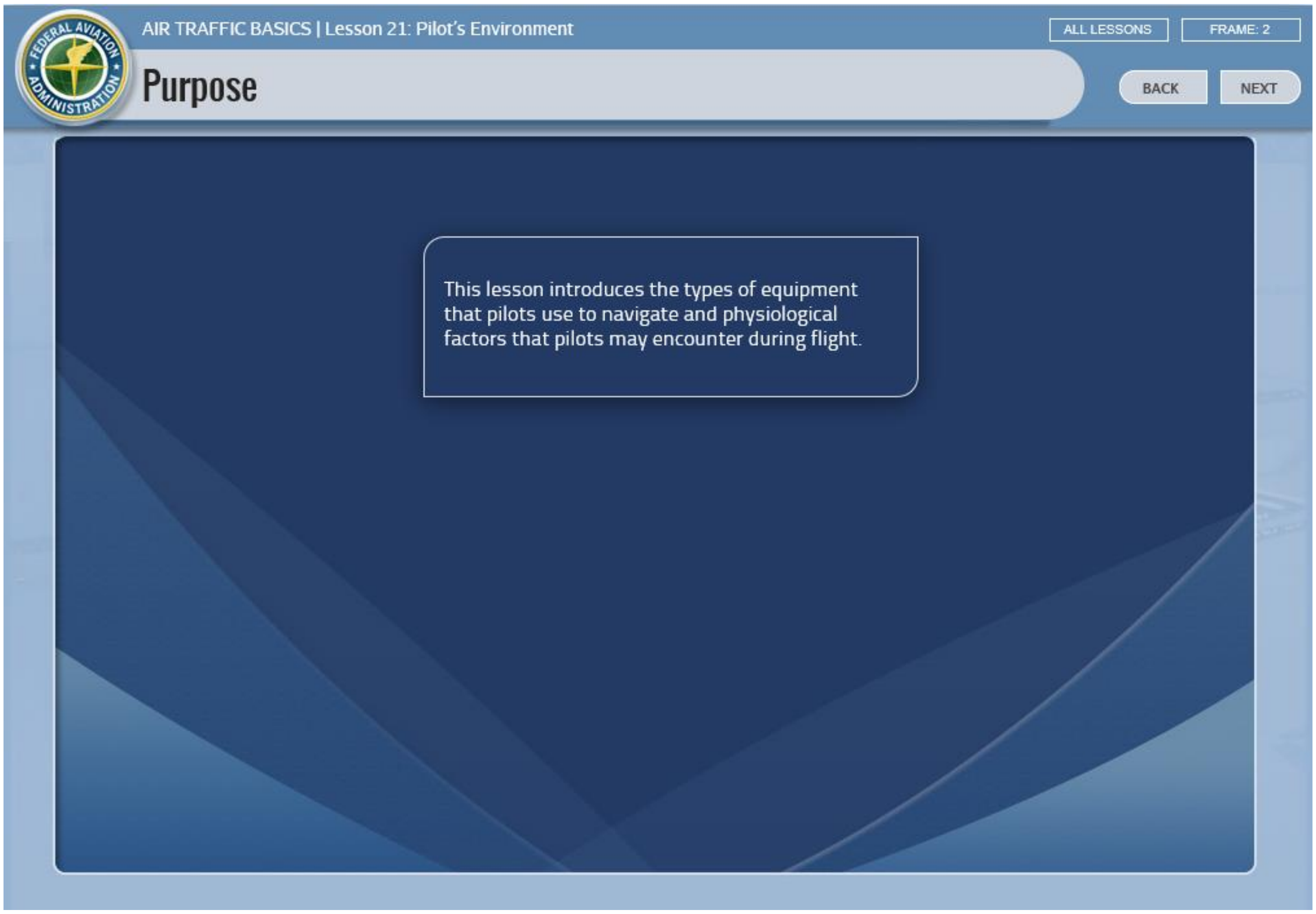
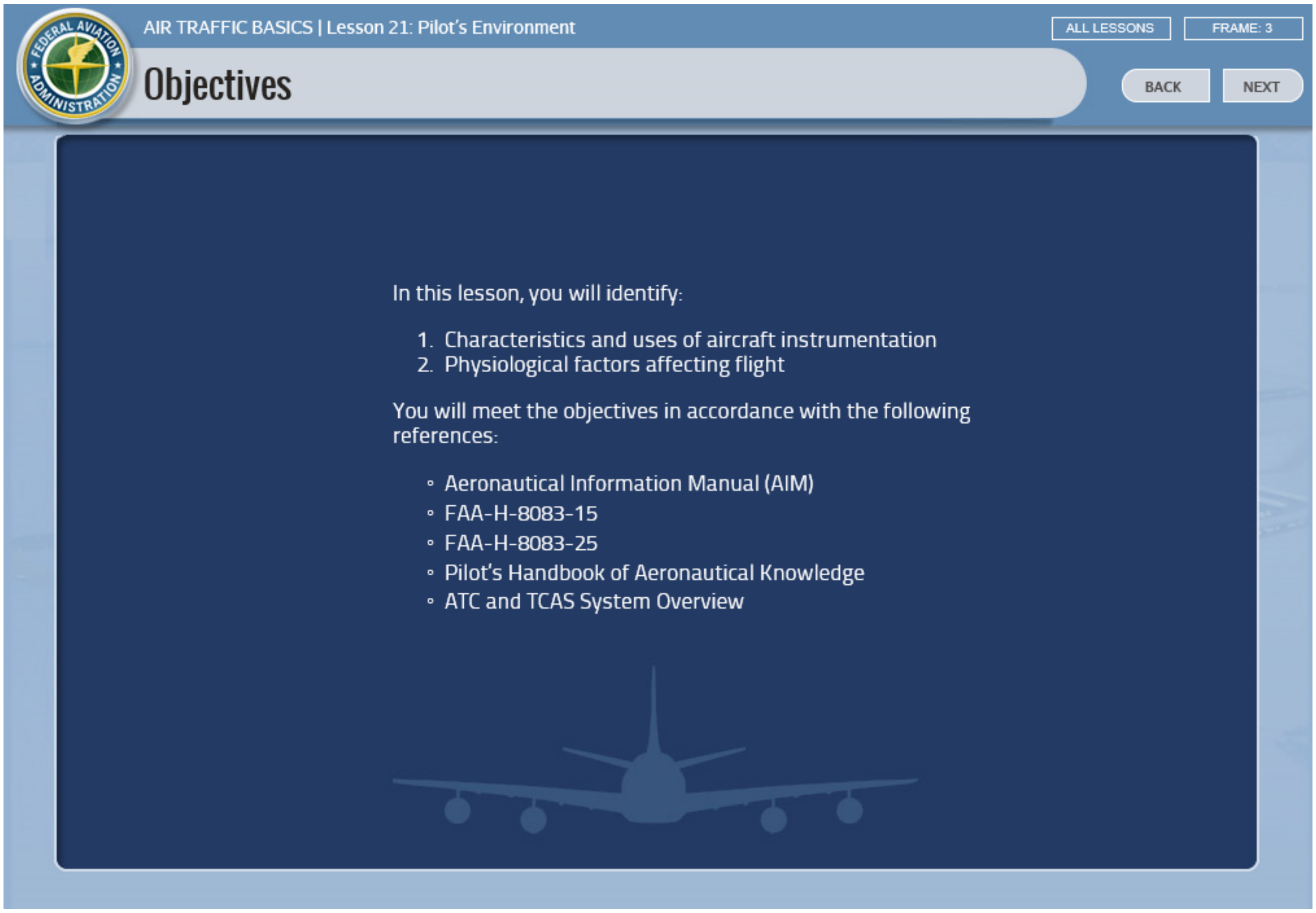
When an aircraft is cleared "direct OKC," how does the pilot find OKC?

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.


AIR TRAFFIC BASICS | Lesson 21: Pilot's Environment
ALL LESSONS
FRAME: 2
Purpose
BACK
NEXT
This lesson introduces the types of equipment that pilots use to navigate and physiological factors that pilots may encounter during flight.

