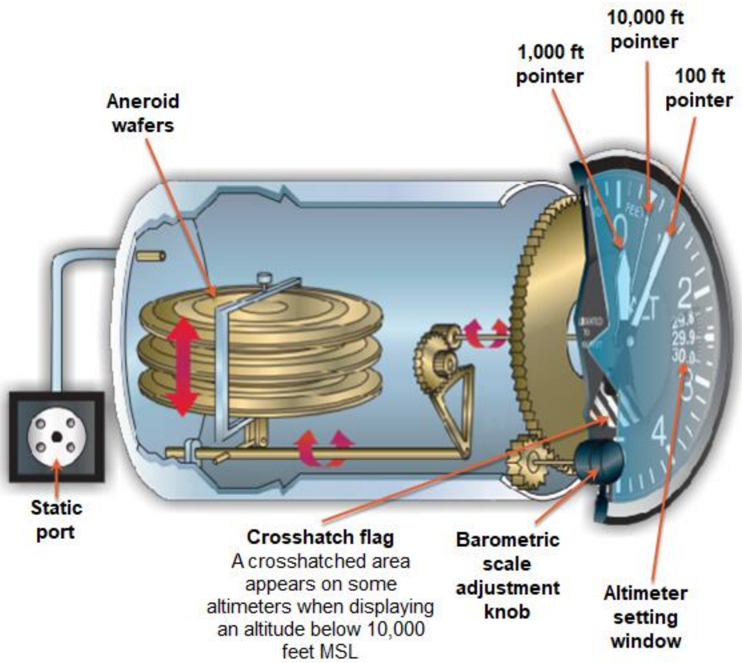
- Altimeter
- Vertical speed indicator
- Airspeed indicator

Altimeter

The altimeter displays the height of the aircraft above a given level.

How an altimeter works:

- Pressure is sensed by an aneroid wafer (barometer) in the altimeter and converted to an altitude
- The aneroid wafer expands and contracts with pressure changes and displays altitude changes accordingly
- An altimeter indicates height above sea level when set to the local altimeter setting
  - Correct altimeter settings are set by the altimeter setting knob
  - The altimeter setting currently set is read from the altimeter setting (Kollsman) window

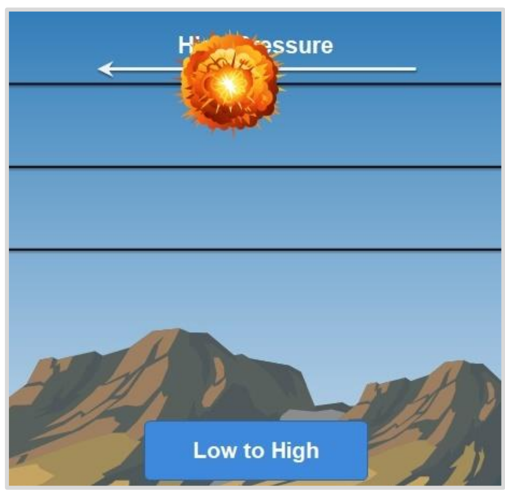
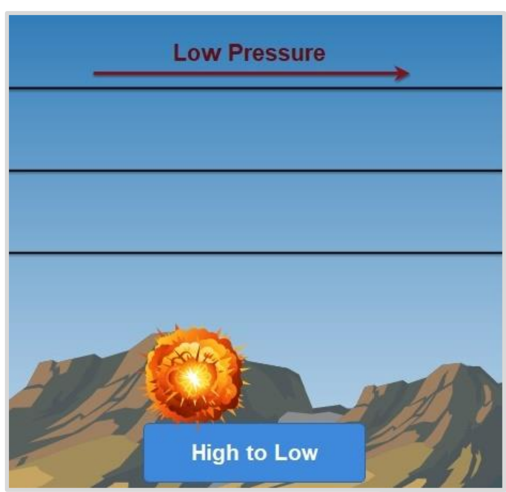


Altimeter settings recalibrate the altimeter for changing pressures.

- Altimeter settings are measured in inches of mercury
  - Standard setting is 29.92 inches of mercury
- Altimeter setting updates are required for all flights below 18,000 feet mean sea level (MSL) and for flights descending below flight level (FL) 180 from Class A airspace
- The altimeter setting of 29.92 is always used for flights at and above 18,000 feet MSL

Altimeter Not Adjusted to Current Altimeter Setting

If the altimeter setting is **NOT** updated, there can be a decrease in the accuracy of the altitude information displayed to the pilot. When flying from a higher pressure to lower pressure, the altimeter reads a higher altitude than the actual altitude of the aircraft.

When flying from lower pressure to higher pressure, the altimeter reads a lower altitude than the actual altitude of the aircraft. ***The actual altitude is higher than shown on the altimeter.***	
When flying from higher pressure to lower pressure, the altimeter reads a higher altitude than the actual altitude of the aircraft. ***The actual altitude is lower than shown on the altimeter.***	

Vertical Speed Indicator (VSI)

The Vertical Speed Indictor (VSI) measures the rate of climb or descent in hundreds of feet per minute.

The VSI displays two different types of information:

- **Trend information** shows an immediate indication of an increase or decrease in the aircraft's rate of climb or descent
- **Rate information** shows a stabilized rate of change in altitude

The VSI utilizes static pressure only.

Airspeed Indicator

The airspeed indicator measures indicated airspeed (impact pressure, the difference between pitot and static pressures) in knots.

The airspeed indicator:

- Is connected to both the pitot tube and the static vent
- Is the only instrument that uses pitot tube for information

Arcs are color coded for certain speeds and ranges.

- White arc: commonly referred to as the flap operating range
- Green arc: the normal operating range
- Yellow arc: caution range
- Red line: never exceed speed

Note: *The blue radial line represents the best single-engine rate of climb (in a multi-engine aircraft) and the red/white needle indicates the maximum allowable airspeed (which varies with air density).*

Types of Airspeed

There are two types of airspeed: **Indicated Airspeed (IAS)** and **True Airspeed (TAS)**.

IAS is read directly from the airspeed indicator.

TAS is indicated airspeed corrected for temperature and pressure.

- The actual speed of an aircraft through a mass of air
- Flight plans are filed using TAS

Note: *MACH airspeed will be covered in a later stage of training.*

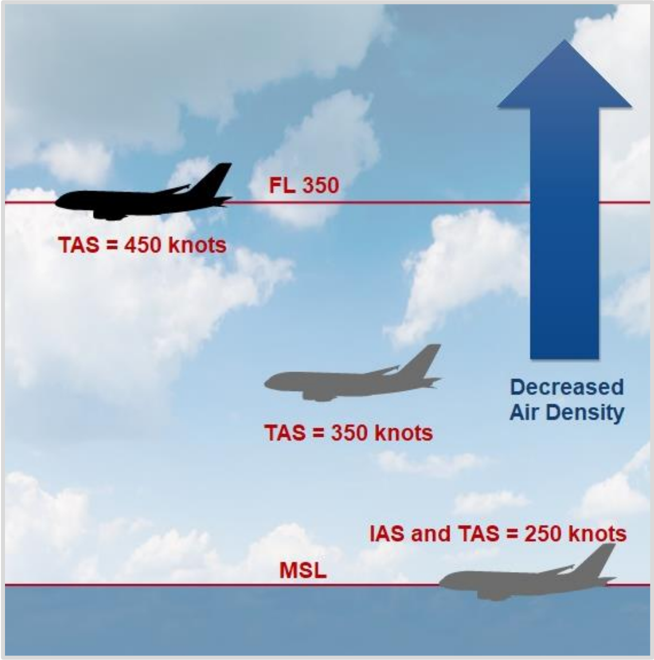
Effects of Altitude on Airspeed

TAS and IAS are approximately equal at sea level.

However, altitude affects both types differently.

- IAS becomes less than TAS as altitude increases
- The density of air decreases greatly with increasing altitude

Note: *An airplane at FL 350 with an indicated airspeed of 230-250 knots has a true airspeed of approximately 430-450 knots.*



Knowledge Check B

REVIEW what you have learned so far about aircraft instrumentation. ANSWER the questions listed below.

1. What instruments are affected by the pitot-static system? *(Select all correct answers that apply.)*
   - ❑ **Airspeed indicator**
   - ❑ Attitude indicator
   - ❑ **Altimeter**
   - ❑ **Vertical speed indicator**
   - ❑ Heading indicator

2. Altimeter Settings – Fill in the blank with the correct reading for each altimeter. Select from the following: 12,420 feet; FL 215; 7,500 feet; 15,600 feet; FL 410; 8,880 feet.

7,500 feet

15,600 feet

FL 215

8,880 feet

12,420 feet

FL 410

3. What does an altimeter measure? *(Select the correct answer.)*
   - ❑ Height above ground level
   - ❑ **<u>Height above sea level</u>**
   - ❑ Vertical trend information

4. Which types of information are displayed on the vertical speed indicator? *(Select all correct answers that apply.)*
   - ❑ **<u>Climb/descent trend information</u>**
   - ❑ Airspeed and impact pressure
   - ❑ **<u>Altitude rate of change information</u>**
   - ❑ Maximum allowable airspeed

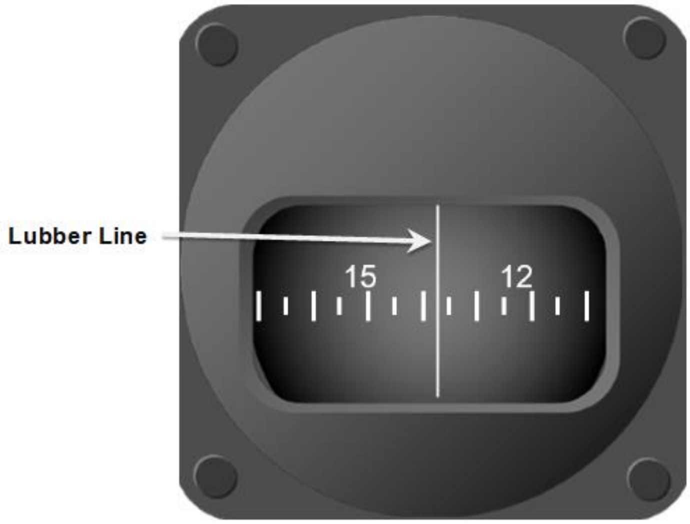
Magnetic Compass

The magnetic compass is used to tell the pilot the aircraft’s heading in relation to magnetic north.

