Slide 1

NOTE: This course covers the theory of the general operation, not model specific Avionics equipment. This course does not supersede Original Equipment Manufactures instructions or operation. It is for training purposes only!!

Upon completion of this course the student will be able to state the purpose and function for the following:
- •Theory of Flight and Control Surfaces
- •Electrical Safety
- •Electrical Power Sources
- •Altimetry and the Atmosphere
- •Pitot Static Systems
- •Servo Motors and Tach Rate Generators
- •Inertial Reference
- •Compass Systems
- •Inertial Navigation/Reference Systems
- •Automatic Direction Finder (ADF)
- •Global Positioning System (GPS)
- •Very High Frequency Omni-Range (VOR)
- •Instrument Landing System (ILS)
- • Air Traffic Control System (ATC)
- •Distance Measuring Equipment (DME)
- •Marker Beacon System (MB)
- •Radio Altimeter Principle (RA)
- •Air Data Systems (ADS)
- •Ground Proximity Warning System (GPWS)

•Flight Directors
•Auto Pilot
•Autopilot Yaw Damper- Rudder Channel
•Automatic Flight Guidance Systems
•Area Navigation (RNAV)
•Radio Altimeter
•Weather Radar
•Traffic Collision Avoidance System (TCAS)

Slide 2

AIRCRAFT AVIONICS

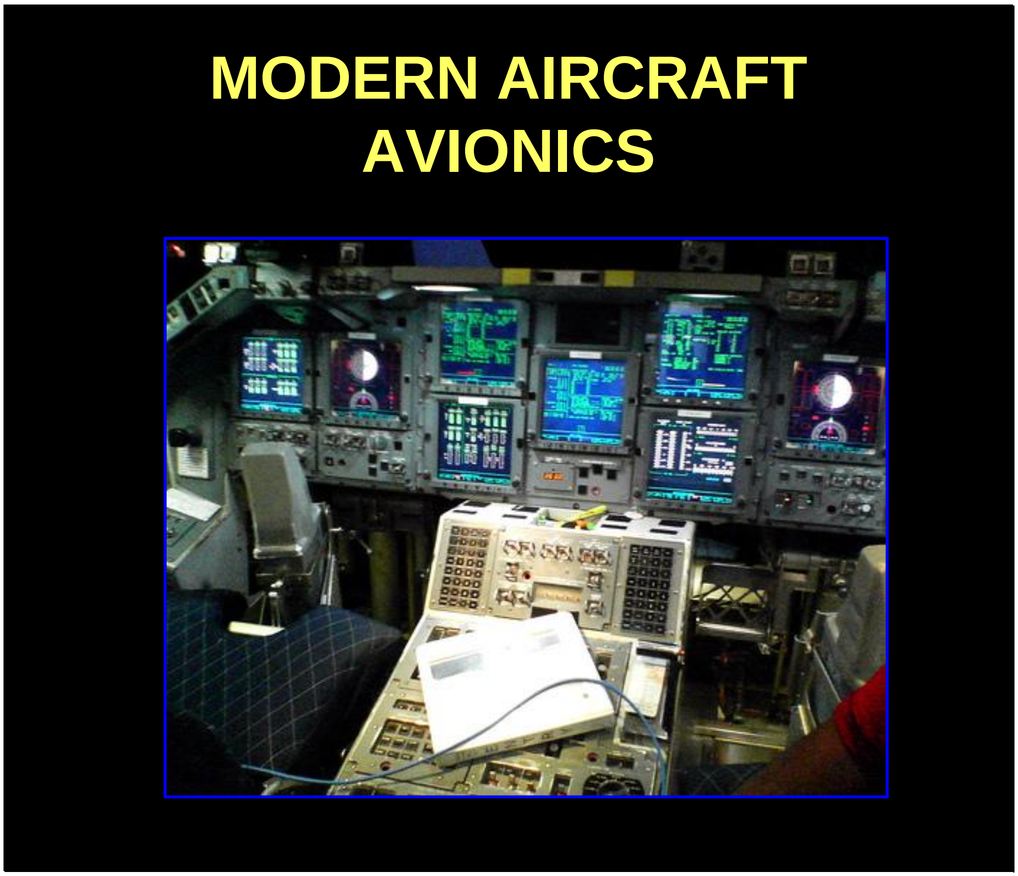
During the Wright brothers first flight they had no idea of speed, altitude, the direction the aircraft was flying. They also did not know fuel consumption, engine temperature, prop RPM ex. So basically they had no aircraft system, just flight controls.

The term **avionics** was not in general use until the early 1970s. Up to this point instruments, radios, radar, fuel systems, engine controls and radio navigation had individual mechanical systems.

In the 1970s era, **avionics** was born, driven by military modernization rather than civil development. Military aircraft had become flying computer platforms, and making large amounts of electronic equipment work together had become the new norm.

Today, avionics as used in civil aircraft. The glass cockpit (TV type screens instead of individual instruments) Under the floor and nose of an aircraft is a major location for avionic equipment, including control, monitoring, communication, navigation, weather, and anti-collision systems. The majority of aircraft avionics are using 14 or 28 volt DC electrical systems.
There are several major vendors of flight avionics just to list a few, including Honeywell Bendix King, Baker Electronics, Allied Signal, Rock Well Collins, Thales Group Garmin, and Ayidyne Corporation ex.

Slide 3



MODERN AIRCRAFT AVIONICS:
The pilot programs the Flight Management System (FMS) for destination and the computers take over after take-off.

The **Avionics system** in today's Aircraft are based on the computer hardware and software interface. The Modern Avionics system of today enhances flight safety and pilot comfort:
Improves pilot situational awareness,
Complete man-machine interface,
Better crew coordination,
Reduced flight crew workload,
It keeps the pilot and co-pilot well informed.

The Navigation system includes the navigation with:
Two or more Air Data Systems (ADS),
Two Radar Altimeter (RA),
One Weather Radar System (WX),
One Enhance Ground Proximity Warning System (EGPWS),
One Traffic Collision Avoidance System (TCAS),

The **Indicating-Recording** system provides:
Visual and Aural Warnings,

Crew Alerting Systems (CAS)
Data Recording,
Data Collecting,
Data Calculating for Different Systems.
Flight Data recorder

When **Auto Pilot** is engaged, the primary flight controls computers controls the aircraft through the flight control surfaces that follow Automatic Flight Control System commands.

The **auto flight system** includes the computer and servo systems that automatically control the flight of the aircraft. These systems use data from different sources and feedback circuits to control the direction, heading, attitude, and speed of the aircraft.
The auto flight system has the subsystems that follow:
Automatic Flight Control System (AFCS),
Auto throttle.