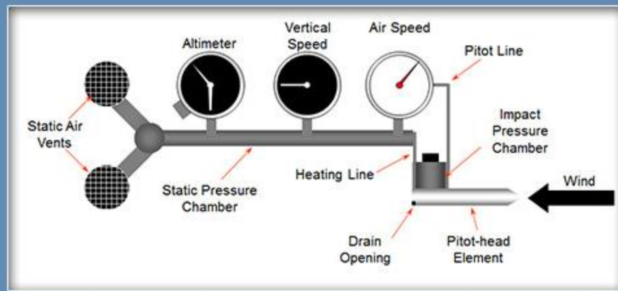

AIR TRAFFIC BASICS | Lesson 21: Pilot's Environment
ALL LESSONS
FRAME: 3
Objectives
BACK
NEXT
In this lesson, you will identify:
1. Characteristics and uses of aircraft instrumentation
2. Physiological factors affecting flight
You will meet the objectives in accordance with the following references:
◦ Aeronautical Information Manual (AIM)
◦ FAA-H-8083-15
◦ FAA-H-8083-25
◦ Pilot's Handbook of Aeronautical Knowledge
◦ ATC and TCAS System Overview

AIR TRAFFIC BASICS | Lesson 21: Pilot's Environment

ALL LESSONS FRAME: 4

Pitot-Static System

BACK NEXT



PITOT-STATIC SYSTEM COMPONENTS

The pitot-static system provides the sources of air pressure for the operation of the following instruments:

- **Altimeter**
- **Vertical speed indicator**
- **Airspeed indicator**

There are two major parts of the pitot-static system:

- **The pitot tube with impact pressure chamber and lines**
- **The static air vents with static pressure chamber and lines**

FAA-H-8083-15, Chap. 3; FAA-H-8083-25, Chap. 6

AIR TRAFFIC BASICS | Lesson 21: Pilot's Environment

ALL LESSONS FRAME: 5

Pitot-Static System

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Pitot Tube

The pitot tube is the source of impact pressure.

- Impact pressure is the result of the aircraft's motion through the air.
- The pitot tube has an opening in the front of the tube.

The pitot tube is usually mounted on the leading edge of the wing, on the nose section, or on the vertical stabilizer.

- Some aircraft have two pitot systems.

The pitot tube is connected to the airspeed indicator.

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

FAA-H-8083-15, Chap.3 FAA-H-8083-25, Chap. 6

AIR TRAFFIC BASICS | Lesson 21: Pilot's Environment

ALL LESSONS FRAME: 6

Pitot-Static System

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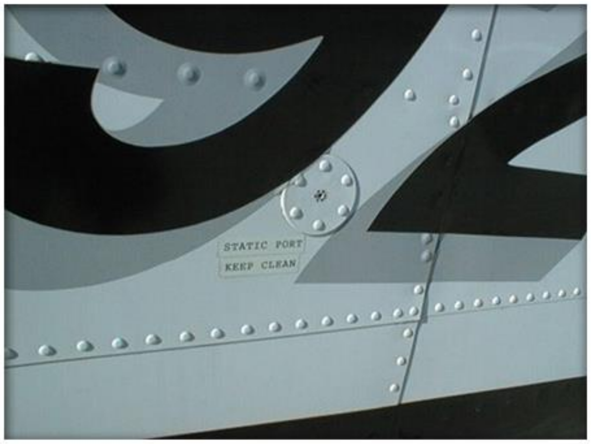

Static Air Vents

Static air vents are the source of external atmospheric pressure.

A static air vent is a small hole or group of holes connecting outside air pressure to the pitot-static instruments.

Static air vents are normally mounted:

- Flush on the side of the fuselage

  or

- Behind the pitot tube

All three pitot-static system instruments are vented to the static vent openings.

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

FAA-H-8083-15, Chap. 3; FAA-H-8083-25, Chap. 6

AIR TRAFFIC BASICS | Lesson 21: Pilot's Environment

ALL LESSONS FRAME: 7

Pitot-Static System Instruments

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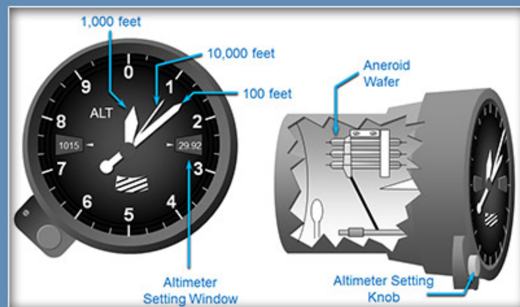

Altimeter

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

- **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 window.**

FAA-H-8083-15, Chap. 3; FAA-H-8083-25, Chap. 6

AIR TRAFFIC BASICS | Lesson 21: Pilot's Environment

ALL LESSONS FRAME: 8

Pitot-Static System Instruments

BACK NEXT

Altimeter

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, and for flights descending below FL180 from Class A airspace.
- The altimeter setting of 29.92 is always used for flights at and above 18,000 feet MSL.

If the altimeter settings are not updated, there can be adverse effects of pressure change on altitude information.

- 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.
- 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.

AIR TRAFFIC BASICS | Lesson 21: Pilot's Environment

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Pitot-Static System Instruments

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Vertical Speed Indicator

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

The VSI:

- **Gives immediate indication of changes in altitude (up or down)**
- **Utilizes static pressure only**

FAA-H-8083-15, Chap. 3; FAA-H-8083-25, Chap. 6

Pitot-Static System Instruments

Arcs are color coded for certain speeds and speed ranges

Airspeed Indicator

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**

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**

FAA-H-8083-15, Chap. 3; FAA-H-8083-25, Chap. 6

AIR TRAFFIC BASICS | Lesson 21: Pilot's Environment

ALL LESSONS FRAME: 11

Pitot-Static System Instruments

BACK NEXT

Types of Airspeed

Types of airspeed include:

- Indicated Airspeed (IAS) is read directly from the airspeed indicator.
- True Airspeed (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.

FAA-H-8083-15, Chap. 3 FAA-H-8083-25, Chap. 6

Pitot-Static System Instruments

Effects of Altitude on Airspeeds

True Airspeed and Indicated Airspeed are approximately equal at sea level.

Indicated Airspeed becomes less than True Airspeed as altitude increases.

- **The density of air decreases greatly with increasing altitude.**

NOTE: An airplane at FL350 with an Indicated Airspeed of 230-250 knots has a True Airspeed of approximately 430-450 knots.

FAA-H-8083-25, Chap. 6

AIR TRAFFIC BASICS | Lesson 21: Pilot's Environment

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Pitot-Static System Instruments

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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.
- The compass card has letters for cardinal headings and 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.

- A line (called the lubber line) is mounted behind the glass of the instrument that can be used for a reference line when aligning the headings on the compass card.

FAA-H-8083-15, Chap. 3; FAA-H-8083-25, Chap. 6

AIR TRAFFIC BASICS | Lesson 21: Pilot's Environment

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Pitot-Static System Instruments

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Magnetic Compass: Compass Error

Variation and Deviation are two types of compass error.

- **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' north-seeking magnetized needles with reference to true north.**
- **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.**

FAA-H-8083-15; Chap. 3; FAA-H-8083-25, Chap. 6

Gyroscopic Flight Instruments

Types of 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.

FAA-H-8083-15; Chap. 3; FAA-H-8083-25, Chap. 6

Gyroscopic Flight Instruments

Instrument Sources of Power

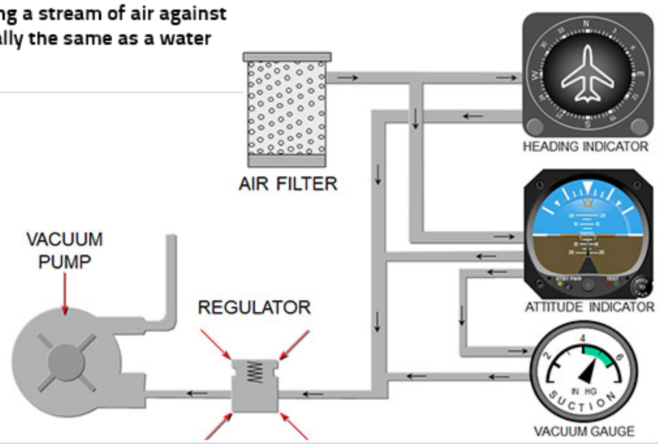
In some aircraft, the gyros are vacuum, pressure, or electrically operated.

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.

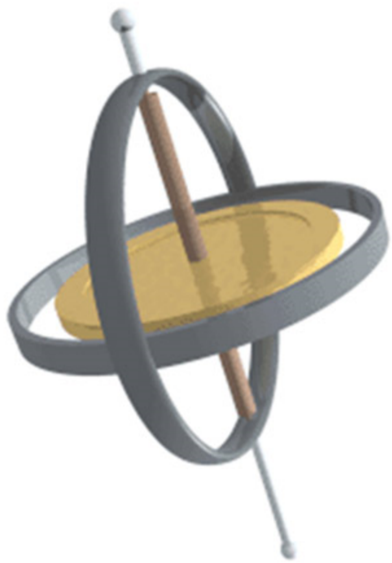
- **In most small aircraft, the failure of the vacuum pump would render the heading indicator and attitude indicator inoperative.**

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.

FAA-H-8083-25, Chap. 6



Gyroscopic Flight Instruments



Engine Driven Vacuum Pump

One source of vacuum for the gyros installed in light aircraft is the vane-type engine-driven pump which is mounted on the engine.

- Pump capacity varies in different aircraft, depending on the number of gyros to be operated.
- The gauge is mounted in the aircraft's instrument panel and indicates the amount of pressure in the system.