The magnetic compass:

- Is the only self-contained direction-seeking instrument in the aircraft
- Has a compass card that has letters for cardinal headings
  - Each 30-degree interval is represented by a number, the last zero of which is omitted
  - **Example:** 30 degrees would appear as a 3 and 300 degrees would appear as 30; between these numbers, the card is graduated for each 5 degrees

The magnetic compass is located above the aircraft's instrument panel. A line called a lubber line is mounted behind the glass of the instument. This line can be used for a reference when aligning the heading on the compass card.



Variation
Variation is the angular difference between true north and the direction indicated by the magnetic compass. Local magnetic fields from mineral deposits and other conditions may distort the Earth's magnetic field and cause an error in the position of the compass's north-seeking magnetized needles with reference to true north.

Deviation
Deviation is a magnetic compass error caused by electromagnetic interference within the aircraft. Magnetic disturbances from magnetic fields produced by metals and electrical accessories in an aircraft disturb the compass needles and produce an additional error.

Knowledge Check C

REVIEW what you have learned so far about aircraft instrumentation. ANSWER the question listed below.

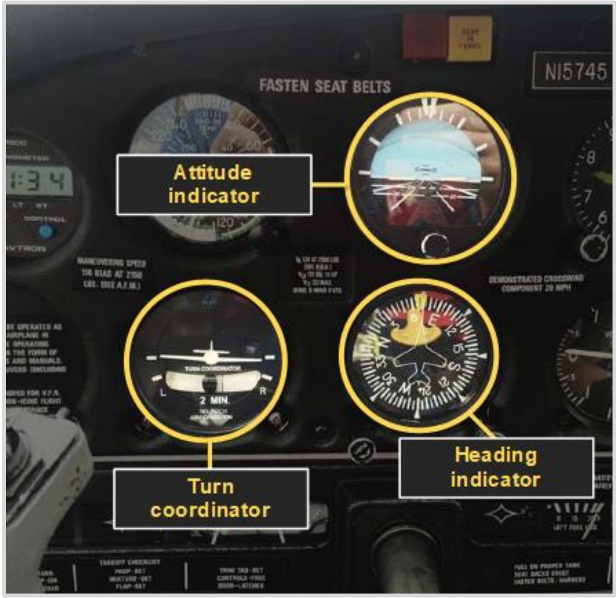
1. Which is the correct heading that represents 180 degrees on a magnetic compass? *(Select the correct answer.)*
   - ❑ **<u>18</u>**
   - ❑ 180
   - ❑ 180°

Gyroscopic Flight Instruments

Several flight instruments use the properties of a gyroscope for their operation.

- Turn coordinator
- Heading indicator (directional gyro)
- Attitude indicator

To understand how these instruments operate requires knowledge of the gyroscopic principles and the operating principles of each instrument.



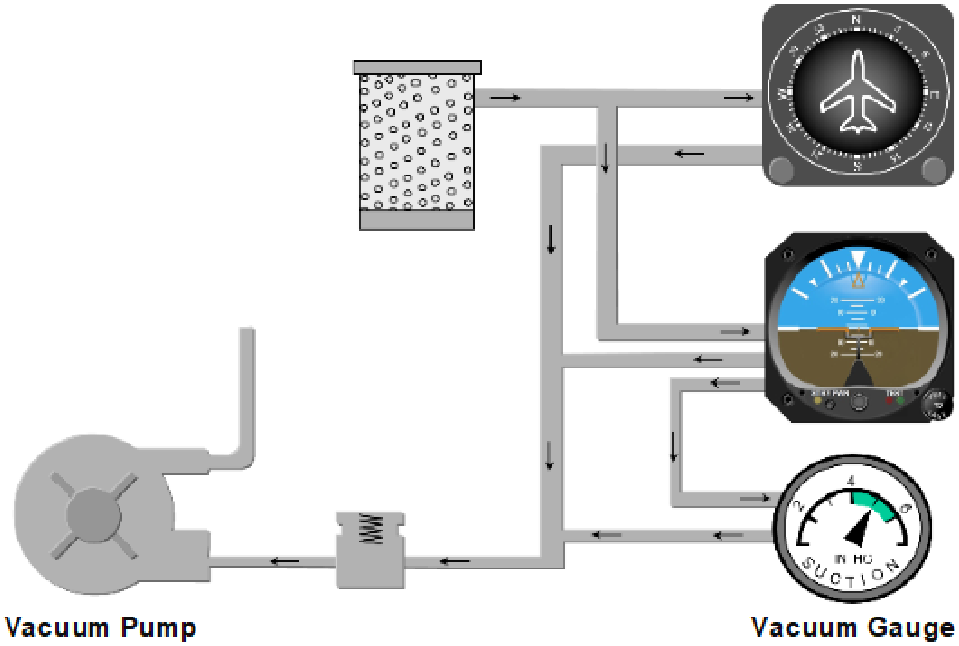
Instrument Sources of Power

In some aircraft, the gyros are vacuum, pressure, or electrically operated. In most cases, vacuum or pressure systems provide the power for the heading and attitude indicators, while the electrical system provides the power for the turn coordinator. In most small aircraft, the failure of the vacuum pump would render the heading indicator and attitude indicator inoperative.

The vacuum or pressure system spins the gyro by drawing a stream of air against the rotor vanes to spin the rotor at high speeds, essentially the same as a water wheel or turbine operates.

Vacuum Pump
One source of vacuum for the gyros installed in light aircraft is the vane-type engine-driven pump that is mounted on the engine. Pump capacity varies in different aircraft, depending on the number of gyros to be operated.

Vacuum Gauge
The gauge is mounted in the aircraft's instrument panel and indicates the amount of pressure in the system.



Gyroscopic Components

Any spinning object exhibits gyroscopic properties; however, a wheel designed and mounted to use these properties is called a gyroscope.

There are two fundamental properties of gyroscopic action:

- Rigidity in space
- Precession

Gyroscope Within Normal Limits

Rigidity in space can best be explained by applying Newton's First Law of Motion, which states, "A body at rest will remain at rest; or if in motion in a straight line, it will continue in a straight line unless acted upon by an outside force."

- When the wheel is spinning, it exhibits the ability to remain in its original plane of rotation regardless of how the base is moved
- All flight instruments using the gyroscopic property rely on rigidity for their operation

Gyroscope Within Normal Limits Example

An example of rigidity in space is that of a bicycle wheel. As the bicycle wheels increase speed, they become more stable in their plane of rotation. This is why a bicycle is unstable and maneuverable at low speeds and stable and less maneuverable at higher speeds.

Gyroscope Precession

Precession, the second property of a gyroscope, unrestrained in just two coordinate axes, is the deflection of a spinning wheel when a force is applied.

- When a force is applied to the rim of a rotating wheel, the resultant force is 90 degrees ahead in the direction of rotation and in the direction of the applied force
- The force with which the wheel processes is the same as the force applied

Gyroscope Precession Example

Precession acts on the wheels of a bicycle in order to allow it to turn. While riding at normal speed, it is not necessary to turn the handle bars in the direction of the desired turn; a rider simply leans in the direction that they wish to go.

If a rider leans to the right, a force is applied to the top of the wheel to the right. The force actually acts 90 degrees ahead, in the direction of rotation, which has the effect of applying a force to the front of the tire, causing the bicycle to move to the right.

Knowledge Check D

REVIEW what you have learned so far about aircraft instrumentation. ANSWER the question listed below.

1. Which flight instruments use gyroscopic properties for their operation? *(Select all correct answers that apply.)*
   - ❑ **Heading indicator**
   - ❑ Magnetic compass
   - ❑ **Turn coordinator**
   - ❑ **Attitude indicator**

Turn Coordinator

The turn coordinator shows the yaw and roll of the aircraft around the vertical and longitudinal axes.

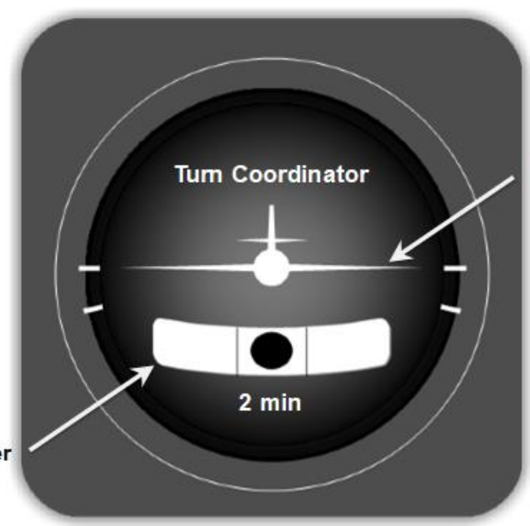
The turn coordinator is actually two separate instruments combined into one.

Inclinometer
The inclinometer of the turn coordinator indicates the coordination of aileron and rudder.

- The ball indicates whether the airplane is in coordinated flight, a skid, or a slip

Rate of Turn Indicator
The rate of turn indicator relies on the gyroscopic principle for its operation.

- When rolling in or out of a turn, the miniature airplane banks in the direction of the turn
- The miniature airplane indicates rate of turn, not the actual bank angle of the aircraft



If the appropriate amount of rudder is applied, a **coordinated turn** results. If inadequate rudder is applied in a turn, a **slip** results. If excessive rudder is applied, a **skid** results.

- During a slipping turn, the aircraft is banked too much for the rate of turn, pulling the aircraft toward the inside of the turn. This generally occurs when the pilot applies too little rudder
- During a skidding turn, the aircraft is banked too little for the rate of turn, pulling the aircraft to the outside of the turn. This generally occurs when the pilot applies too much rudder

Heading Indicator/Directional Gyro (DG)

The Heading Indicator/Directional Gyro (DG) is a mechanical instrument designed to facilitate the use of the magnetic compass.

- Errors in the magnetic compass are numerous, making straight flight and precision turns to headings difficult to accomplish, particularly in turbulent air
- A heading indicator, however, is not affected by the forces that make the magnetic compass difficult to interpret

Because of precession, caused chiefly by friction, the heading indicator creeps or drifts from a heading to which it is set. Therefore, it is important for the pilot to frequently check and reset the heading indicator to align with the magnetic compass.