The Automatic Flight Control System (AFCS) controls the aircraft heading and altitude automatically and provides system indications. The Navigation system management is provided by:
Two or more Primary Display Unit (PDU),
One or two Head Up Guidance System (HGS) (optional).
Autopilot (AP),
Yaw Damper (YD),
Mach trim,
Flight Director (FD).
The aircraft basically controls the Flight envelope to protect itself during flight.

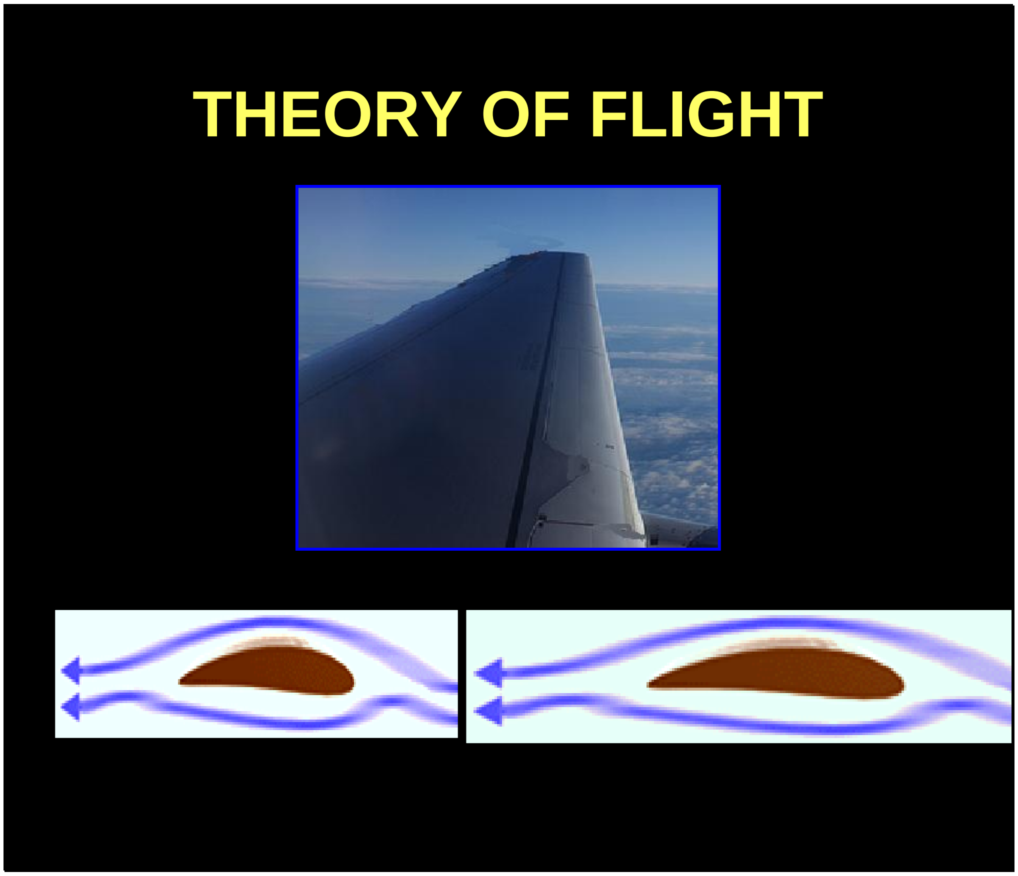
Auto Throttle The auto throttle supplies automatic speed control, this is similar to your **Cruise Control** on your car. This system sets the speed and fuel management with a minimum of flight crew inputs.

The **Communications system** performs the radio transmissions in an aircraft, between pilot ,co-pilot, other aircraft, and ground stations. The antennas for the systems are installed on the fuselage and vertical stabilizer of most aircraft.
The communications system include the avionics equipment used for:
Voice and data communications, cockpit audio and monitoring.
The Electrical system architecture is built upon the main parts that follows:

The **Electrical System** provides:
DC electrical power,
AC electrical power,
Batteries that store electrical power
Distribution system (Buses) for electric power distribution to different systems in the aircraft,
Protect aircraft wiring from overheating during fault problems,
Breakers so power source failures can be reset,
Allow the flight crew to manually shut down systems,
Provide APU starting and electrical power capability,
Allow connection to an external Ground Power Unit (GPU).

Slide 4

THEORY OF FLIGHT
To achieve flight certain 4 forces have to be put in balance.
•First the force of **GRAVITY** holds the aircraft on the ground.
•Secondly **DRAG** prevents forward motion. Engines are installed to produce **THRUST** (forward motion) to overcome drag and create forward motion. (Air Speed)
•This is the force which is (Air Speed) overcomes drag. Once forward motion is achieved the wing can begin to produce **LIFT**, the force that overcomes gravity.



THEORY OF FLIGHT

For the **Aircraft** to fly there are certain forces to overcome:

•First the force is **GRAVITY** that holds the aircraft on the ground has to be overcome. Lift will overcome gravity. The Wing creates lift by using forward motion.

• **LIFT** is produced by air flowing over the curved upper wing surface at a velocity higher than airflow on the lower surface. Increased airflow causes an increase in velocity and a subsequent drop in air pressure. (Vacuum effect) Airflow is achieved by maintaining forward movement. (Air Speed)