FAA-H-8083-25, Chap. 6

AIR TRAFFIC BASICS | Lesson 21: Pilot's Environment

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Gyroscopic Flight Instruments

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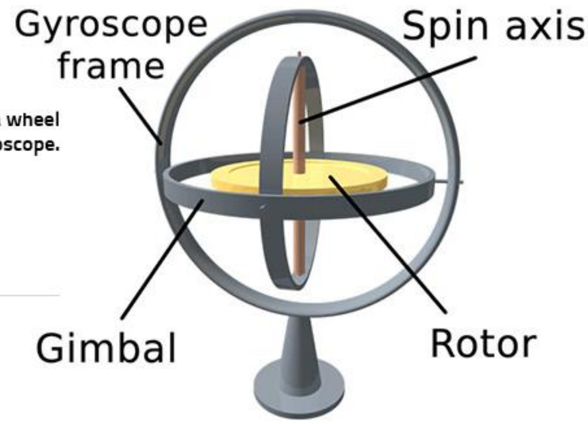
Gyroscopic Principles

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**

FAA-H-8083-25, Chap. 6



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Gyroscopic Flight Instruments

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Gyroscopic 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.

FAA-H-8083-25, Chap. 6

AIR TRAFFIC BASICS | Lesson 21: Pilot's Environment

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Gyroscopic Flight Instruments

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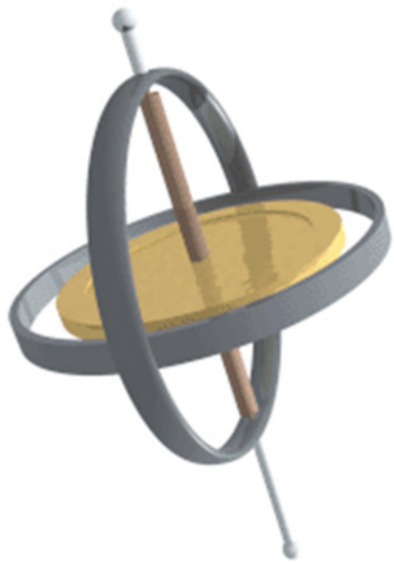

Gyroscopic Precession

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.**

FAA-H-8083-25, Chap. 6

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Gyroscopic Flight Instruments

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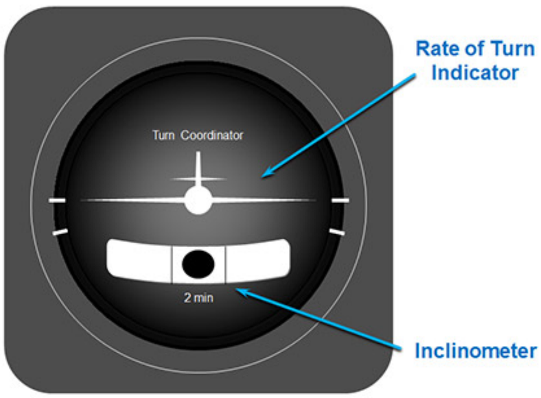

Turn Coordinator

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, composed of a rate-of-turn indicator and an inclinometer.

- 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.

FAA-H-8083-25, Chap. 6

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Gyroscopic Flight Instruments

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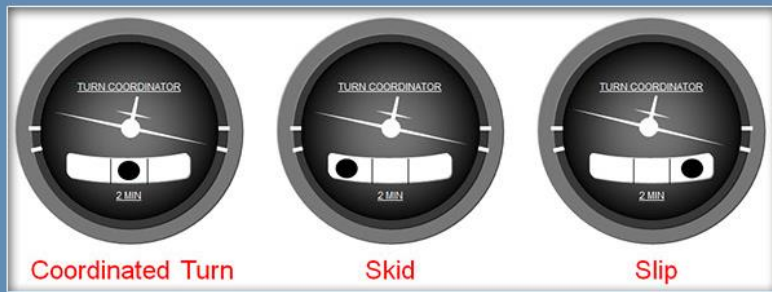
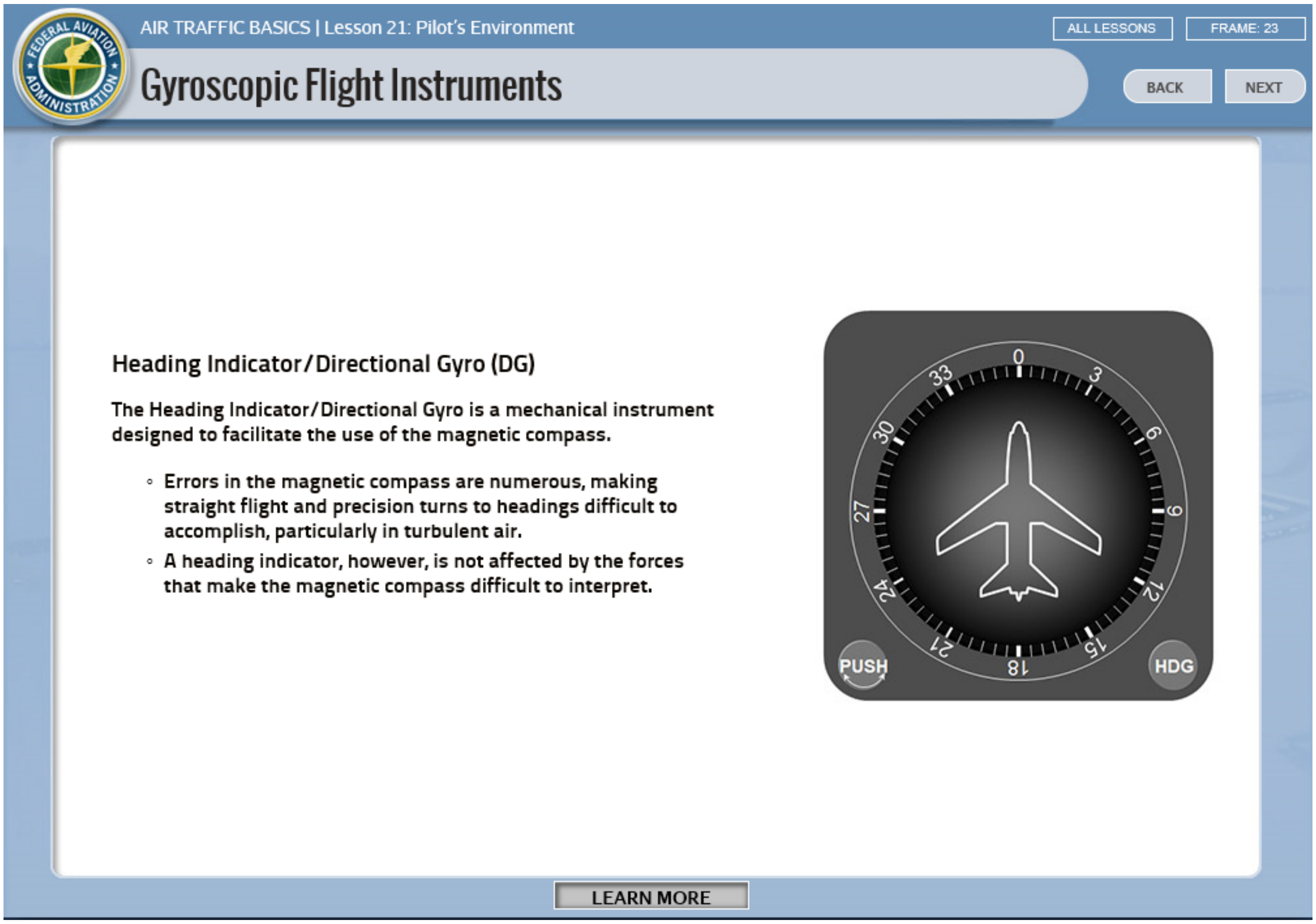


Inclinometer

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

- **The ball indicates whether the airplane is in coordinated flight, or is in a skid or slip.**
- **When the ball is centered, the miniature aircraft represents a standard rate of turn of 3 degrees per second and the aircraft should complete a 360-degree turn in two minutes.**