Note: *The heading indicator is not a direction-seeking instrument; however, the magnetic compass is.*

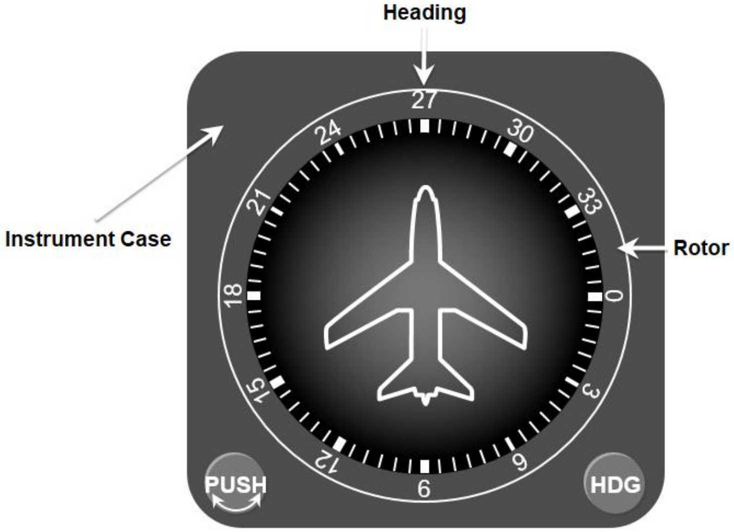
Heading
Headings are read by adding zero.

Examples:

- 3 = 30 degrees
- 27 = 270 degrees

Instrument Case
As the instrument case and the airplane revolve around the vertical axis, the card provides clear and accurate heading information.

Rotor
Since the rotor remains rigid in space, the points of the card hold the same position in space.



Attitude Indicator

The attitude indicator, with its miniature aircraft and horizon bar, displays a picture of the attitude of the aircraft. The aircraft's attitude is the nose-up or nose-down pitch of the aircraft, and the left or right bank of the aircraft.

The relationship of the miniature aircraft to the horizon bar is the same as the relationship of the real aircraft to the actual horizon. The instrument gives an instantaneous indication of even the smallest changes in attitude.

Pitch
Some instruments have a horizontal row of lines that usually indicate each 5 degrees of pitch.

Bank
The scale at the top of the instrument indicates the degree of bank. Each line usually represents 10 degrees of bank.

The attitude indicator is reliable and the most realistic flight instrument on the instrument panel.

Shown here are examples of an attitude indicator displaying level flight, a 30-degree left bank, and a nose-up pitch.

Knowledge Check E

REVIEW what you have learned so far about aircraft instrumentation. ANSWER the questions listed below.

1. Which two instruments make up the turn coordinator? *(Select all correct answers that apply.)*
   - ❑ **Inclinometer**
   - ❑ **Rate of turn indicator**
   - ❑ Attitude indicator
   - ❑ Directional gyro

2. What may be obtained from the attitude indicator? *(Select the correct answer.)*
   - ❑ Rate of turn
   - ❑ **Degrees of bank**
   - ❑ Height above sea level

Aircraft Instrumentation Summary

Throughout the history of manned flight, the flight instrument panel has evolved into a complex, multifunctional computer system. It is important that you, as their guide, know the purpose and function of each instrument.

FACILITATOR INSTRUCTIONS	DELIVERY METHOD
■ Review content presented in ***Aircraft Instrumentation*** lesson ■ Navigate to the ***Parking Lot*** link within Blackboard and review any student questions ■ Address ***Parking Lot*** questions and facilitate a brief discussion of the lesson content	Facilitated Discussion **EST. RUN TIME** 25 mins.

FACILITATOR INSTRUCTIONS	DELIVERY METHOD
■ **ENABLE *Navigational Instruments*** lesson in Blackboard ■ Instruct students to navigate to the ***Navigational Instruments*** lesson in Blackboard ■ Instruct students to work individually through the lesson content ■ Upon completion of the lesson, students should review previously introduced content or wait quietly until other students have completed	Blackboard **EST. RUN TIME** 35 mins.

NAVIGATIONAL INSTRUMENTS

Purpose: The purpose of this lesson is to describe how navigational instruments and radio equipment are used to help pilots navigate.

Objectives:

- Define operating principles of navigational instruments
- Identify types and characteristics of radio equipment

References for this lesson are as follows:

- FAA-H-8083-15, Instrument Flying Handbook
- FAA-H-8083-25, Pilot's Handbook of Aeronautical Knowledge

Navigational Instruments

The following navigational instruments are used by the pilot to determine position, course, and distance traveled:

- Automatic direction finder (ADF)
- Very high frequency (VHF) omnidirectional range (VOR) instrument
- Instrument landing system (ILS) receiving equipment
- Radio magnetic indicator (RMI)
- Horizontal situation indicator (HSI)
- Distance measuring equipment (DME)
- Global positioning system (GPS)

Automatic Direction Finder (ADF)

The **automatic direction finder** (ADF) is used to navigate using non-directional radio beacons (NDBs).

The ADF equipment consists of a navigational display and a tuner.

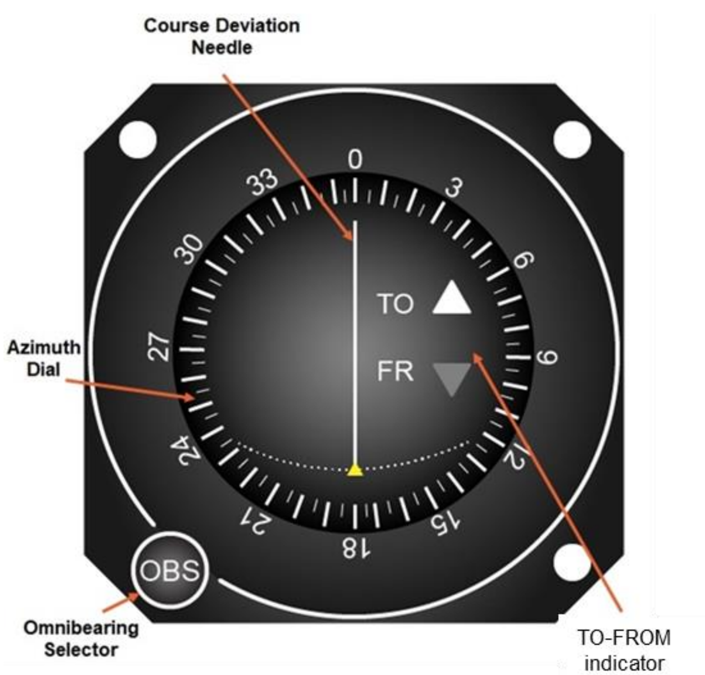
- The navigational display consists of a **dial** upon which the azimuth is printed and a **needle** that rotates around the dial and points to the station to which the receiver is tuned, indicating the bearing to the station
- Some of the ADF dials can be rotated so as to align the azimuth with the aircraft heading; others are fixed with 0 degrees representing the nose of the aircraft and 180 degrees representing the tail

VOR Instrument

The **VOR receiver** presents information to indicate bearing TO or FROM the station.

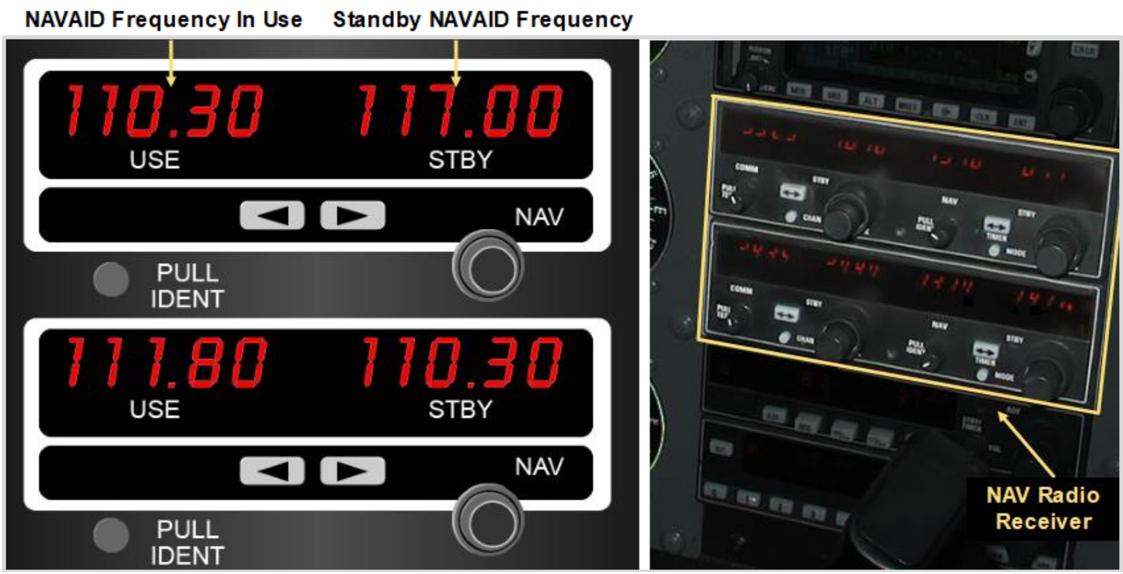
The instrument consists of a(n):

- Omnibearing Selector (OBS), sometimes referred to as course selector, consists of a selector knob and azimuth dial
- Course deviation indicator needle (left-right needle)
- TO-FROM indicator
- Navigation frequency tuner



NAV Radio Receiver

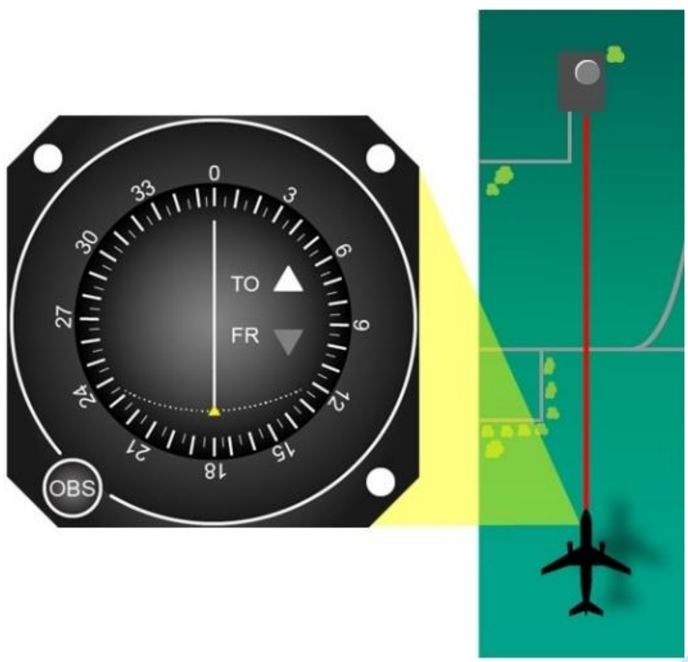
The VOR instrument is connected to the **NAV radio receiver**. The frequency of the VOR is dialed into the NAV radio receiver for navigation to and from the navigational aid (NAVAID).