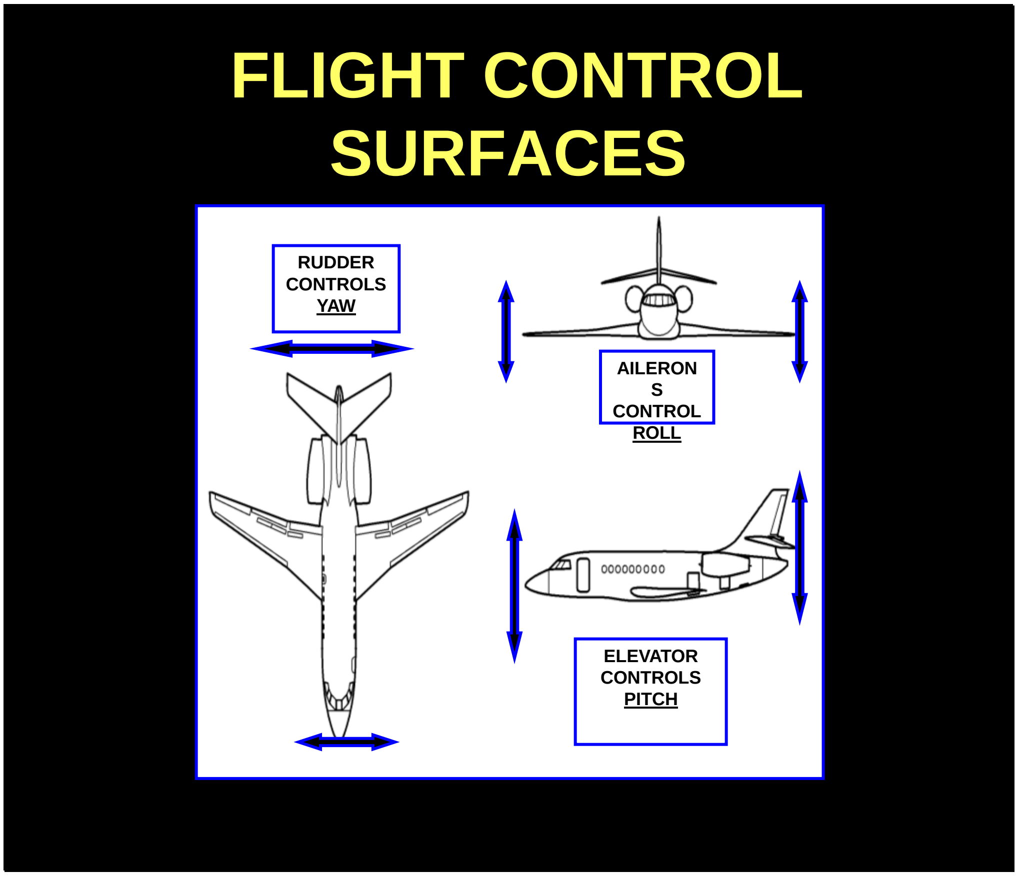
•The larger the wing area the thicker the wing require less air flow at lower air speed to maintain lift.

•The thin wing requires more airspeed for more airflow to maintain lift.

•In Flight you must have Flight Control, which is controlled by Flight Surfaces.

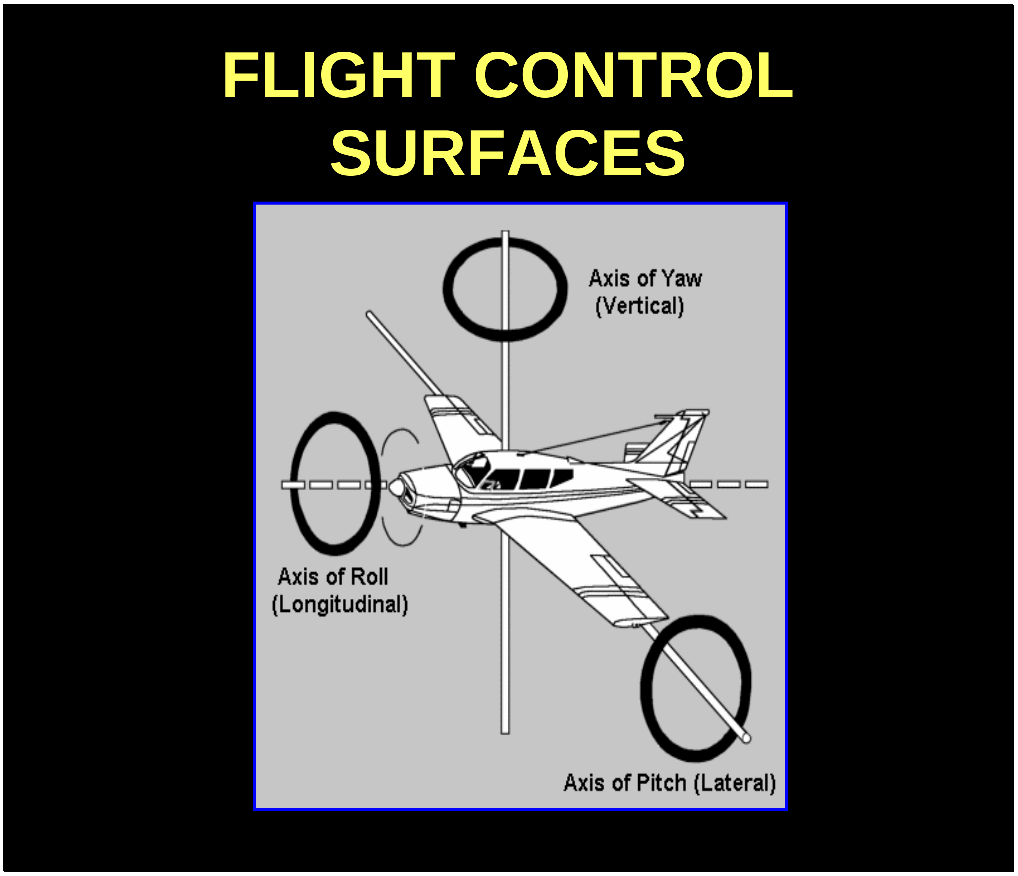
•The Pilot can control Flight Surfaces or the Avionics Systems.

Slide 6



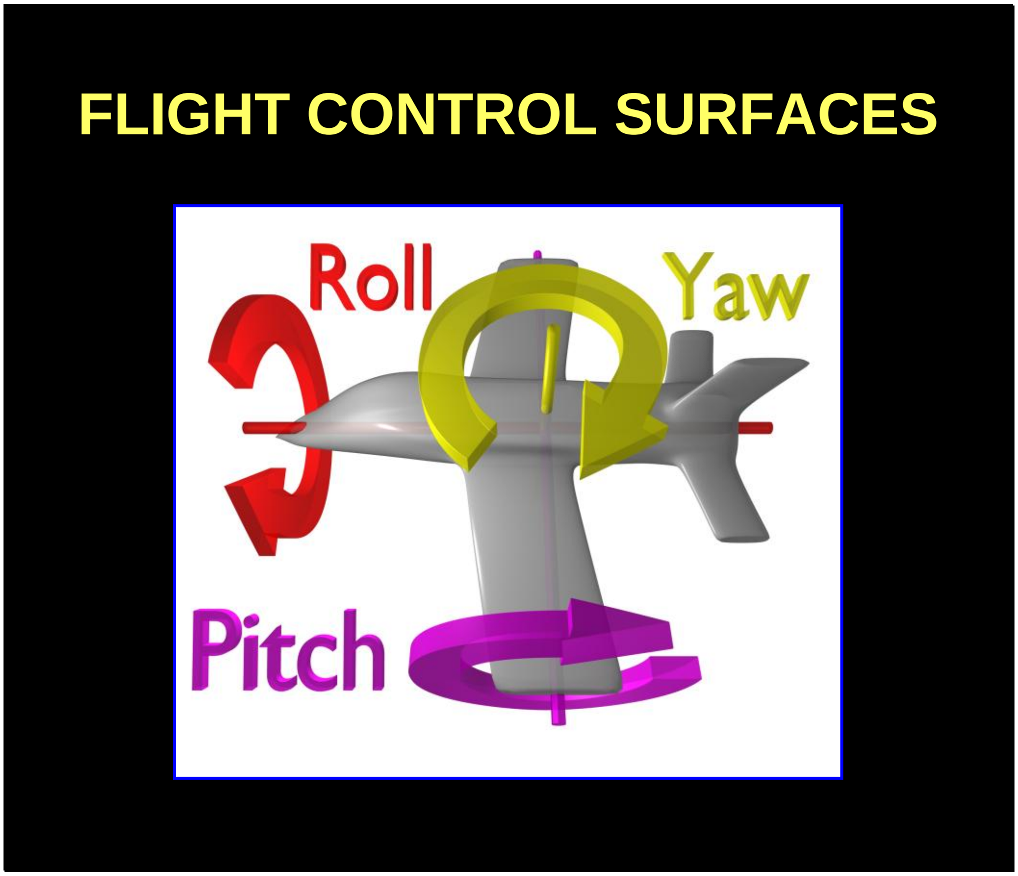
Flight Control Surfaces
Yaw: Is Controlled By The **Rudder**
Foot pedals are connected by means of push-pull tubes and or Cables and hydraulics to the rudder of the tail section. The rudder is the vertical part of the tail that can move from side to side. (left to right)
•Pushing on the left rudder pedal moves the rudder to the left, causing the nose of the airplane to move to the left.
•Pushing on the right rudder pedal moves the rudder to the right, causing the nose of the airplane to move to the right.