FAA-H-8083-25, Chap. 6



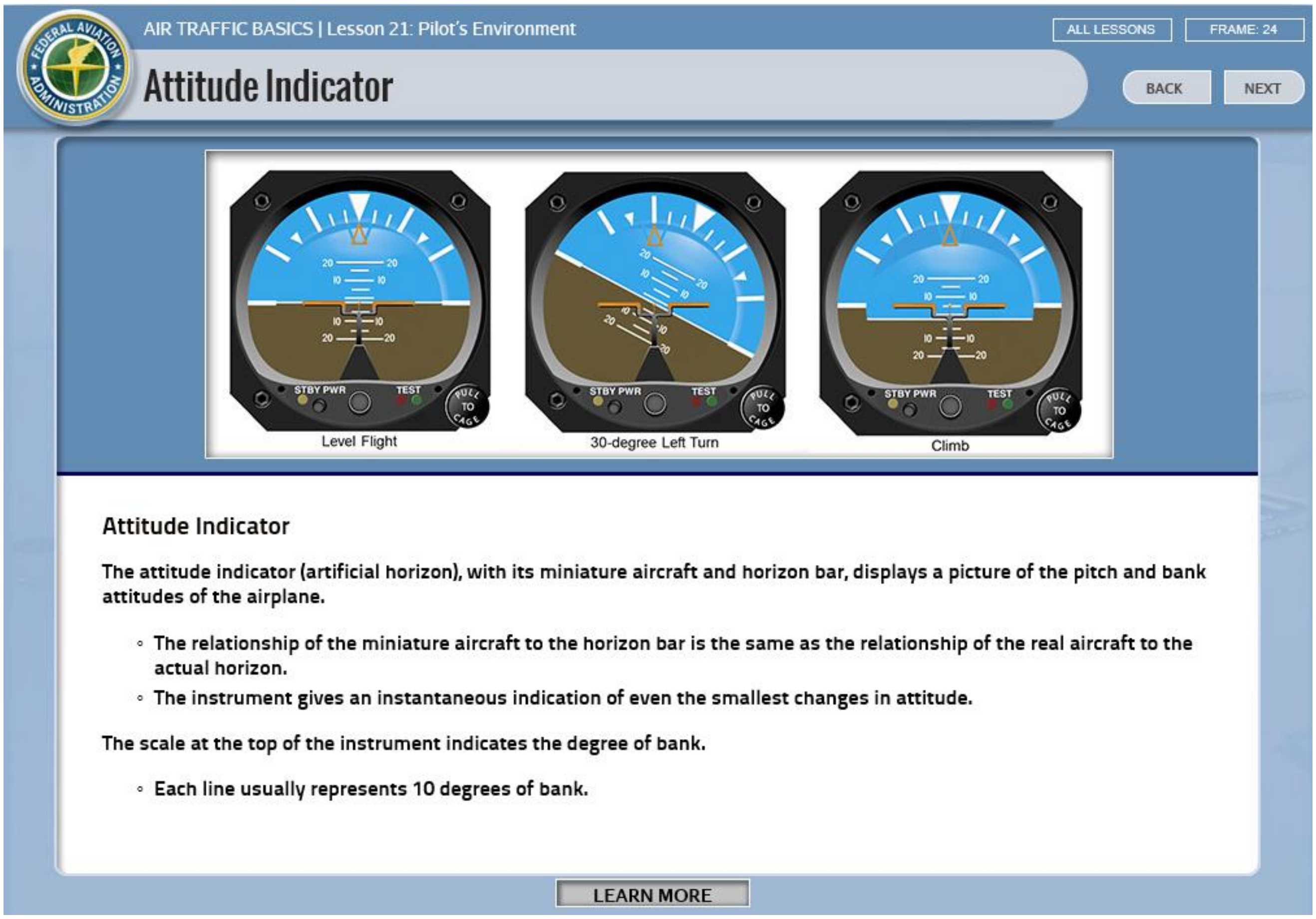
Because of precession, caused chiefly by friction, the heading indicator creeps or drifts from a heading to which it is set. Therefore, it is important for the pilot to frequently check and reset the heading indicator to align with the magnetic compass.

- Since the rotor remains rigid in space, the points of the card hold the same position in space.
- As the instrument case and the airplane revolve around the vertical axis, the card provides clear and accurate heading information.
- The heading indicator is not a direction-seeking instrument, however the magnetic compass is.

Headings are read by adding zero:

Examples: 3 = 30 degrees, 27 = 270 degrees

Reference: FAA-H-8083-25, Chap. 6



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

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

References:

- FAA-H-8083-15, Chap. 3
- FAA-H-8083-25, Chap. 6

AIR TRAFFIC BASICS | Lesson 21: Pilot's Environment

ALL LESSONS FRAME: 25

Navigation Instruments

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Navigational Uses

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

- Automatic Direction Finder (ADF)
- VOR instrument
- Instrument Landing System (ILS) Receiving Equipment
- Radio Magnetic Indicator (RMI)
- Horizontal Situation Indicator (HSI)
- Distance Measuring Equipment (DME)
- Global Positioning System (GPS)

FAA-H-8083-15, Chap. 7; FAA-H-8083-25, Chap. 14; AIM, Chap. 1

AIR TRAFFIC BASICS | Lesson 21: Pilot's Environment

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Navigation Instruments

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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 which 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.**

FAA-H-8083-15, Chap. 7; FAA-H-8083-25, Chap. 14

Navigation Instruments

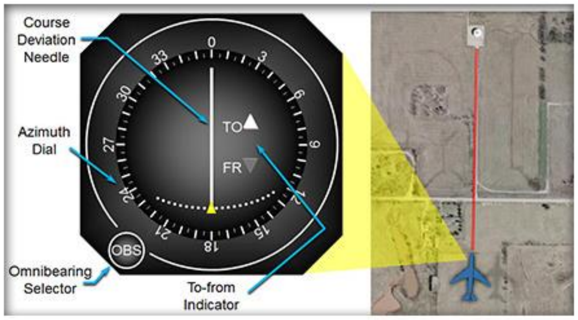
VOR Instrument

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

FAA-H-8083-15, Chap. 7; FAA-H-8083-25, Chap. 7



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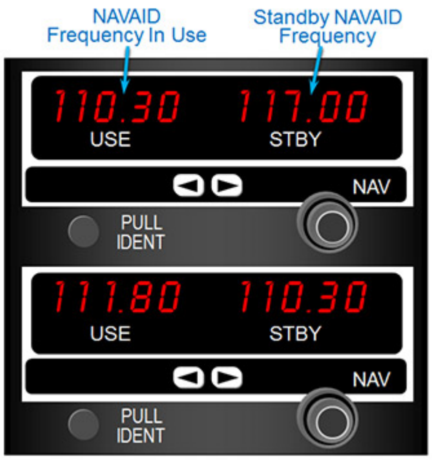
Navigation Instruments



NAV Radio Receiver

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)

    or

  - 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 which is set in the course selector.

FAA-H-8083-15, Chap. 7; FAA-H-8083-25, Chap. 7

AIR TRAFFIC BASICS | Lesson 21: Pilot's Environment

ALL LESSONS FRAME: 29

Navigation Instruments

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NAV Radio Receiver

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

- 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.
- 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 which is 180 degrees opposite of the desired course.

FAA-H-8083-15, Chap. 7; FAA-H-8083-25, Chap. 14

AIR TRAFFIC BASICS | Lesson 21: Pilot's Environment

ALL LESSONS FRAME: 30

Navigation Instruments

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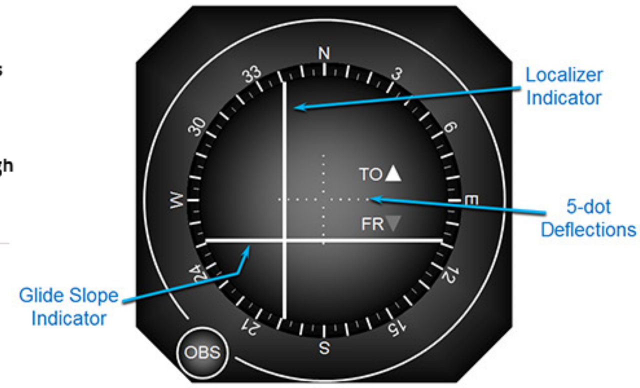
Instrument Landing System (ILS) Receiving Equipment

Instrument Landing System (ILS) receiving equipment is used to make an ILS approach.

- When the crossed horizontal (glide slope) and vertical (localizer) needles are free to move through standard 5-dot deflections, they indicate the position on the localizer course and glide path.

FAA-H-8083-15, Chap. 7



AIR TRAFFIC BASICS | Lesson 21: Pilot's Environment

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Navigation Instruments

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Instrument Landing System (ILS) Receiving Equipment

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.
- 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.
- 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.