VOR Instrument

When the OBS is rotated, it moves the course deviation needle to indicate the position of the radial relative to the aircraft.

- If the course selector is rotated until the deviation needle is centered, the pilot can determine:
  - The radial (magnetic course from the station)
  - Its reciprocal (magnetic course to the station)
- The course deviation needle also moves to the left or right if the aircraft is flown or drifts away from the radial that is set in the course selector



After centering the needle by turning the OBS selector, the TO-FROM indicator indicates either "TO" the station or "FROM" the station.

TO	FROM
If the selector displays "TO," the course shown on the course selector must be flown to the station.	If "FROM" is displayed and the course shown is followed, the aircraft is flying away from the station.

Reversed
Course deviation information is **reversed** if the pilot is flying with a "FROM" reading but is headed toward the station or is flying with a "TO" reading while headed away from the station. This could occur if the pilot misreads the course indicator on the VOR and tries to fly a heading that is 180 degrees opposite of the desired course.

Knowledge Check F

REVIEW what you have learned so far about navigational instruments. ANSWER the questions listed below.

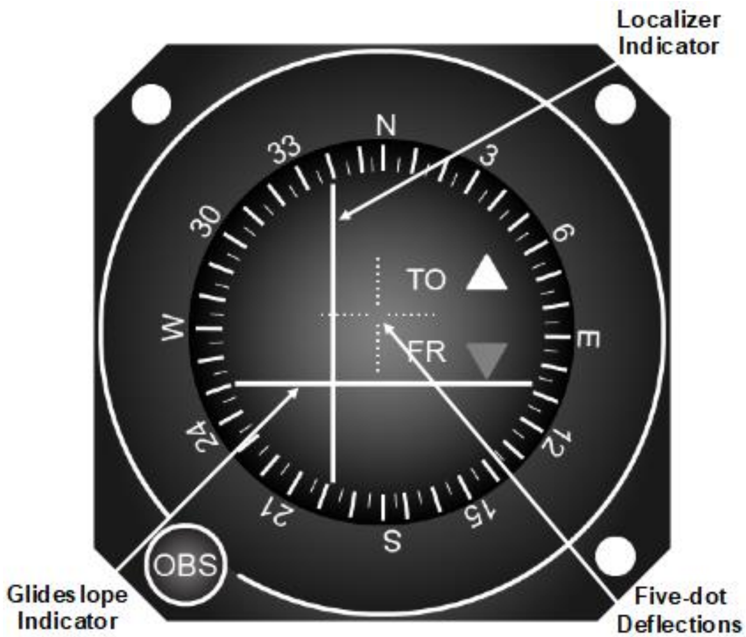
1. What type of equipment does the automatic direction finder use to aid with navigation? *(Select the correct answer.)*
   - ❑ Distance Measuring Equipment
   - ❑ VHF Omnidirectional Range
   - ❑ **<u>Non-directional radio beacons</u>**

2. Correctly label each component on the VOR instrument. Enter your answers in the spaces below.

ILS Receiving Equipment

Instrument landing system (ILS) receiving equipment is used to make an ILS approach.

When the crossed horizontal **glideslope indicator** and vertical **localizer indicator** needles are free to move through standard **five-dot deflections**, they indicate the position on the localizer course and glide path.



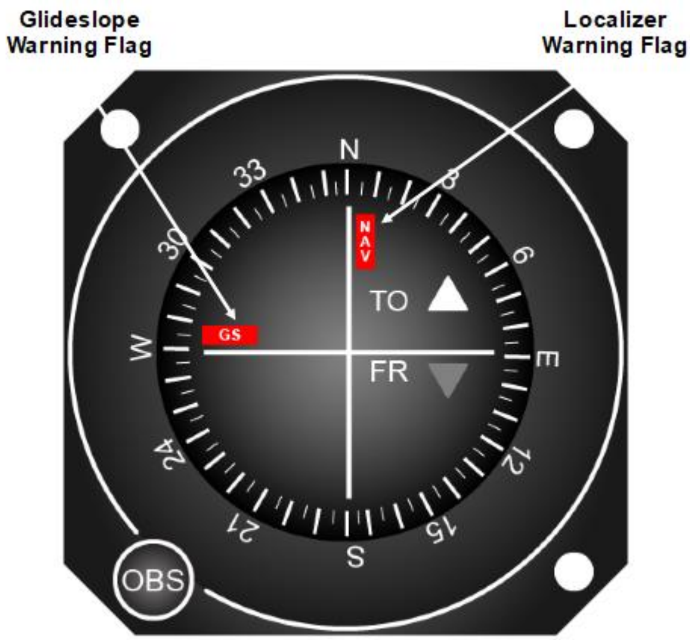
The **localizer needle** indicates, by deflection, whether the aircraft is right or left of the localizer centerline, regardless of the position or heading of the aircraft. Rotation of the course selector has no effect on the operation of the localizer needle.

Turn Towards Needle – When the aircraft is **inbound on the front course** or **outbound on the back course,** the needle deflects **toward** the on course. The pilot turns the aircraft **in the direction of** the needle to correct the course.	**Turn Towards Needle** 
Turn Away from Needle – When the aircraft is **outbound on the front course** or **inbound on the back course**, the needle deflects **away** from the on course. The pilot turns the aircraft **away** from the needle to correct the course.	**Turn Away from Needle** 

Deflection of the **glideslope needle** indicates the position of the aircraft with respect to the glide path.

		
Down When the aircraft is above the glideslope, the needle is deflected down.	**Up** When the aircraft is below the glideslope, the needle is deflected up.	**Centered** When the aircraft is on the glideslope, the needle is centered.

The red **localizer** and **glideslope warning flags** appear when insufficient voltage is received to actuate the needles. The flags also appear when an unstable signal or receiver malfunction occurs.



Knowledge Check G

REVIEW what you have learned so far about navigational instruments. ANSWER the question listed below.

1. An aircraft is inbound on the front course. Which ILS indicator shows where the pilot must turn the aircraft to the left and remain centered on the glideslope in order to line up with the runway? *(Select the correct answer.)*

Radio Magnetic Indicator (RMI)

The **radio magnetic indicator** (RMI) is designed to receive both VOR and NDB signals.

RMI can be set up to indicate either bearing to a waypoint or to a VHF Omnidirectional Range/Tactical Air Navigation (VORTAC) used to establish the waypoint.

The RMI consists of the following components:

Single-Barred Bearing Indicator (green arrow) – The single-barred bearing indicator functions exactly the same as the double-barred bearing indicator.

Double-Barred Bearing Indicator (black/yellow arrow) – The double-barred bearing indicator gives the magnetic bearing to the VOR, VORTAC, or NDB to which the receiver is tuned. The tail of the double-barred indicator tells the pilot the radial or course.

Rotating Compass Card – The rotating compass card, actuated by the aircraft's compass system, rotates as the aircraft turns. The heading of the aircraft is always directly under the index at the top of the instrument.

Horizontal Situation Indicator (HSI)

The **horizontal situation indicator** (HSI) is a combination of three instruments:

- Heading indicator
- VOR/Localizer (LOC) indicator
- Glideslope indicator

Heading Indicator

- The aircraft heading is under the upper lubber line

VOR/LOC Indicator

- Course Indicating Arrow (Head) – The course indicating arrow shows the course selected.
- Course Deviation Bar – The course deviation bar operates with a VOR/LOC navigation receiver to indicate left or right deviation from the course selected with the course indicating arrow.
- TO-FROM Indicator – The TO-FROM indicator is a triangular-shaped arrow. When the indicator points to the head of the course arrow, it indicates that the course selected will take the aircraft to the selected facility.

Glideslope Indicator

- Glideslope Indicator – The glideslope deviation pointer indicates the relation of the aircraft to the glideslope

Knowledge Check H

REVIEW what you have learned so far about navigational instruments. ANSWER the questions listed below.

1. Which signal types are received by the radio magnetic indicator? *(Select all correct answers that apply.)*
   - ❑ **NDB**
   - ❑ ILS
   - ❑ **VOR**
   - ❑ DME

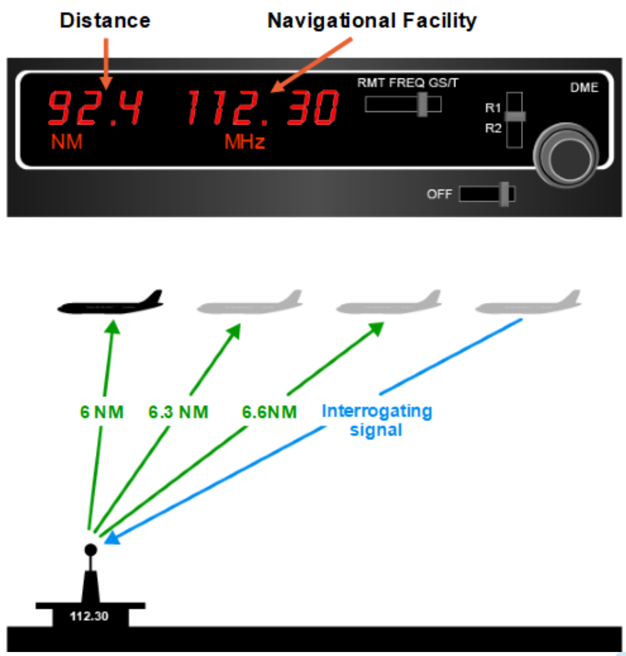
2. Which instruments are contained within the horizontal situation indicator? *(Select all correct answers that apply.)*
   - ❑ **Heading indicator**
   - ❑ Automatic direction finder
   - ❑ NAV radio receiver
   - ❑ **VOR/LOC indicator**
   - ❑ **Glideslope indicator**

Distance Measuring Equipment (DME)

The **distance measuring equipment** (DME) is used in conjunction with the VOR system to show the pilot the slant range distance from that VOR.