Slide 7



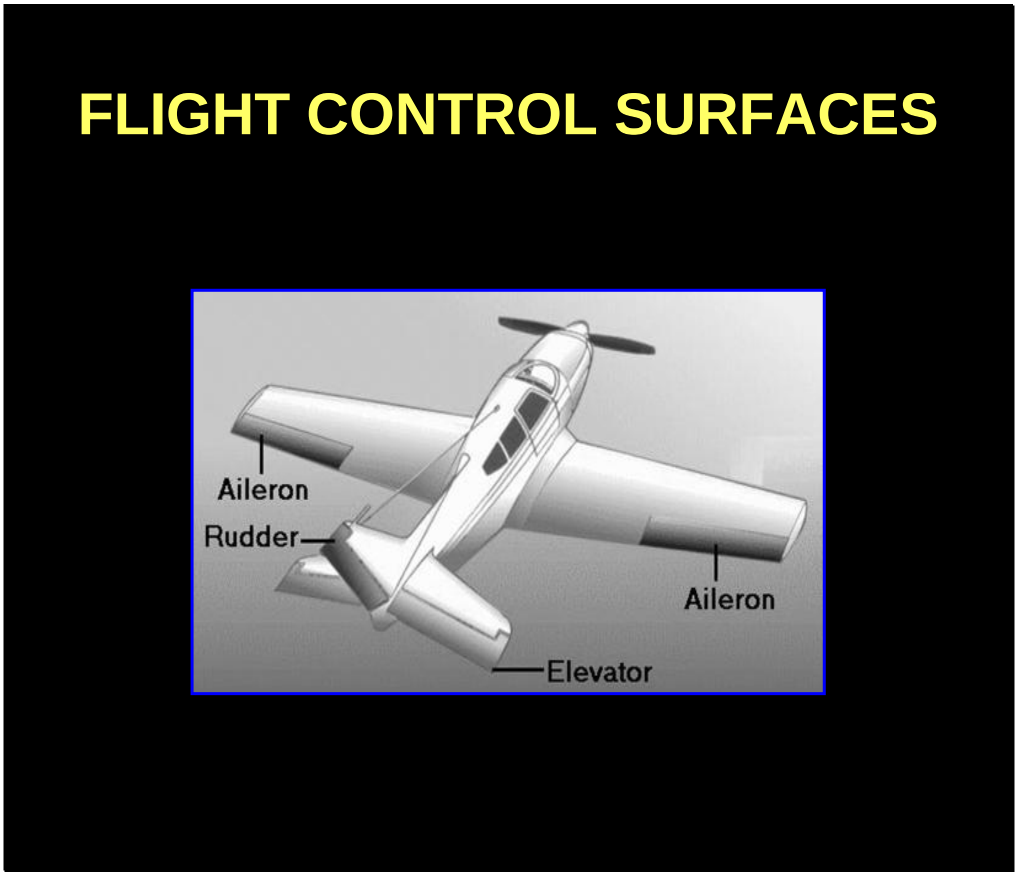
Theory of Flight and Control Surfaces
ROLL: Is Controlled By The **Ailerons**.
The control wheel (yoke) is connected by means of push-pull tubes and or Cables and hydraulics to the wings' ailerons. By turning the left or right, the pilot can change the positions of the ailerons.
•When the control wheel is turned to the right, the right aileron goes up and the left aileron goes down, rolling the airplane to the right.
•Turned to the left, the right aileron goes down and the left aileron goes up, rolling the airplane to the left.

Slide 8



Theory of Flight Control Surfaces
PITCH: Is Controlled By The **Elevator**. nose up, nose down
The control column (Yoke) is connected by means of push-pull tubes and or Cables and hydraulics to the tail section's elevators. By moving the yoke, the pilot can change the position of the elevators.
•Pushing the control column forward, the elevators move down, pitching the tail of the airplane up and the nose down, rolling the airplane down.
•Pulling the control column back makes the elevators move up, pitching the tail of the airplane down an the nose up, rolling the airplane upwards.