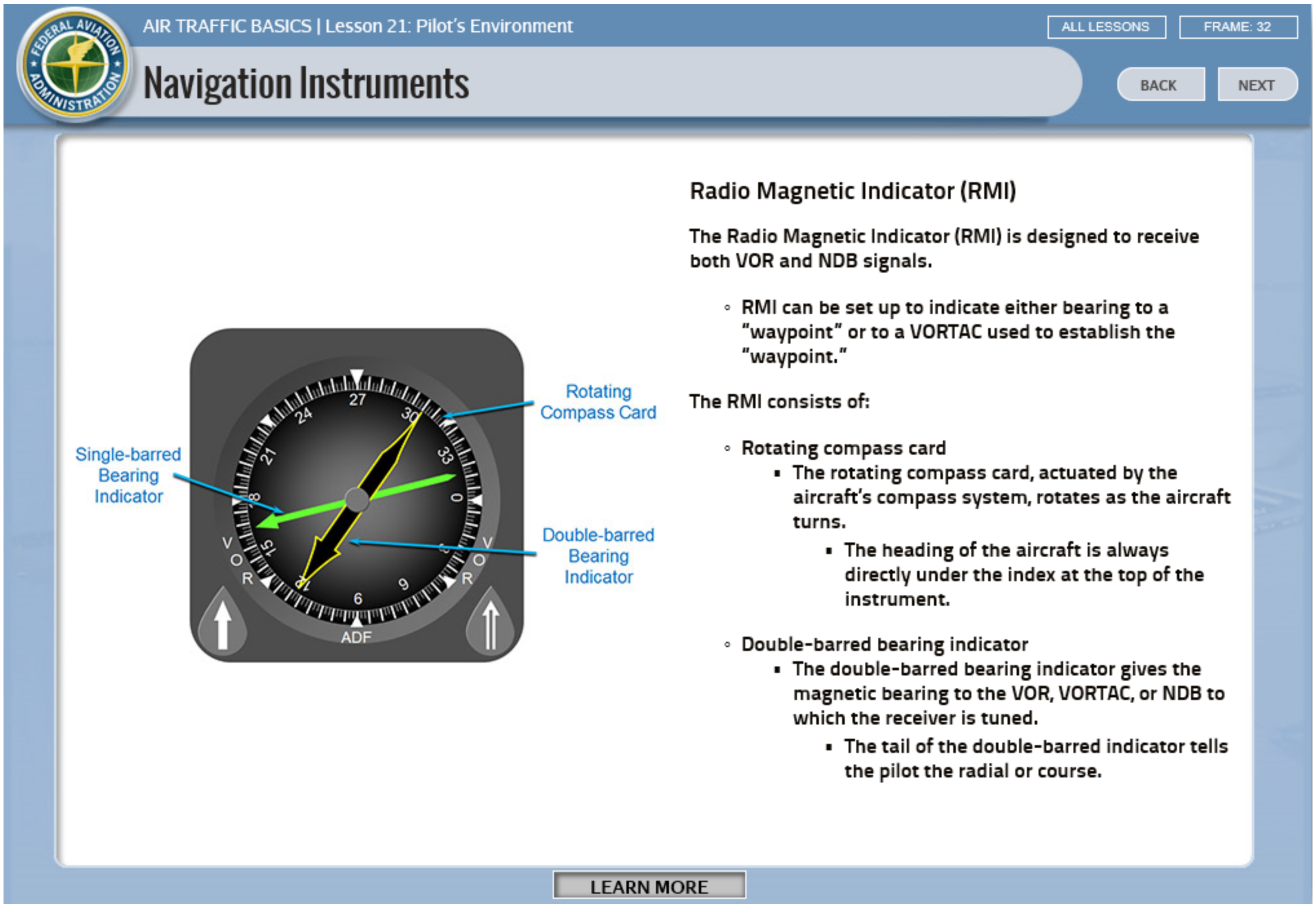
Deflection of the glide slope needle indicates the position of the aircraft with respect to the glide path.

- When the aircraft is above the glide slope, the needle is deflected down.
- When the aircraft is below the glide slope, the needle is deflected up.
- When the aircraft is on the glide slope, the needle is centered.

The red localizer and glide slope warning flags appear when insufficient voltage is received to actuate the needles.

- The flags also appear when an unstable signal or receiver malfunction occurs.

FAA-H-8083-15, Chap. 7



- Single-barred bearing indicator
  - The single-barred bearing indicator functions exactly the same as the double barred bearing indicator.

Reference: FAA-H-8083-15, Chap. 7

AIR TRAFFIC BASICS | Lesson 21: Pilot's Environment

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Navigation Instruments

Horizontal Situation Indicator (HSI)

The Horizontal Situation Indicator (HSI) is a combination of three instruments:

- **Heading indicator**
  - **The aircraft heading is under the upper lubber line.**
- **VOR/LOC indicator**
  - **The course indicating arrow shows the course selected.**
  - **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.**
  - **The TO-FROM indicator is a triangular-shaped pointer.**
    - **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.**
- **Glide slope indicator**
  - **The glide slope deviation pointer indicates the relation of the aircraft to the glide slope.**

FAA-H-8083-15, Chap 7

AIR TRAFFIC BASICS | Lesson 21: Pilot's Environment

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Navigation Instruments

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Distance Measuring Equipment (DME)

The Distance Measuring Equipment (DME) is used in conjunction with the VOR system to show the pilot the exact 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.

FAA-H-8083-15, Chap. 7

Navigation Instruments

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 IFR navigation for domestic en route, 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, waypoint.**
- **In an emergency, a GPS receiver can direct the pilot to the nearest airports.**

AIM, Chap. 1; FAA-H-8083-15, Chap. 7

AIR TRAFFIC BASICS | Lesson 21: Pilot's Environment

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Radio Equipment

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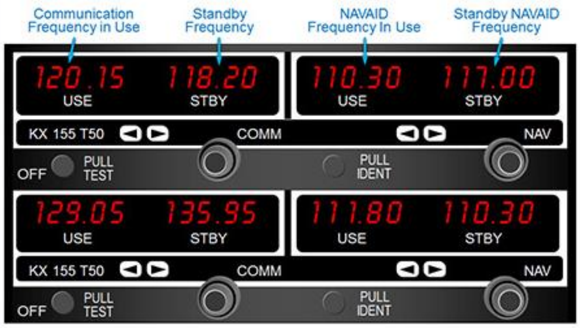


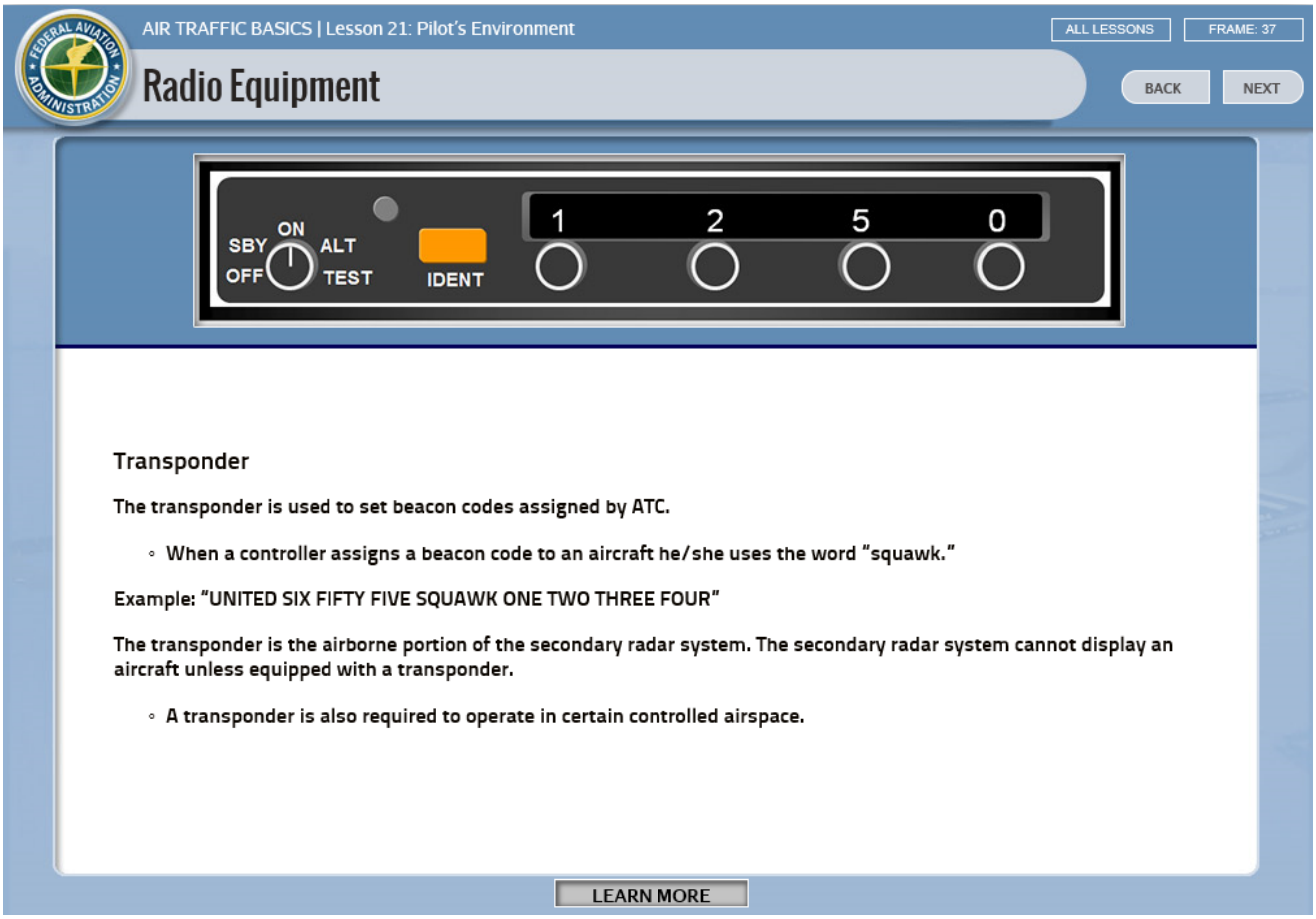
NAV/COM Radio

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

- It is used to tune in air-to-ground and navigational frequencies used by the pilot.
- The NAV is set to the navigation frequency.
- Air-to-ground communications are accomplished on the transceiver (combined transmitter/receiver).
  - Civilian transceivers operate in the Very High Frequency (VHF) range.