The DME transmits an **interrogating signal**, which is received by the DME transponder antenna at the ground facility.

- The signal triggers ground receiver equipment and the pulse is generated and transmitted through the DME transponder antenna back to the interrogating aircraft
- The airborne equipment measures the elapsed time between the interrogating and reply pulses and converts the time measurement into a mileage, groundspeed, or time readout



Global Positioning System (GPS)

The **global positioning system** (GPS) provides accurate position, speed, and precise time information on a continuous global basis, reported in latitude and longitude. Properly certified GPS equipment may be used as a means of instrument flight rules (IFR) navigation for domestic en route and terminal operations and certain instrument approach procedures.

Most receivers notify the pilots when they are getting close to the desired waypoint or in the vicinity of airspace in which they do not belong. Panel receivers display the bearing and distance to the nearest airport, VOR, NDB, or waypoint. In an emergency, a GPS receiver can direct the pilot to the nearest airports.

Knowledge Check I

REVIEW what you have learned so far about navigational instruments. ANSWER the questions listed below.

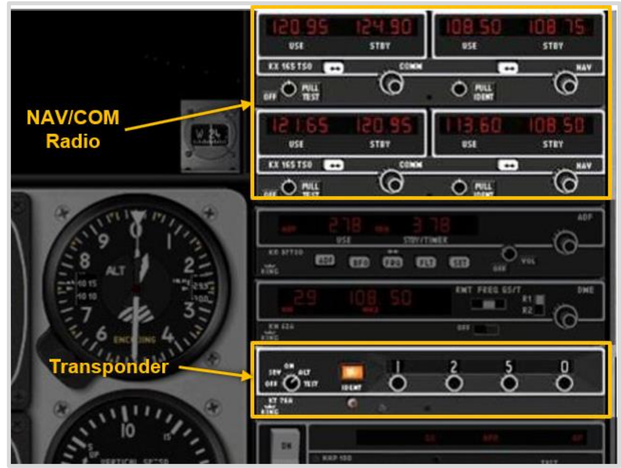
1. The VOR course deviation needle indicates the aircraft's position in relation to the selected _____. *(Select the correct answer.)*
   - ❑ Heading
   - ❑ **Radial**
   - ❑ Bearing

2. The range displayed on the DME indicator is called _____ range. *(Select the correct answer.)*
   - ❑ Omni
   - ❑ Straight
   - ❑ **Slant**

Radio Equipment

Radio equipment on an aircraft allows for communications with air traffic control (ATC) and NAVAIDs on the ground and consists of:

- NAV/COM Radio
- Transponder



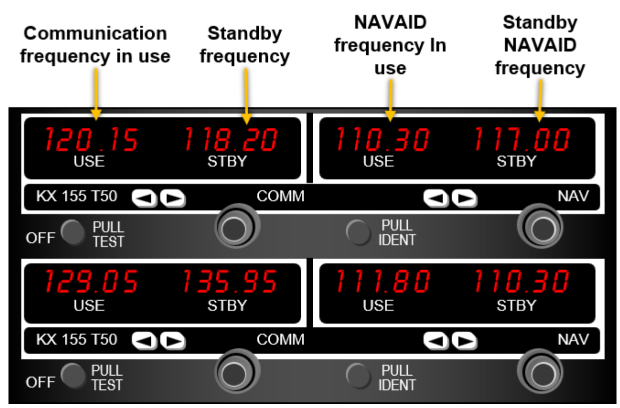
NAV/COM Radio

The **NAV/COM Radio** incorporates NAVigation and COMmunications radios in one unit.

The NAV/COM Radio is used to tune in communication and navigation frequencies used by the pilot.

- The NAV is set to the navigation frequency
- Communications are accomplished on the transceiver (combined transmitter/receiver)
  - Civilian transceivers operate in VHF range

Most NAV/COMs may be set with two frequencies and the pilot can change frequencies by pushing a button.



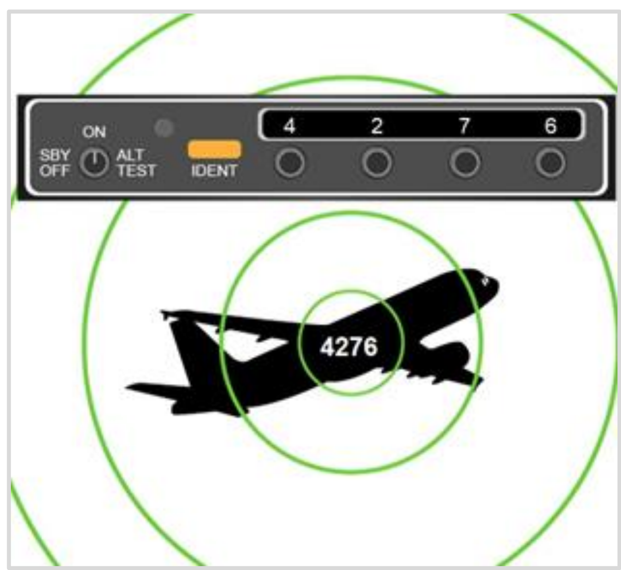
Transponder

The **transponder** is used to set beacon codes assigned by ATC. When a controller assigns a beacon code to an aircraft, he/she uses the word "squawk."

Example: "UNITED SIX FIFTY-FIVE SQUAWK ONE TWO THREE FOUR."

The transponder is the airborne portion of the secondary radar system. The secondary radar system cannot display an aircraft unless equipped with a transponder. A transponder is also required to operate in certain controlled airspace.

A transponder code consists of four numbers ranging from zero to seven (4,096 possible codes).



- Codes assigned by ATC for the purposes of radar identification and flight tracking are referred to as "discrete" codes
  - Discrete codes are codes that are assigned only to one aircraft for identification purposes
- There are also some non-discrete codes that are used in aviation (e.g. 7700 emergency, 1200 VFR)

When set on "ALT," the aircraft's Mode C is activated and secondary radar will receive altitude information.

Knowledge Check J

REVIEW what you have learned so far about navigational instruments. ANSWER the questions listed below.

1. What is an example of the phraseology used by air traffic controllers to direct a pilot to use a beacon code? *(Select the correct answer.)*
   - ❑ "SCREECH ONE TWO THREE FOUR"
   - ❑ **"SQUAWK ONE TWO THREE FOUR"**
   - ❑ "DIAL IN ONE TWO THREE FOUR"

2. The NAV/COM Radio is used to tune in which type of frequencies? *(Select all correct answers that apply.)*
   - ❑ **Air-to-ground**
   - ❑ **Air-to-air**
   - ❑ **Navigational**
   - ❑ AM radio

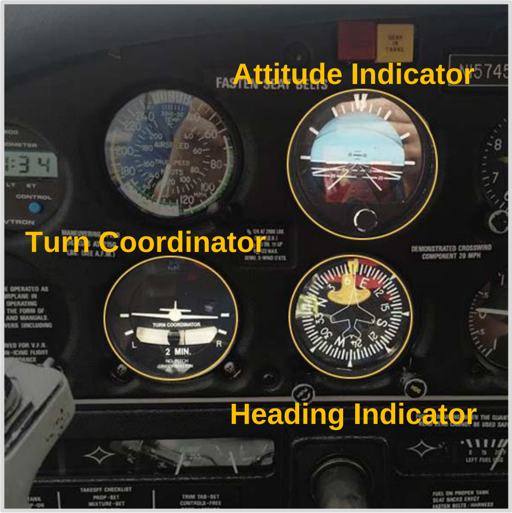
3. Which type of equipment is used to set beacon codes assigned by ATC? *(Select the correct answer.)*
   - ❑ NAV/COM Radio
   - ❑ Transistor
   - ❑ **Transponder**

Navigational Instruments Summary

Navigation instruments are those that contribute information used by the pilot to guide the aircraft along a course. Radio instruments are what connect the pilot to the ground and can sometimes serve as a lifeline in emergency situations. It is important to be familiar with these instruments so you can assist pilots in any way possible that is within your power.

FACILITATOR INSTRUCTIONS	DELIVERY METHOD
■ Instruct students to locate the study aid ***Flight Instruments Quick Reference Chart*** in ***Student Guide*** ■ Facilitator will review content provided in the study aid with an emphasis on GPS ■ Review content presented in ***Navigational Instruments*** lessons ■ Navigate to the ***Parking Lot*** link within Blackboard and review any student questions ■ Address ***Parking Lot*** questions and facilitate a brief discussion of the lesson content	Study Aid **EST. RUN TIME** 30 mins.

STUDY AID: FLIGHT INSTRUMENTS QUICK REFERENCE CHART

1		**Pitot-Static System Instruments:** ■ Altimeter ■ Vertical speed indicator (VSI) ■ Airspeed indicator
2		**Self-Contained Instruments:** ■ Magnetic compass
3		**Gyroscopic Instruments:** ■ Turn coordinator ■ Heading indicator ■ Attitude indicator

4		**Radio/ Satellite Instruments:** ▪ Automatic direction finder (ADF) (Non-directional beacon [NDB] receiver) ▪ Very High Frequency Omnidirectional Range (VOR) ▪ Instrument landing system (ILS) ▪ Distance measuring equipment (DME) ▪ Global positioning system (GPS)
5		**Combination Instruments:** ▪ Radio magnetic indicator (RMI) ▪ Heading indicator ▪ Dual VOR/ADF displays
6		**Horizontal Situation Indicator (HSI):** ▪ Heading Indicator ▪ VOR or LOC indicator ▪ Glideslope indicator

FACILITATOR INSTRUCTIONS	DELIVERY METHOD
■ **ENABLE *Flight Management and Alert Instrumentation*** lesson in Blackboard ■ Instruct students to navigate to the ***Flight Management and Alert Instrumentation*** lesson in Blackboard ■ Instruct students to work individually through the lesson content ■ Upon completion of the lesson, students should review previously introduced content or wait quietly until other students have completed	Blackboard **EST. RUN TIME** 20 mins.

FLIGHT MANAGEMENT AND ALERT INSTRUMENTATION

Purpose: The purpose of this lesson is to identify instrumentation used by pilots that is designed to help navigate and manage routes, and alert pilots to prevent airborne collisions.