Slide 9



Flight Control Surfaces

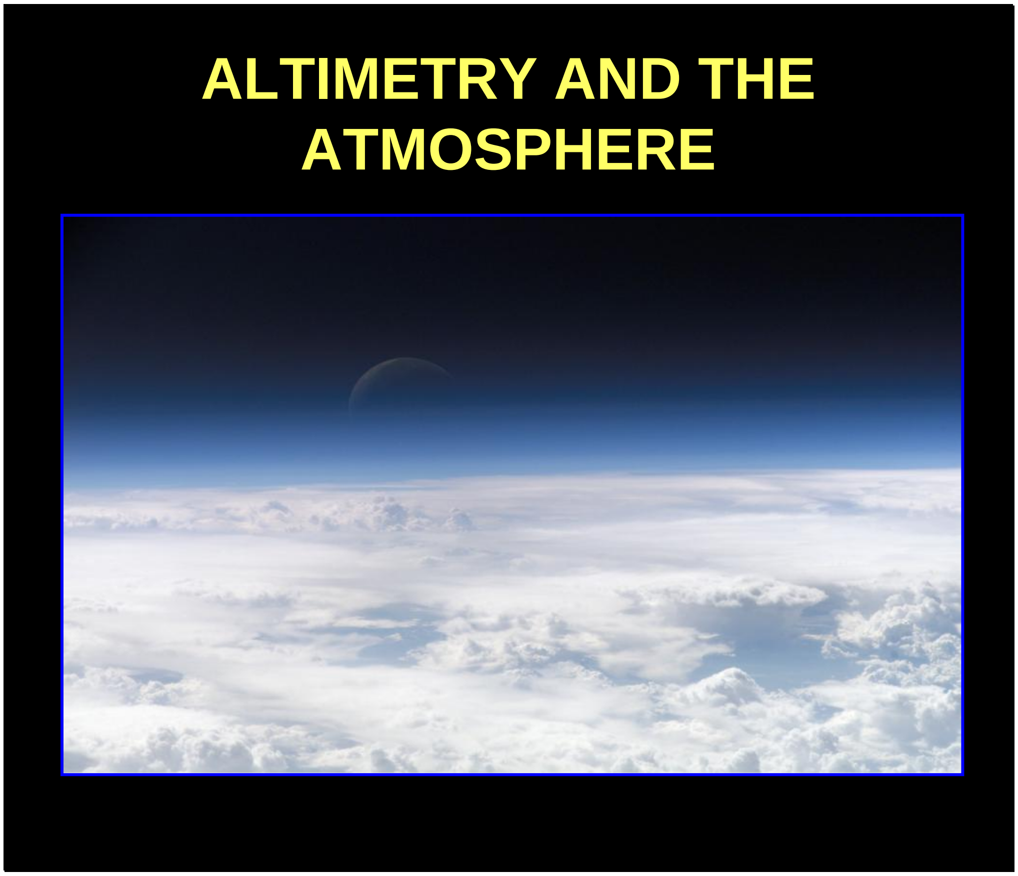
These Flight Control Surfaces can provide control for the following:

- Turns
- Nose up, Nose Down for climbing or descending.

The first 2 bullets are usually controlled by Avionics systems after the pilot programs the trip into the system prior to flight. (Auto Pilot)

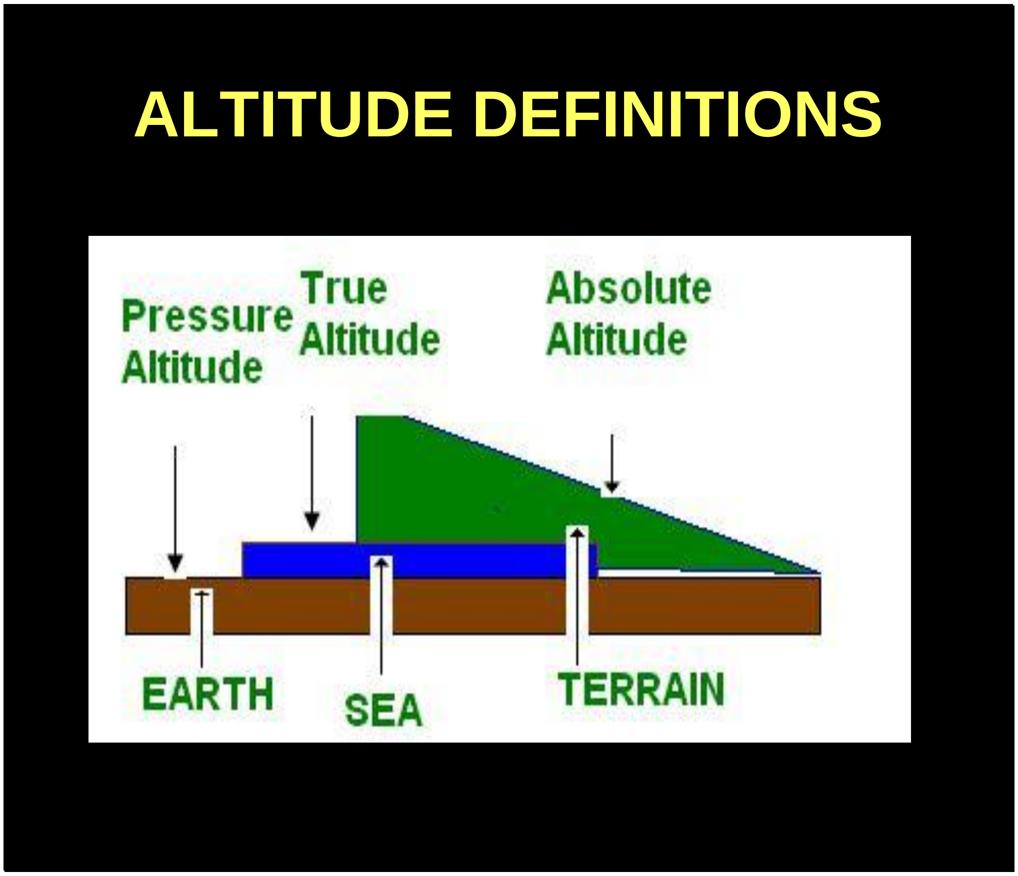
- Height above the earth (Altitude) 0 is considered Sea Level.
- Compass Headings: (Direction the aircraft is to fly)
- They also provide control for Take-off and Landings.(Usually controlled by the Pilots)
- The following slides we will go into **Avionics Fundamentals**.

Slide 10



Altimetry and the Atmosphere
Altimetry is the height above sea level. (The measurement of altitude)
Atmosphere is the mixture of gases (Air) that surrounds the Earth.
•**Atmospheric Pressure** is the force per unit area that is applied perpendicularly to a surface by the surrounding gas. It is determined by the Earths gravitational force in combination with the total mass of a column of air above a location. (Barometric pressure)
• The pressure is greater at sea level than at 45,000 feet.

Slide 11



ALTITUDE DEFINITIONS

•Indicated altitude is read directly from the altimeter when set to current barometric pressure.

•**Earths Pressure altitude** is read from the altimeter when set to the standard barometric pressure of 29.92 in. Hg.

•**True altitude** is the exact height above mean **Sea** level.

•**Absolute altitude** is the l height above the **Terrain** surface.

Slide 12

AVIONICS:

•**Avionics** is defined as "aviation electronics".

• It consist of electronic systems for use on aircraft, comprising communication, navigation with display and management of multiple systems.

• It also includes multiple variants of systems that are used on aircraft to meet their individual roles, these can be simple avionics or more complex computer systems in ultra modern aircraft.