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

FAA-H-8083-15, Chap. 9 FAA-H-8083-25, Chap. 12



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.

References:

- FAA-H-8083-15, Chap. 9
- FAA-H-8083-25, Chap. 14
- JO 7110.65, Chap. 5

AIR TRAFFIC BASICS | Lesson 21: Pilot's Environment

ALL LESSONS FRAME: 38

Flight Management System (FMS)

BACK NEXT

FMS Uses

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.**

AIM, Chap. 1, Pilot/Controller Glossary; FAA-H-8083-15, Chap.3

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Flight Management System (FMS)

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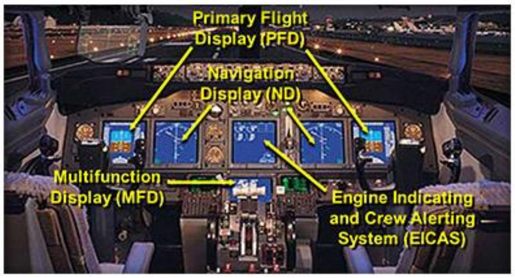
Glass Cockpit

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



FMS takes raw flight and navigation data, (attitude, heading, VOR or any other navigation system course and track, weather radar information, plus a variety of supplemental data such as DME distance, airspeed, and radar altitude) and displays it to the pilot.

FMS displays include at least:

- Primary Flight Display
- Navigation Display
- Engine Indicating and Crew Alerting System
- Multifunction Display
- The Primary Flight Display (PFD) combines all the primary flight instruments into a single visual presentation, including heading, attitude, altitude, and vertical speed.
  - It may also present route and glide slope guidance as well as airspeed and altitude trends and warnings.

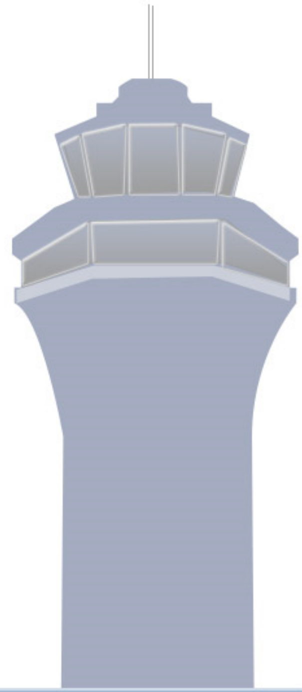
Aviator's Guide to Navigation, Chap. 15

Flight Management System (FMS)

An Engine Indicating and Crew Alerting System (EICAS) provides digital readouts of engine operating data such as fuel flow and temperatures, as well as an alerting capability to warn pilots when individual engine parameters are exceeded.

A Multifunction Display (MFD) serves as a multi-purpose computer and can be used as a backup for the other displays in addition to providing route planning, checklists, weather information, and schematic diagrams of aircraft systems for use in trouble shooting and during an emergency.

Aviator's Guide to Navigation, Chap. 15



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Flight Management System (FMS)

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Primary Flight Display

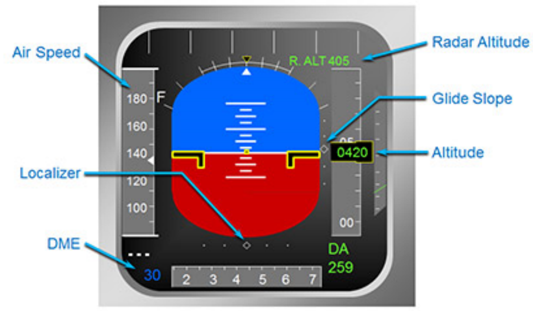
The PFD replaces the attitude indicator (artificial horizon), altimeter, radar altimeter, airspeed indicator, and glide slope indicator.

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

- In the approach configuration, only information unique to the approach phase of flight will be displayed.
  - Localizer information (disappears when en route)
  - Glide slope information (disappears when en route)
  - Radar altitude (height above ground) not usable above 1,200 feet
  - Altimeter
  - DME
  - Decision Altitude (DA)
- In the cruise configuration, only information unique to the en route phase of flight will be displayed.
  - Pressure altitude
  - Indicated Airspeed or Mach number
  - Heading
  - Course

Aviator's Guide to Navigation, Chap. 15

ELECTRONIC ATTITUDE DIRECTOR INDICATOR (APPROACH CONFIGURATION)



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Flight Management System (FMS)

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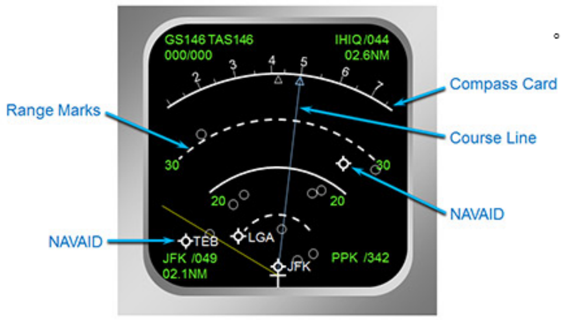
ELECTRONIC HORIZONTAL SITUATION INDICATOR (EHSI)



Navigation Display

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

- The full-compass configuration displays the digital course and ground speed readouts available on most HSIs.
- The ND can also display certain background bits of information, including:
  - Heading source
  - Selected heading
  - Selected course
  - Navigation source
  - Weather radar display along with the antenna tilt angle
  - Ground speed
  - DME
  - TCAS
- In the segmented arc configuration, 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 navigation data.
  - The segmented arc configuration will also display the background bits of information listed above.

Aviator's Guide to Navigation, Chap. 15

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Traffic Alert and Collision Avoidance System (TCAS)

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TCAS

The Traffic Alert and Collision Avoidance System (TCAS) is a self-contained, airborne collision avoidance system that is intended to provide a backup for the separation services provide by ATC in order to prevent near mid-air or mid-air collisions.

- TCAS I generates traffic advisories only.
- TCAS II generates traffic advisories and resolution (collision avoidance) advisories in the vertical plane.

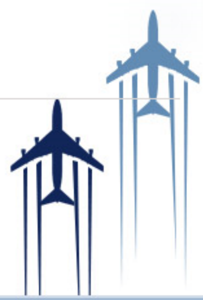
TCAS is not an air traffic system, but it is a system that directly affects ATC.

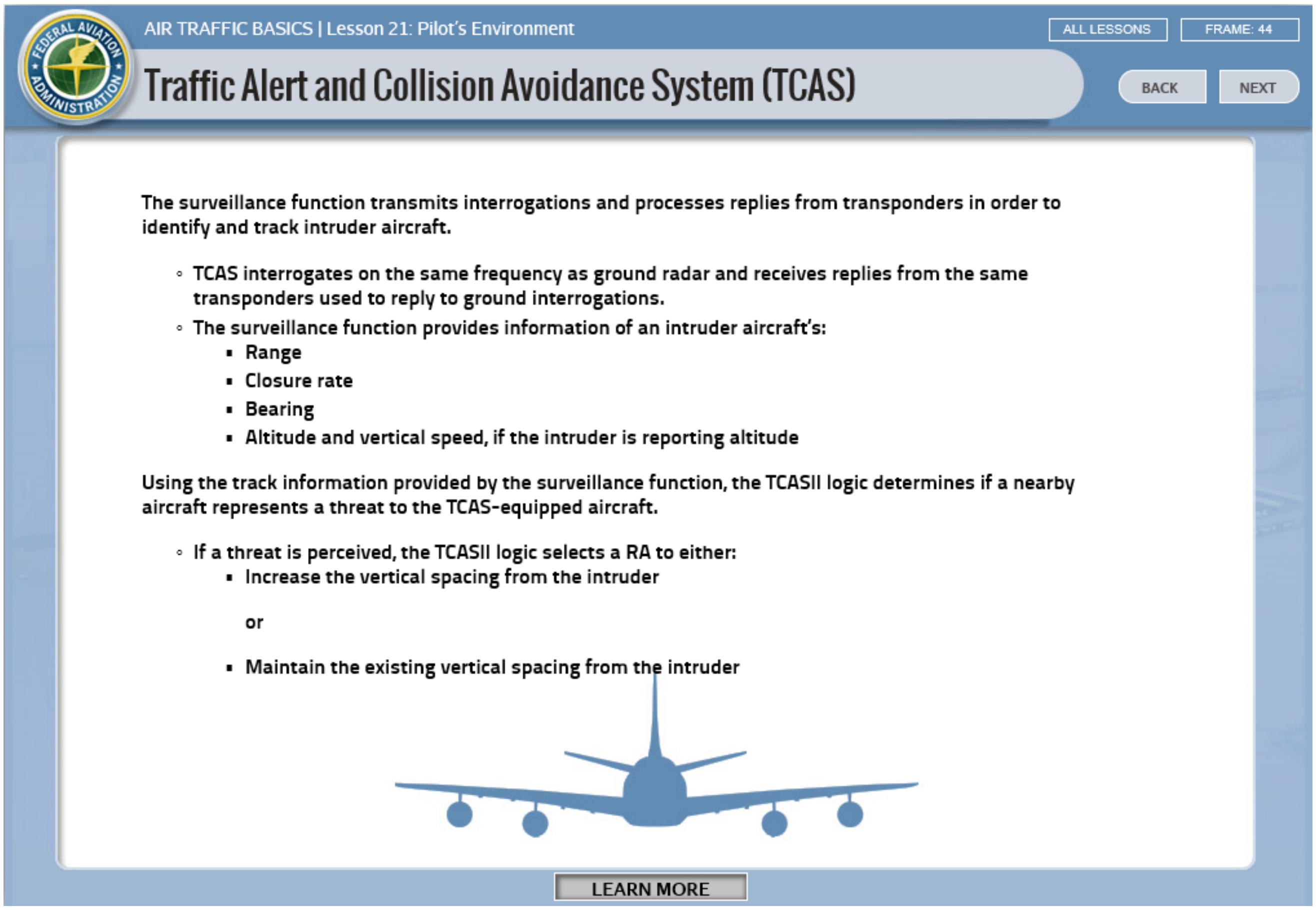
TCAS is required on most commercial, and some general aviation aircraft.