Objectives:

- Identify instrumentation used to manage aircraft flight
- Identify alert systems used to prevent airborne collisions

References for this lesson are as follows:

- Aeronautical Information Manual (AIM)
- FAA-H-8083-15, Instrument Flying Handbook
- FAA Order JO 7110.65, Air Traffic Control

Flight Management System (FMS)

The Flight Management System (FMS) is a computer system that uses a large database to allow routes to be preprogrammed, and fed into the system by means of a data loader.

The system is constantly updated with respect to position accuracy by reference to navigation aids.

This sophisticated program, and its associated database, ensures that the most appropriate aids are automatically selected during the information update cycle.

Glass Cockpit

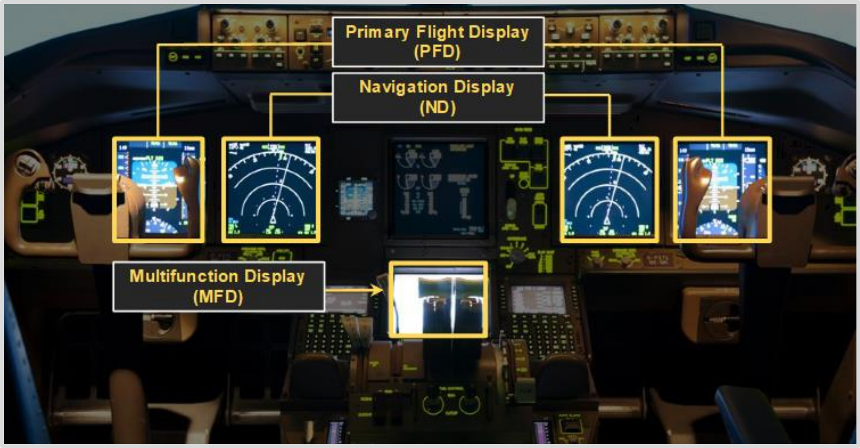
The electronic flight instruments, commonly referred to as the "glass cockpit," replace the conventional instruments in a fully equipped Instrument Flight Rules (IFR) aircraft with computer-generated, color-digital, electronic displays.

FMS takes raw flight and navigation data, then displays to the pilot:

- Attitude
- Heading
- Navigation system course
- Supplemental data
  - Distance
  - Airspeed
  - Radar altitude

FMS displays include at least:

- Primary Flight Display (PFD)
- Navigation Display (ND)
- Multifunction Display (MFD)



Multifunction Display (MFD)

An MFD serves as a multi-purpose computer, and can be used as a backup for the other displays in addition to providing:

- Terrain display
- Route planning
- Checklists
- Weather information
- Schematic diagrams of aircraft systems:
  - Troubleshooting
  - During an emergency

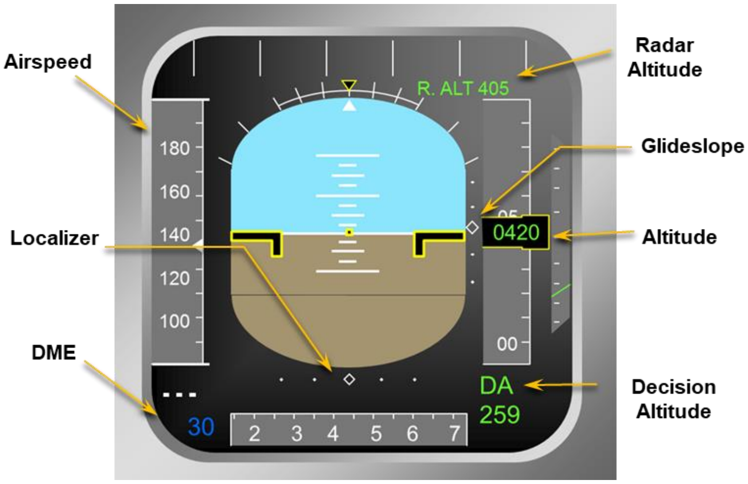
Primary Flight Display (PFD)

The Primary Flight Display (PFD) replaces the attitude indicator, altimeter, radar altimeter, airspeed indicator, and glideslope indicator.

The PFD can be configured in the approach configuration or the cruise configuration.

Approach Configuration

Displays information unique to **approach phase** of flight.



Cruise Configuration

Displays information unique to **en route phase** of flight.

- Altitude
- Indicated airspeed
- Heading
- Course

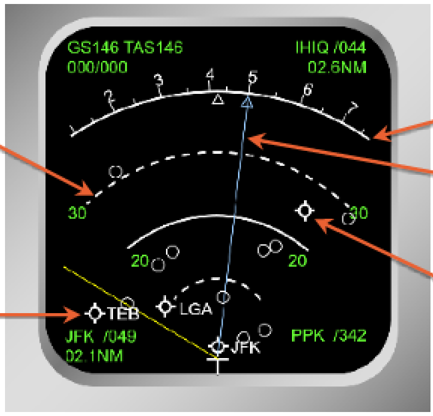
Navigational Display (ND)

The Navigation Display (ND) can be configured in either the full-compass or the segmented arc configuration.

Full-Compass Configuration	Segmented Arc Configuration
Displays the digital course and ground speed readouts available on most horizontal situation indicator.	Aircraft position relative to the selected route ahead, and relative to any hazardous weather can be displayed with great clarity and without sacrificing any essential navigational data.

Information Displayed

- Heading source
- Selected heading
- Selected course
- Navigation source
- Weather radar display along with the antenna tilt angle
- Ground speed
- DME
- TCAS



Traffic Alert and Collision Avoidance Systems (TCAS)

The TCAS is a self-contained, airborne collision system that is intended to provide a backup for the separation services provided by ATC, in order to prevent near mid-air or mid-air collisions.

TCAS is:

- Not an ATC system, but it is a system that directly affects ATC
- Required on most commercial, and some general aviation aircraft

TCAS I	TCAS II
Generates: - Traffic advisories	**Generates:** - Traffic advisories - Resolution advisories

TCAS Functions

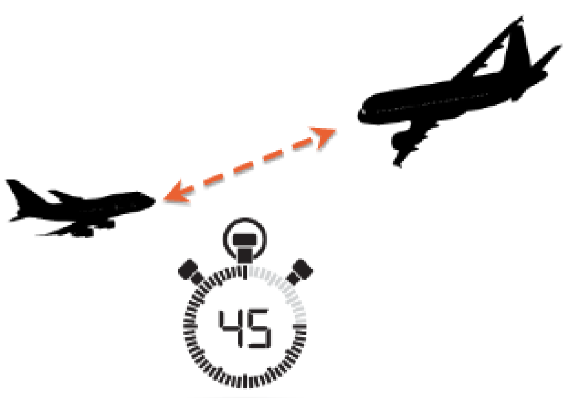
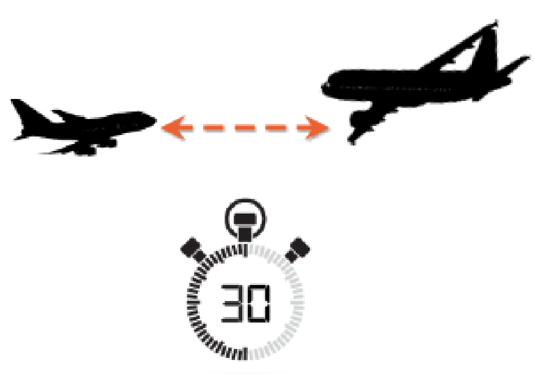
TCAS consists of three functions:

- Surveillance
- Collision Avoidance System (CAS) Algorithms
- Air-to-Air Coordination

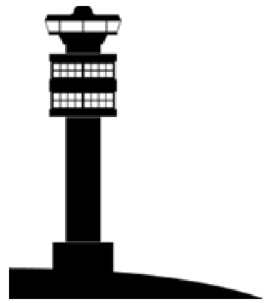
Surveillance – The surveillance function transmits interrogations, and processes replies from transponders in order to identify, and track intruder aircraft. TCAS interrogates on the same frequency as ground radar, and receives replies from the same transponders used to reply to ground interrogations. The surveillance function provides information of an intruder aircraft's: ▪ Range ▪ Closure rate ▪ Bearing ▪ Altitude and vertical speed, if the intruder is reporting altitude	**CAS Algorithms –** Using the track information provided by the surveillance function, the TCAS II logic determines if a nearby aircraft represents a threat to the TCAS-equipped aircraft. If a threat is perceived, the TCAS II logic selects a Resolution Advisory (RA) to either: ▪ Increase the vertical spacing from the intruder ▪ Maintain the existing vertical spacing from the intruder	**Air-to-Air Coordination** – Occurs via data-link where both aircraft are equipped with TCAS. Coordination between the two aircraft occurs prior to the issuance of any RA, to ensure that the RAs issued to each aircraft are in opposite directions and are compatible.

TCAS Alerting System

TCAS has two levels of alerting:

Traffic Advisories (TAs) are issued about 45 seconds prior to the Closest Point of Approach (CPA). ▪ Potential traffic is brought to the attention of the pilot visually and/or audibly	**Resolution Advisories** (RAs) are issued about 30 seconds prior to the CPA (TCAS II only).
	

Responding to Resolution Advisory (RA)

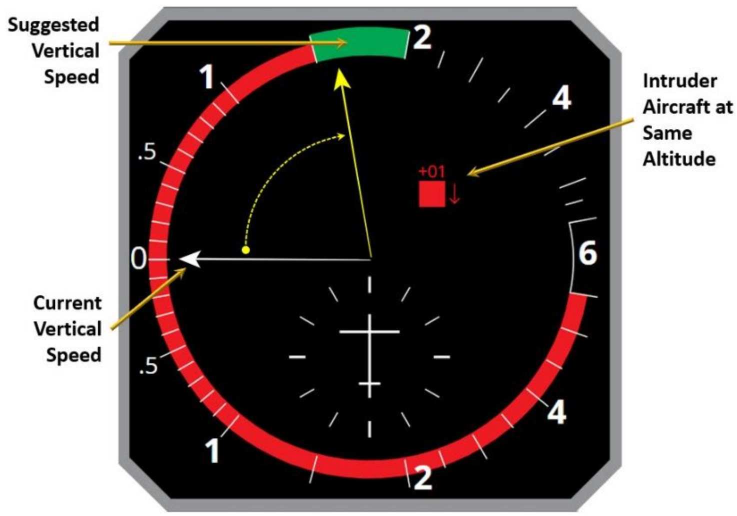
Any pilot who deviates from an ATC clearance in response to a TCAS II RA shall: ▪ Notify ATC of that deviation as soon as practicable ▪ Expeditiously return to the current ATC clearance when the traffic conflict is resolved	
When an aircraft under ATC jurisdiction informs ATC that it is responding to a TCAS RA, **do not** issue control instructions that are contrary to the RA. ATC is responsible for providing safety alerts regarding terrain or obstructions and traffic advisories.	