•Today's aircraft being built using more complicated avionics systems than the aircraft built in the previous 50 years.

•Usually there are 2 sets of instruments 1 set each side of the aircraft, Right hand side for Co-Pilot, Left Hand side for Pilot.

•The FAA requires that avionics systems be redundant in case of failure of one system, there is a back up system.

•The following information will help you have better basic understanding of the how, and why of Avionics Instruments.

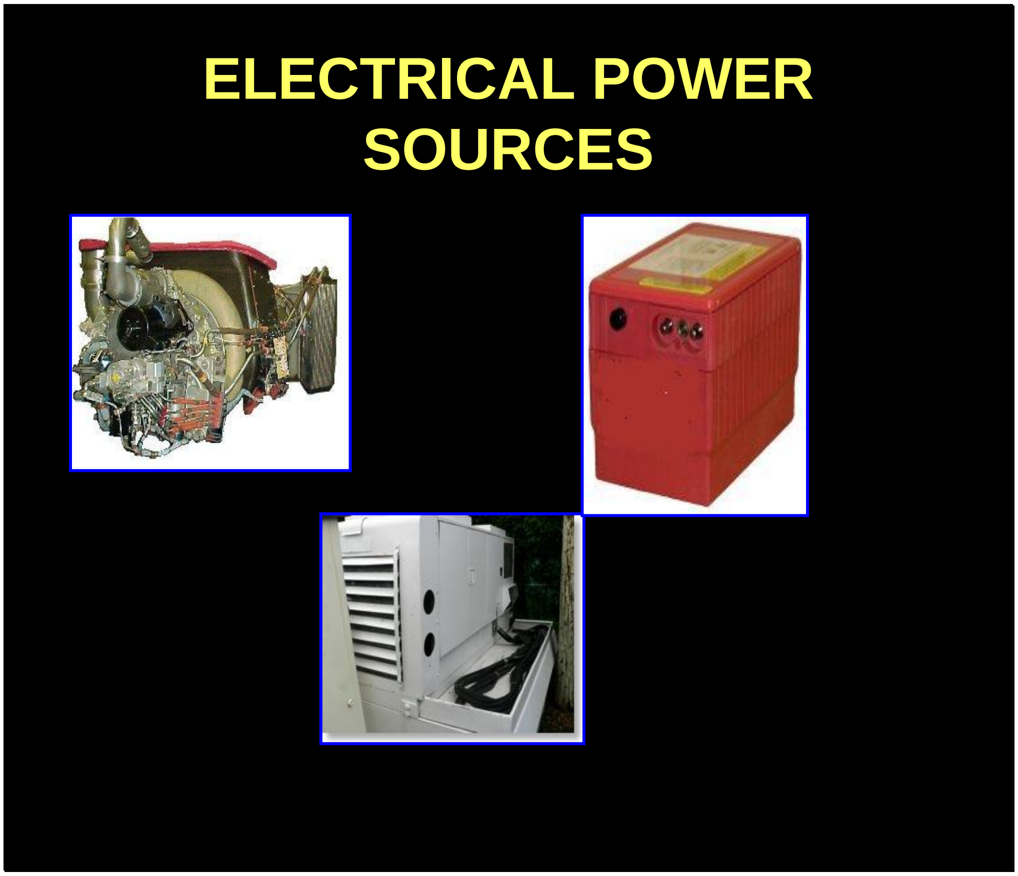
Slide 13

ELECTRICAL SAFETY

Remember the life you save could be yours!!!

Before working on any Avionics systems/Wiring ask your self the following:

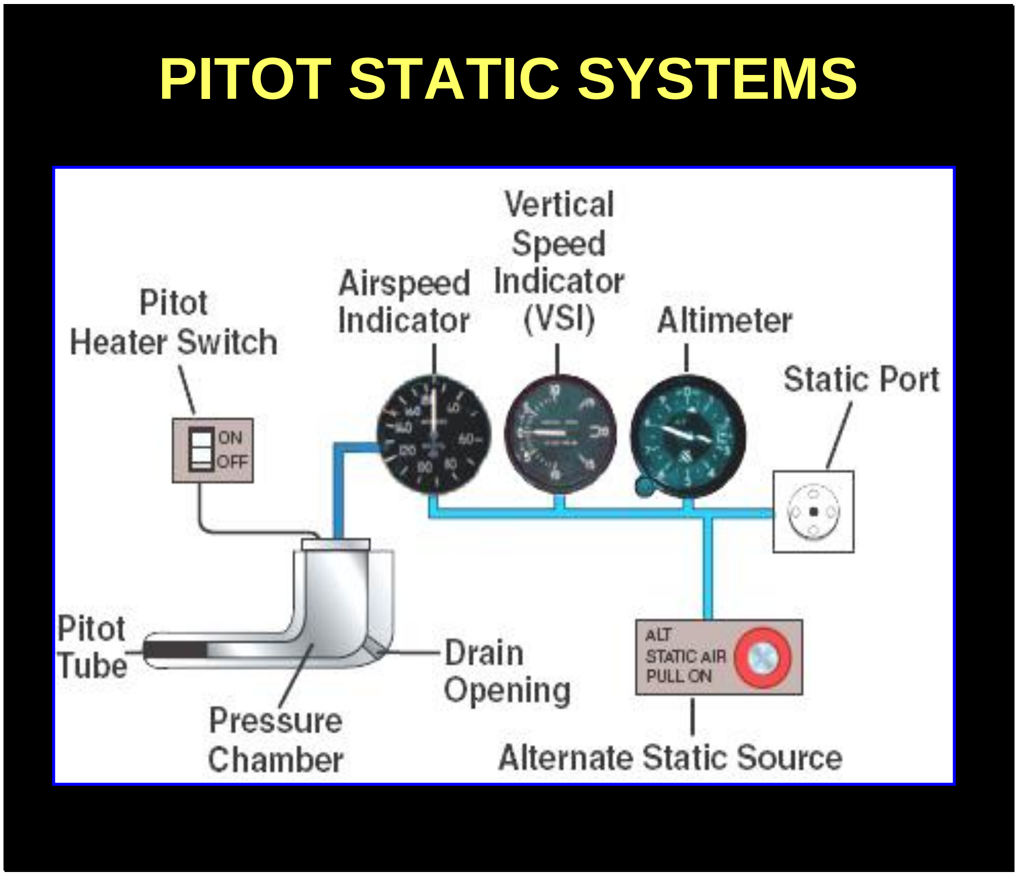
- Is Aircraft power On or Off?
- Any Batteries connected?
- Are switches and breakers On or Off?
- Are there breakers locked out tagged out for other maintenance?
- Can I safely apply power to the Aircraft?
- Do I have the proper Approved Aircraft Data for the job I am doing?
- I am using correct Electro Static Discharge (ESD) procedures?