TCAS consists of three functions:

- Surveillance
- Collision Avoidance System (CAS) algorithms
- Air-to-air coordination using the data link provided by the Mode S Transponder

JO 7110.65, Pilot/Controller Glossary, FAR Part 1, 91, 121 and 135





Air-to-air coordination logic:

- 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

References:

- JO 7110.65, Pilot/Controller Glossary
- FAR Part 1, 91, 121, and 135

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Traffic Alert and Collision Avoidance System (TCAS)

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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 CPA (TCAS II only).**

JO 7110.65, Pilot/Controller Glossary, FAR Part 1, 91, 121 and 135

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Traffic Alert and Collision Avoidance System (TCAS)

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Responding to an 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 and expeditiously return to the current ATC clearance when the traffic conflict is resolved.

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

When an aircraft under your control jurisdiction informs you 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.**

AIM, Chap. 4, JO 7110.65 Chap. 2

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Traffic Alert and Collision Avoidance System (TCAS)

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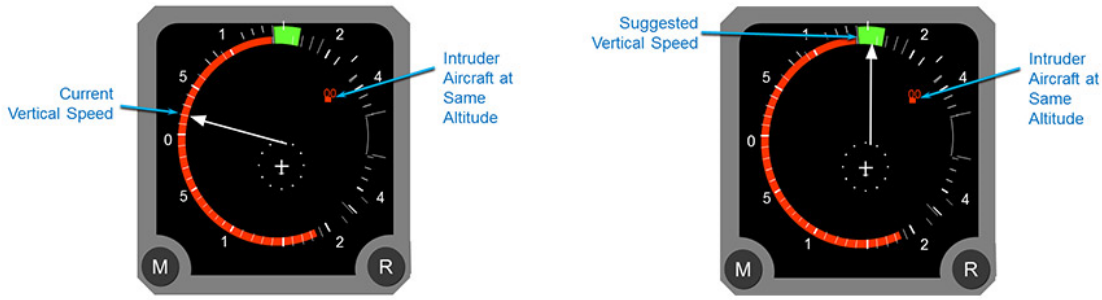
TRAFFIC ALERT AND COLLISION AVOIDANCE SYSTEM (TCAS)



Display

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

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

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Traffic Alert and Collision Avoidance System (TCAS)

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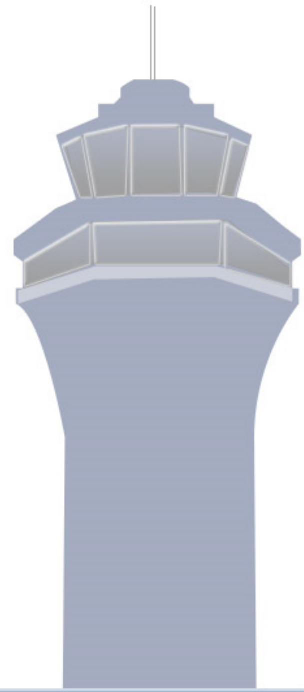
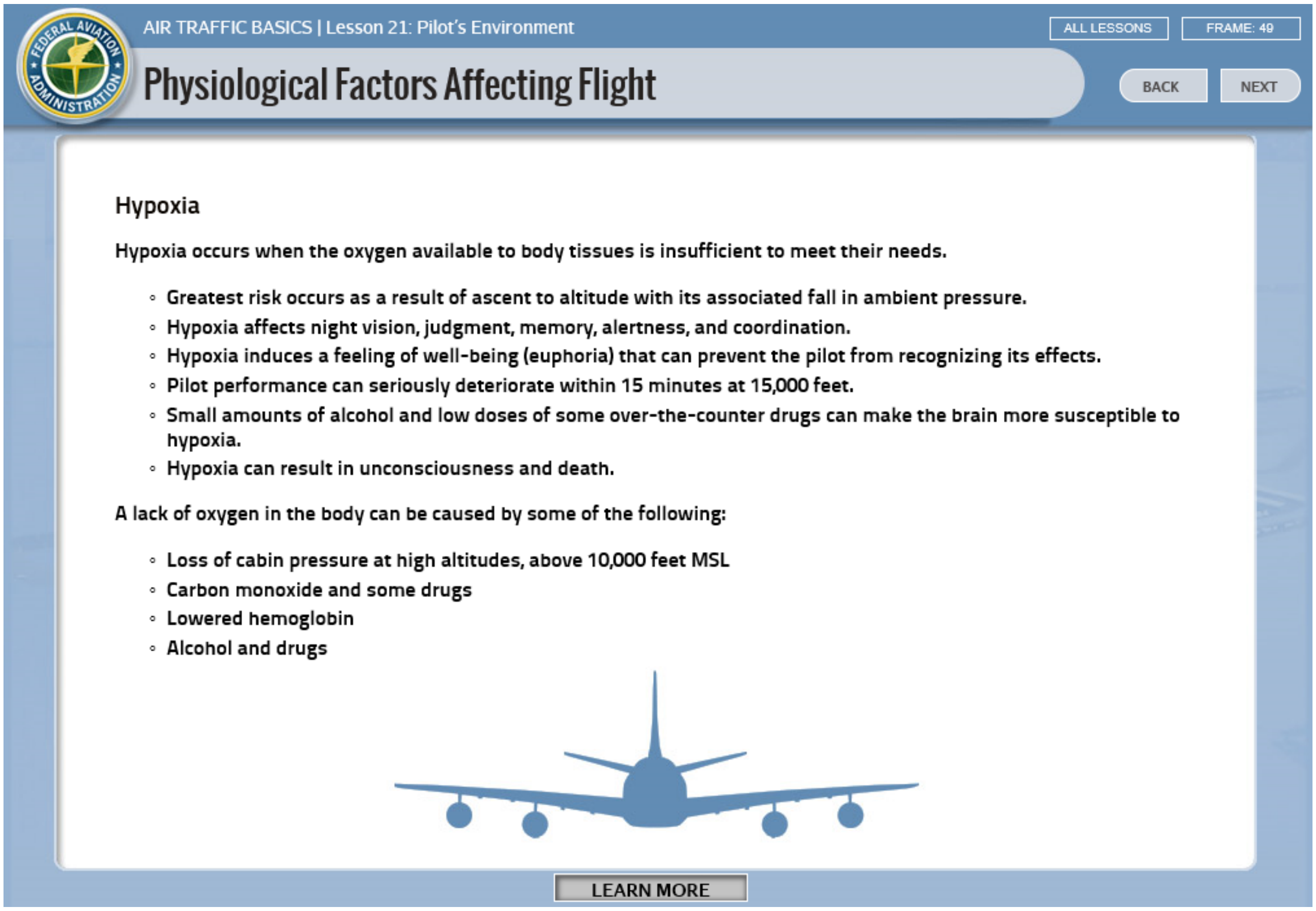
Limitations

- 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.





Symptoms of hypoxia include:

- Slow reactions
- Impaired thinking
- Unusual fatigue
- Pilot sounds intoxicated and may reflect carefree, humorous attitude

If erratic flight or any symptoms of hypoxia are observed, request the pilot to check oxygen system.

- If the pilot has no oxygen system, suggest descent below 10,000 feet.

References:

- AIM, par. 8-1-2
- FAA-H-8083-25, Chap. 15

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Physiological Factors Affecting Flight

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Hyperventilation

Hyperventilation occurs when there is an abnormal increase in the volume of air breathed in and out of the lungs.

- 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.

The symptoms of hyperventilation include:

- Dizziness
- Nausea
- Drowsiness

Be alert to the possible occurrence of hyperventilation during emergency conditions.