Note: *ATC is not responsible for providing standard separation between an aircraft responding to an RA and any other aircraft, airspace, terrain, or obstructions.*

TCAS Display and Limitations

The display function provides the interface between the pilot and TCAS.

- Display presents the pilot with a plan view of the location of nearby traffic
- RA presents information on the vertical speed to be flown, or the range of vertical speeds to be avoided



Limitations

TCAS does not know the intent of either aircraft. Its calculations are based on projections of both aircraft and flight profiles using the last three or four track updates.

Only aircraft with an operational transponder will be identified by the TCAS system.

Video – *TCAS* (3:57 mins.)

Knowledge Check K

REVIEW what you have learned so far about flight management. ANSWER the questions listed below.

1. Which computer system is used by pilots for navigation and consists of a large database? *(Select the correct answer.)*
   - ❑ MFD
   - ❑ ND
   - ❑ TCAS
   - ❑ **FMS**

2. Match the description of the FMS display panels with the name of the panel. Enter your answers in the spaces below.

   __b__ Multi-purpose computer that can be used as a backup for other computers, in addition to providing terrain display, route planning, and weather information

   __c__ Replaces the attitude indicator, altimeter, and glideslope indicator

   __a__ Displays digital course and ground speed readouts in either full-compass or segmented arc configuration

   a. ND

   b. MFD

   c. PFD

3. Which of the following best describes TCAS? *(Select all correct answers that apply.)*
   - ❑ Consists of two functions of surveillance
   - ❑ Generates only traffic advisories
   - ❑ **Operates independently from ground-based ATC**
   - ❑ Identifies the intent of aircraft
   - ❑ **Designed to prevent near mid-air and mid-air collisions**

4. How should you respond, when an aircraft under your jurisdiction informs you that it is responding to an RA? *(Select the correct answer.)*
   - ❑ Immediately issue an amended clearance
   - ❑ **Don't issue any instructions contrary to the RA**
   - ❑ Continue to separate from the intruder aircraft
   - ❑ Clarify and add additional instructions to the RA

Flight Management and Alert Instrumentation Summary

Controllers are the key point of contact for a pilot and crew during their flight. Having a basic knowledge of the instruments pilots use in their environment, will help you to effectively communicate.

FACILITATOR INSTRUCTIONS	DELIVERY METHOD
■ Review content presented in ***Flight Management and Alert Instrumentation*** lesson ■ Navigate to the ***Parking Lot*** link within Blackboard and review any student questions ■ Address ***Parking Lot*** questions and facilitate a brief discussion of the lesson content	Facilitated Discussion **EST. RUN TIME** 15 mins.

FACILITATOR INSTRUCTIONS	DELIVERY METHOD
■ **ENABLE *Physiological Factors Affecting Flight*** lesson in Blackboard ■ Instruct students to navigate to the ***Physiological Factors Affecting Flight*** lesson in Blackboard ■ Instruct students to work individually through the lesson content ■ Upon completion of the lesson, students should review previously introduced content or wait quietly until other students have completed	Blackboard **EST. RUN TIME** 20 mins.

PHYSIOLOGICAL FACTORS AFFECTING FLIGHT

Purpose: The purpose of this lesson is to identify characteristics of physiological factors affecting pilots during flight, which can cause a pilot to perform erratic, and unpredictable maneuvers.

Objective:

- Describe characteristics of physiological factors affecting pilots during flight

References for this lesson are as follows:

- Aeronautical Information Manual (AIM)
- FAA-H-8083-15, Instrument Flying Handbook
- FAA-H-8083-3, Airplane Flying Handbook
- AC 25-20, Advisory Circular Pressurization, Ventilation and Oxygen Systems Assessment for Subsonic Flight Including High Altitude Operation

Physiological Factors Affecting Flight

Certain conditions occur during flight, that cause a pilot to experience physiological factors. The level to which these factors affect an individual, and the tolerance level of the individual may differ. Typically, any physiological factor that occurs during flight degrades a pilot's decision-making and ability to fly.

Hypoxia

Hypoxia occurs when the blood, tissues, and/or cells don't receive enough oxygen to maintain normal physiological function.

Physiological Effects – At higher altitudes, oxygen molecules are spread farther apart, and exert less pressure per square inch. As pressure decreases, the lungs cannot transfer oxygen effectively from the ambient air to the bloodstream, preventing sufficient oxygen from reaching the rest of the body.

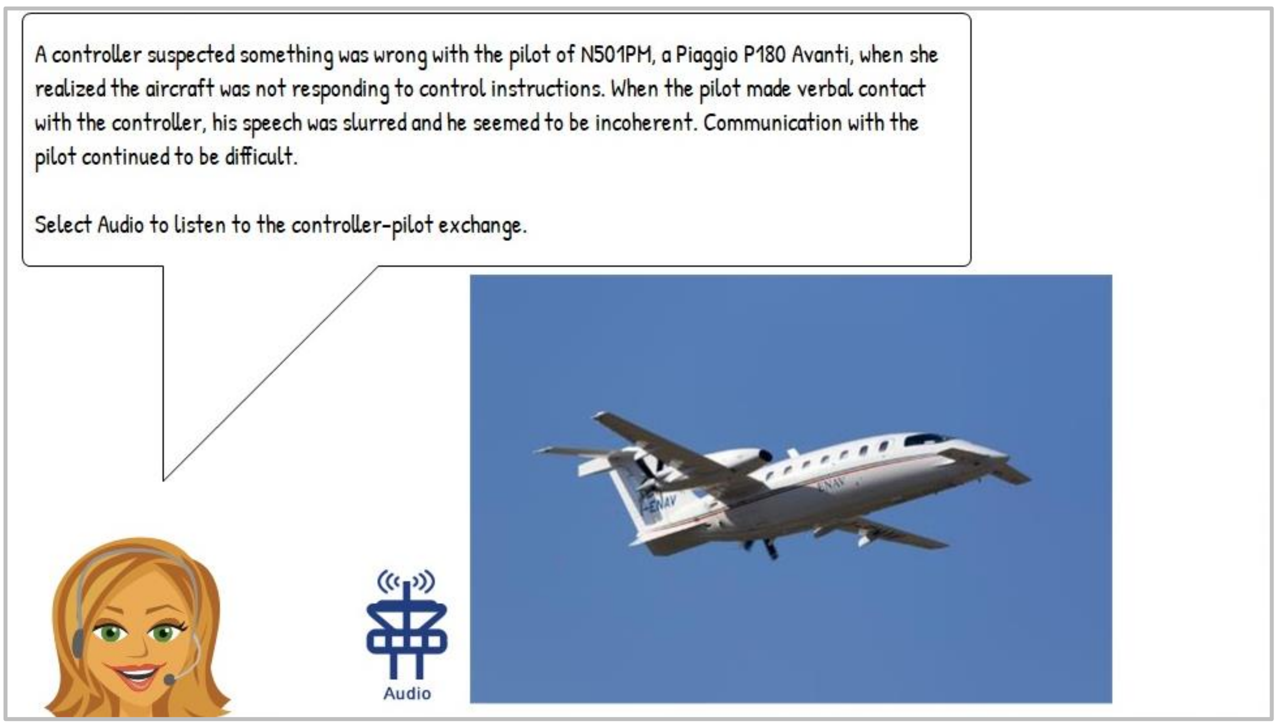
Causes:

- Flying in an aircraft with a cabin altitude above 10,000 feet mean sea level (MSL) without the use of supplemental oxygen
- Malfunction of either the pressurization system or the oxygen system

Hazards, Expectations, and Actions

Hazards	Hypoxia hazards may cause: ■ Unpredictable maneuvers due to pilot's impaired mental ability ■ Pilot's loss of consciousness or death ■ Pilot's performance can seriously deteriorate, within 15 minutes at 15,000 feet
Expectations	What controllers might expect from pilots: ■ Altitude changes ■ Slurred speech ■ Confusion ■ Disorientation ■ Euphoria ■ Erratic headings
What to Do	Best practices controllers may use when they suspect a pilot suffers from hypoxia: ■ Descend the aircraft to an altitude below 10,000 feet MSL or to the lowest Minimum IFR Altitude (MIA) or Minimum Vectoring Altitude (MVA) ■ Advise the pilot of the suspected condition, and remind them to use supplemental oxygen when needed

Hypoxia Scenario

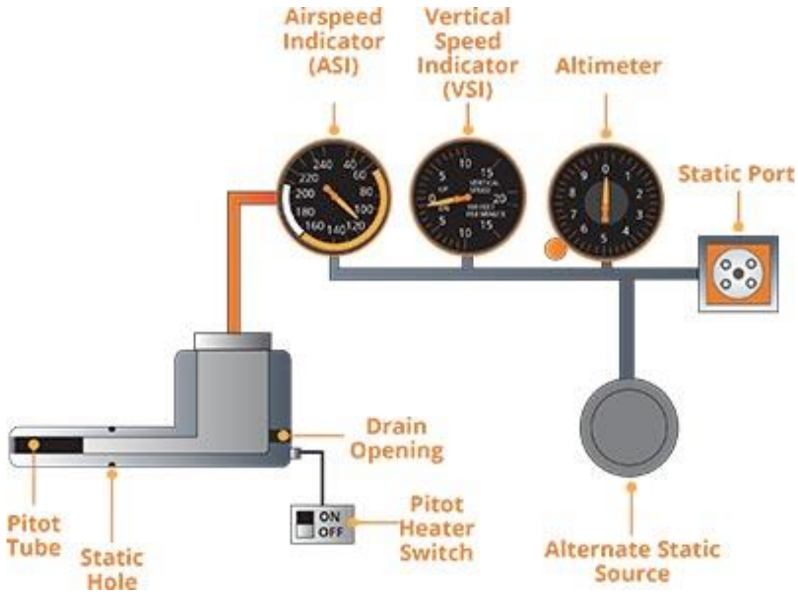


Loss of Pitot-Static or Gyroscopic Systems

Failure of pitot-static or gyroscopic systems can cause erratic and unreliable operation of instrument operations.