ELECTRICAL POWER SOURCES FOR THE AVIONICS SYSTEMS
Aircraft Electrical Power can come from several sources.
This is the list of Power sources that can be used to put Power on the Aircraft Avionics Systems.

- •Auxiliary Power Unit (APU)
- •Aircraft Batteries (Short duration only)
- •Ground Power Unit (GPU)
- •Turbine Engines Generators or Alternators

Slide 15



PITOT STATIC SYSTEMS

Aircraft atmosphere pressure changes as it climbs, descends, accelerates or decelerates.

•The pitot-static system is sensitive to airspeed, altitude, and rates of altitude change thus provides the pressure information displayed on instrumentation.

•Pitot-static system is a system of **Atmospheric Pressure** -sensitive instruments that is most often used in aviation to determine:

• an aircraft's airspeed , Mach number,

• Vertical Speed Indicator

•altitude.

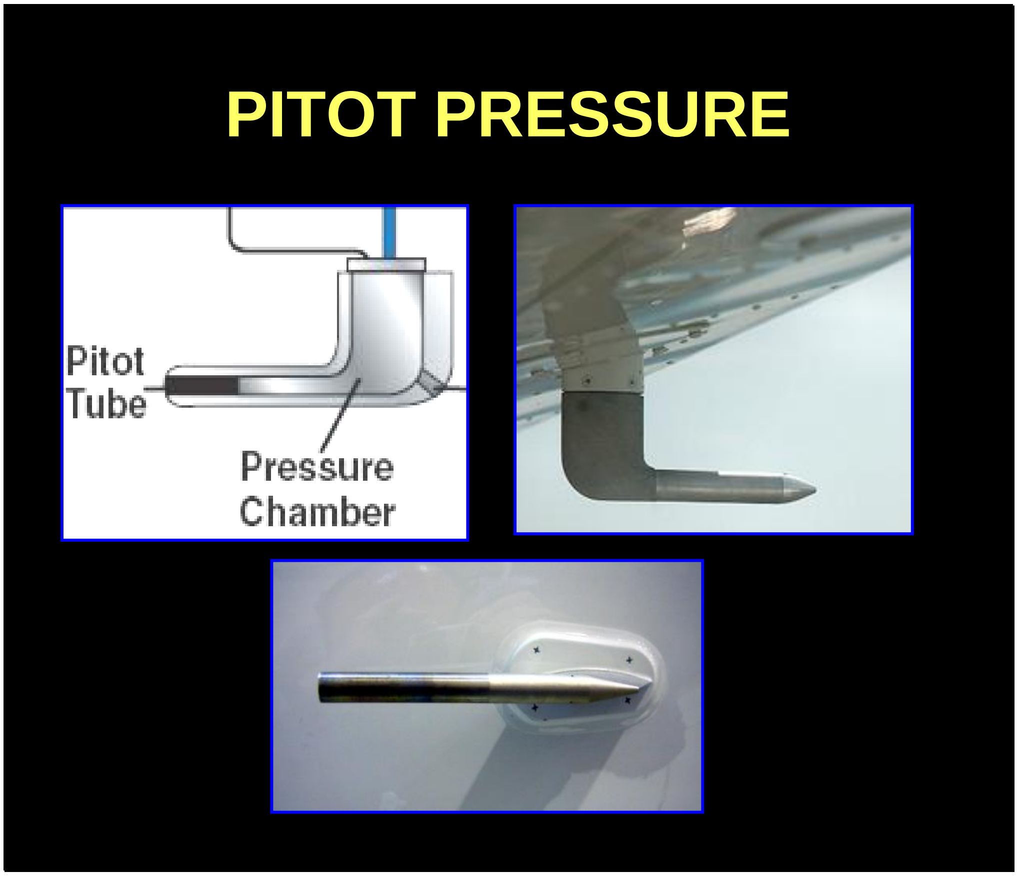
•A pitot-static system generally consists of a 2 pitot tubes, one on each side of the aircraft , and 2 static ports one on each side of the aircraft and the instruments**.**

•These type systems must be Maintained in accordance with applicable regulations 91-411 / 91-413 (per FAR 43 Appendix F, for US registered A/C)

•Inspected per FAR 91.409, for US registered A/C), and (JAR 145,and JAR 1.15.4.3 for European A/C)

(There are FAA regulations governing scratches and damage to the Static plate and pitot Tubes.)

Slide 16



PITOT PRESSURE
Pitot-static system is a system of **Atmospheric Pressure** -sensitive instruments that is most often used in aviation to determine:
PITOT PRESSURE DEFINITION
PITOT TUBE DEFINITION
•The **pitot pressure** is obtained from the **PITOT TUBE**.
• The **pitot pressure** is a measure of ram air pressure (the dynamic air pressure created by air speed or the air ramming into the tube), which, under ideal conditions, is equal to stagnation pressure.
• The **pitot tube** is most often located on the wing or front section of an aircraft, facing forward, where its opening is exposed to the movement of air.
•By placing the pitot tube in these locations, the ram air pressure is more accurately measured since it will be less distorted by the aircraft's structure. When airspeed increases, the ram air pressure is increased, which can be translated by airspeed

indicator.

• Airspeed, Mach number,
•Altitude.
•A pitot-static system generally consists of a pitot tube, a static port, and the instruments**.**