AIM, par. 8-1-3; FAA-H-8083-25, Chap. 15

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Physiological Factors Affecting Flight

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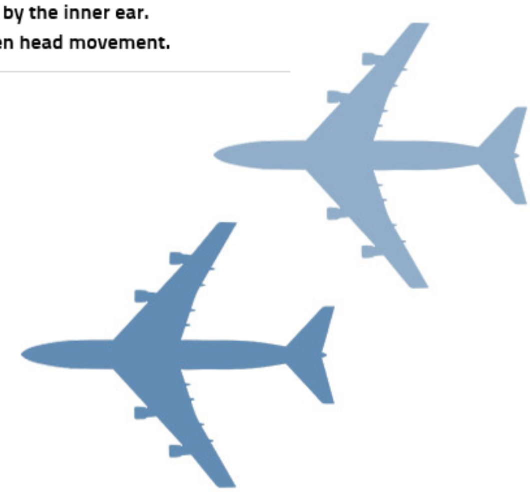
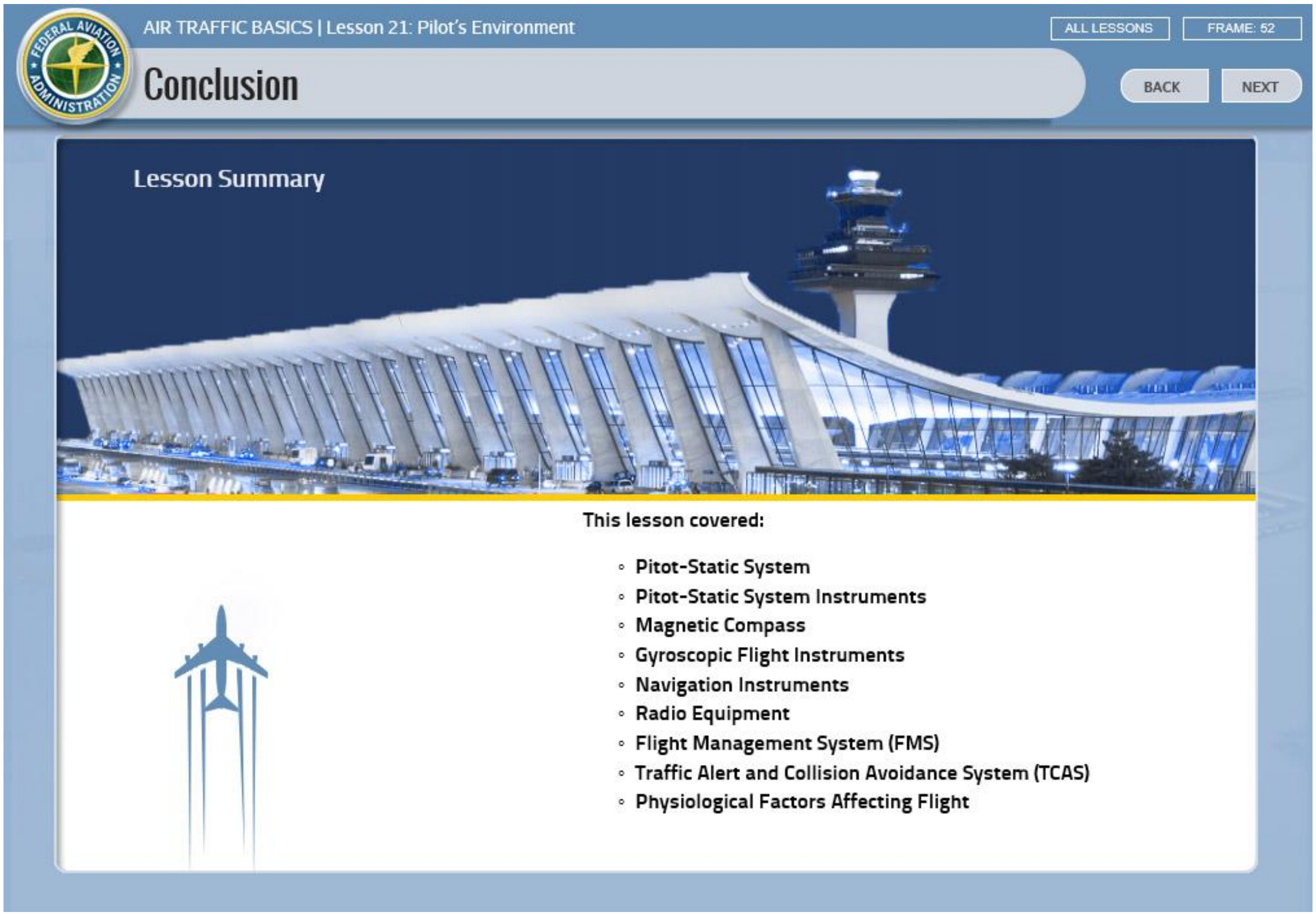
Illusions in Flight

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

- **"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.**

FAA-H-8083-15, p. 1-3; FAA-H-8083-25, Chap. 14; AIM, par. 8-1-5

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Lesson Summary
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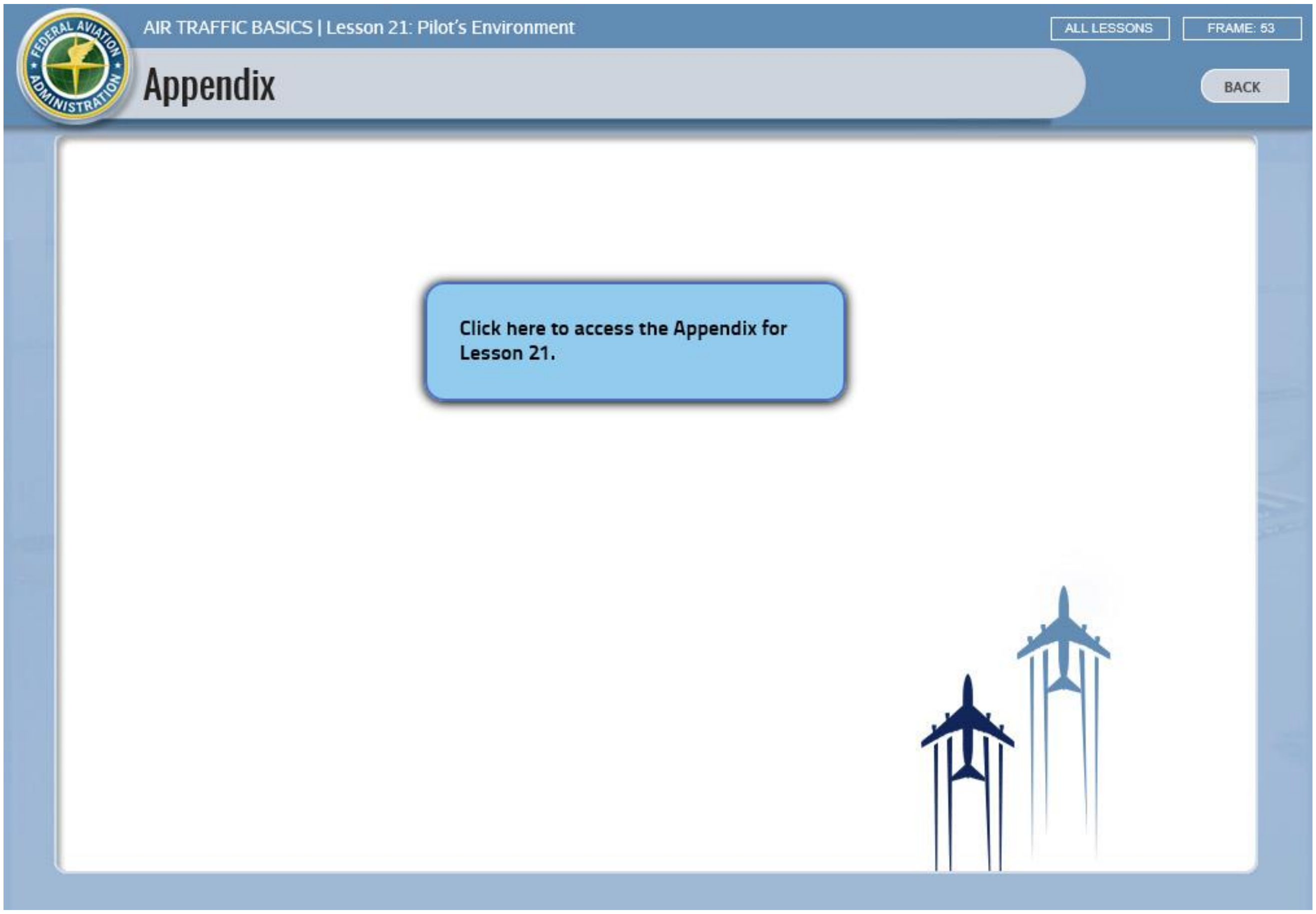
◦ Magnetic Compass
◦ Gyroscopic Flight Instruments
◦ Navigation Instruments
◦ Radio Equipment
◦ Flight Management System (FMS)
◦ Traffic Alert and Collision Avoidance System (TCAS)
◦ Physiological Factors Affecting Flight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