Pitot-Static System Failure

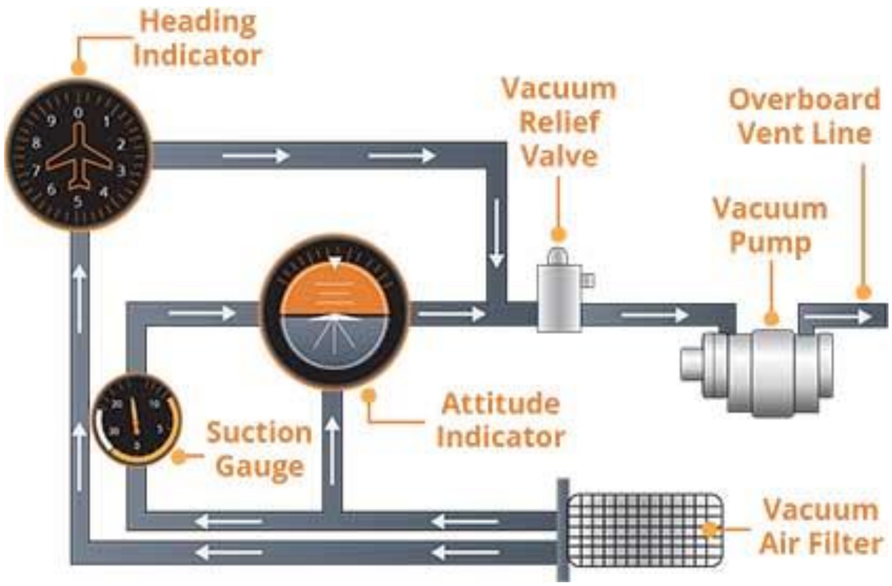
Failure of the pitot-static system can cause erratic and unreliable instrument operations. For example, if ice begins to build on the pitot tube and the pitot heat is not turned on, the dynamic air pressure measurement will be incorrect, causing inaccurate airspeed indications.



Gyroscopic System Failure

Safe flight without reference to a visible horizon (i.e., while in instrument meteorological conditions (IMC)), can be accomplished using flight instruments that operate on gyroscopic principles.

Failure of a gyroscopic system can cause erratic and unreliable operation of the attitude indicator. This can be especially hazardous when flying in IMC and may cause spatial disorientation (vertigo).



Hazards, Expectations, and Actions

Hazards	Hazards such as loss of pitot-static or a gyroscopic system may cause: ■ Spatial disorientation in IMC leading to loss of aircraft control ■ Pilot disorientation
Expectations	What controllers might expect from pilots: ■ Difficulty maintaining straight and level flight ■ Loss of or inaccurate indicated airspace ■ Loss of or inaccurate altitude indication ■ Request for vectors toward visual meteorological conditions (VMC) ■ Difficulty maintaining an assigned heading ■ Request for no-gyro vectors
What to Do	Best practices controllers may use when they suspect a pilot is suffering physiological effects from loss of pitot-static or a gyroscopic system: ■ Advise pilot if you observe a change of altitude and/or heading ■ Provide no-gyro vectors to reported VMC or to an airport

Video – *Pitot-Static or Gyroscopic Systems Failure Scenario* (2:12 mins.)

N4120S was being vectored for the instrument landing system approach into Lincoln, when the controller noticed the pilot seemed to be struggling with assigned headings. Initially, the controller thought the winds were causing the discrepancy in the headings the pilot was flying, and he quickly issued corrective headings. It soon became apparent the pilot was having trouble with his instruments.

Hyperventilation

Hyperventilation occurs when there is an abnormal increase in the volume of air breathed in and out of the lungs. Be alert to the possible occurrence of hyperventilation during emergency conditions.

Physiological Effects – Hyperventilation can occur subconsciously as a result of tension or anxiety when a stressful situation is encountered, and can result in unconsciousness.

If the rate and depth of breathing is consciously brought under control, the body will relax and recover.

Symptoms:

- Dizziness
- Nausea
- Drowsiness

Illusions in Flight

Spatial disorientation (vertigo) is the loss of proper bearings or the state of mental confusion as to position, location, or movement relative to the position of the Earth.

Physiological Effects – Leans occur when an aircraft returns to straight-and-level flight, but the pilot feels compelled to lean into an imaginary turn which is still sensed by the inner ear.

Coriolis illusion occurs when a pilot in a turn makes a sudden head movement.

Knowledge Check L

REVIEW what you have learned so far about physiological factors affecting flight. ANSWER the questions listed below.

1. What condition occurs in your body when experiencing hypoxia? *(Select the correct answer.)*
   - ❑ Abnormal amounts of oxygen in lungs
   - ❑ Lungs can't transfer carbon dioxide
   - ❑ **Lack of oxygen in blood, tissues, and cells**
   - ❑ Spatial disorientation

2. Which physiological factors may affect a pilot, if their aircraft experiences pitot-static or gyroscopic system failure? *(Select the correct answer.)*
   - ❑ Drowsiness
   - ❑ Euphoria and slurred speech
   - ❑ Confusion and nausea
   - ❑ **Spatial disorientation (vertigo)**

3. Which of the following could lead a controller to suspect that a pilot is suffering from physiological effects of hypoxia? *(Select all correct answers that apply.)*
   - ❑ Request vectors
   - ❑ **Erratic headings**
   - ❑ **Altitude changes**
   - ❑ **Slurred speech**
   - ❑ Lean into turns

Physiological Factors Affecting Flight Summary

Physiological factors can affect a pilot and degrade their decision-making or flying abilities, and compromise safety. As a controller, you should be able to identify characteristics of a person suffering from physiological factors and provide guidance to reduce the threat to safety.

SUMMARY

The purpose of this module was to identify the pilot's environment and explain how it affects aviation.

In accordance with FAA-H-8083-25, Pilot's Handbook of Aeronautical Knowledge; FAA-H-8083-15, Instrument Flying Handbook; Aeronautical Information Manual (AIM); FAA Order JO 7110.65, Air Traffic Control; FAA-H-8083-3, Airplane Flying Handbook; and AC 25-20, Advisory Circular Pressurization, Ventilation and Oxygen Systems Assessment for Subsonic Flight Including High Altitude Operation, you should now be able to:

- Define types and characteristics of pitot-static system
- Define operating principles of gyroscopic flight instruments
- Define operating principles of navigational instruments
- Identify types and characteristics of radio equipment
- Identify instrumentation used to manage aircraft flight
- Identify alert systems used to prevent airborne collisions
- Describe characteristics of physiological factors affecting pilots during flight

FACILITATOR INSTRUCTIONS	DELIVERY METHOD
■ Navigate to the ***Parking Lot*** link within Blackboard and review any student questions ■ Address ***Parking Lot*** questions and facilitate a brief discussion of the lesson content ■ Instruct students to prepare for the End-of-Module test by putting away their Student Guides	Facilitated Discussion **EST. RUN TIME** 15 mins.

FACILITATOR INSTRUCTIONS	DELIVERY METHOD
■ **ENABLE *Pilot's Environment End-of-Module Test*** link in Blackboard ■ Instruct students: ○ Clear desks ○ Do not write anything during or after the test ○ Navigate to the ***Pilot's Environment End-of-Module Test*** link in Blackboard ○ Once they are satisfied with their responses, click "Save and Submit;" do not click "OK" to review results until directed to do so ○ Choose "Cancel" if they receive a warning message that the test has unanswered questions; choosing OK will submit the test and not allow them to go back and answer the questions ○ Leave the room after submitting the test and return at the "Be Back" time ■ ***Note:*** *This test is scored but not graded* ■ During test, monitor students to ensure a secure testing environment ■ Identify the most commonly missed questions by reviewing student statistics in Blackboard ■ Instruct students to click "View Results" when ready to review commonly missed questions ■ Review commonly missed questions with students	Blackboard Assessment **EST. RUN TIME** 20 mins.

END-OF-MODULE TEST (ANSWER KEY)

Note: *Test questions in Blackboard are presented to the students in random order. Please be aware the test key question order will not match the student version.*

1. Which of the following components does the altimeter depend on for operation? *(Select the correct answer.)*
   - ❑ **<u>Static air vent</u>**
   - ❑ Pitot tube
   - ❑ Gyro
   - ❑ Rudder

   Reference(s): FAA-H-8083-25, Chap. 8

2. Which instruments become inoperative in most small aircraft if the vacuum pump fails? *(Select the correct answer.)*
   - ❑ **Heading indicator and attitude indicator**
   - ❑ Airspeed indicator, turn, and bank
   - ❑ Altimeter and directional gyro
   - ❑ VSI and attitude indicator

   Reference(s): FAA-H-8083-25, Chap. 8

3. The RMI is designed to receive what types of signals? *(Select the correct answer.)*
   - ❑ **VOR; NDB**
   - ❑ VOR; LOC
   - ❑ NDB; DME
   - ❑ LOC; NDB

   Reference(s): FAA-H-8083-25, Chap. 16

4. Where would you set the NAV frequency on a NAV/COM radio? *(Select the correct answer.)*
   - ❑ **Navigation side**
   - ❑ VHF
   - ❑ UHF
   - ❑ Communications side

   Reference(s): FAA-H-8083-15, Chap. 9

5. Which instrument in the FMS would contain information related to terrain? *(Select the correct answer.)*
   - ❑ **Multifunction Display**
   - ❑ Engine Indicating and Crew Alerting System
   - ❑ Navigational Display
   - ❑ Primary Flight Display

   Reference(s): FAA-H-8083-15, Chap.9

6. Which TCAS level of alerting is issued 45 seconds prior to CPA? *(Select the correct answer.)*
   - ❑ **TA**
   - ❑ RA
   - ❑ CAS
   - ❑ TCAS II

   Reference(s): JO 7110.65, Pilot/Controller Glossary

7. Which behaviors would lead a controller to suspect a pilot is suffering from hypoxia? *(Select the correct answer.)*
   - ❑ **Erratic headings, slurred speech**
   - ❑ Compelled to lean, dizziness
   - ❑ Spatial disorientation, pilot disorientation
   - ❑ Nausea, drowsiness

   Reference(s): AIM, Chap. 8; FAA-H 8083-25, Chap.17