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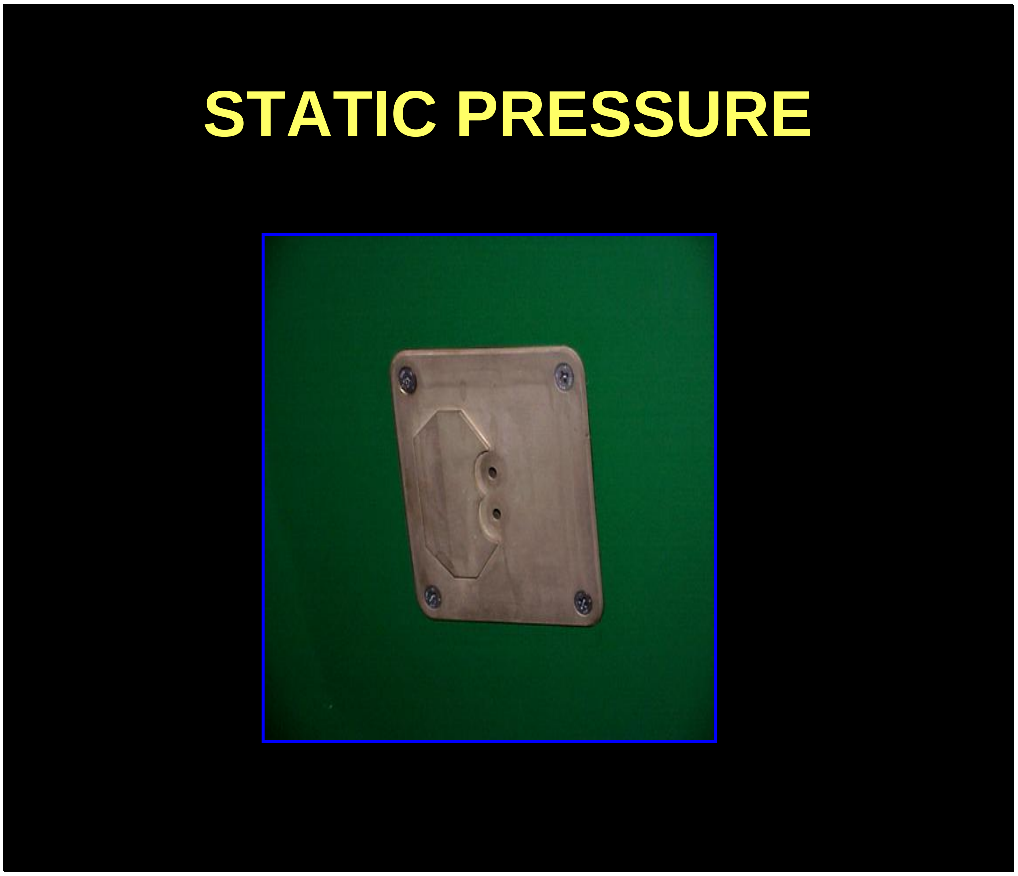
BASIC AIRSPEED INSTRUMENT

•The airspeed indicator uses the ram pressure from the **pitot tube**. The airspeed indicator is connected to both the ram and static pressure sources.

•The greater the difference between the ram pressure and the static pressure, the higher the airspeed Indicated

Slide 18



STATIC PRESSURE

Most aircraft has more than one **static port**, there is usually one located on each side of the fuselage. This positioning, pressure can be taken, which allows for more accurate readings in specific flights.

The holes shown in this static port are for redundancy one hole is for Pilot and one for Co-Pilot.

•The style of static ports and probes vary for each model aircraft.

•Consult your aircraft model’s maintenance manual for your specific type.

•The static pressure is obtained through a static port.

•The static port is most often a flush-mounted hole on the fuselage of an aircraft, and is located where air flow in a relatively undisturbed.

•No paint stripes, stickers or damage is usually allowed in the area of the static plates, consult your aircraft maintenance manual for details.

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BASIC ALTIMETER INSTRUMENT

ALTIMETER INSTRUMENT

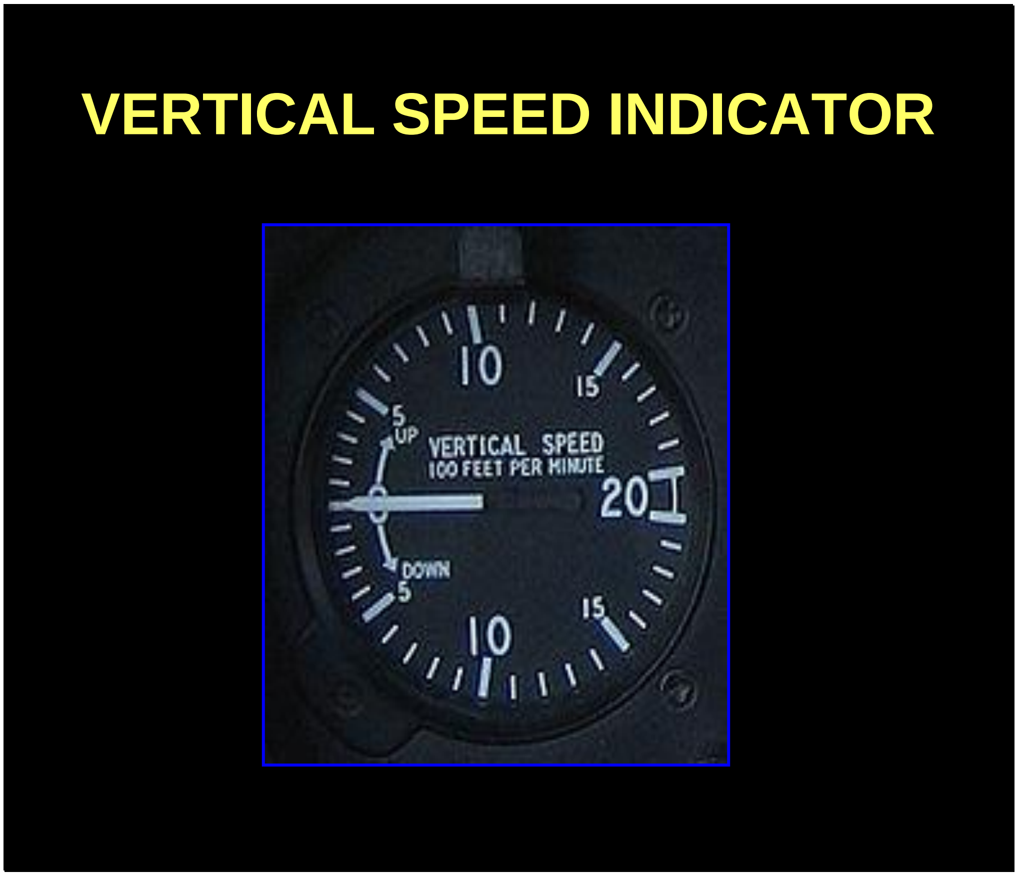
The basic altimeter, also known as the barometric altimeter, is used to determine changes in air pressure that occur as the aircraft's altitude changes.

•It obtains its pressure from the **Static Port**.

•Pressure altimeters must be calibrated prior to flight to register the pressure as an altitude above sea level.

•The instrument case of the altimeter is airtight

Slide 20



VERTICAL SPEED INDICATOR

The **vertical speed indicator** (VSI)), is the pitot-static instrument used to determine whether or not an aircraft is flying in level flight.

•The **vertical airspeed** specifically shows the rate of climb or the rate of descent, which is measured in feet per minute or meters per second.

•This is achieved by measuring how fast the **ambient pressure** changes and translating this as a rate of change in feet per minute.

This section covered the Pitot Static System with Basic Avionics Instruments.

•The Following section will cover more advance Aircraft Avionics System and Instruments, some of which will still rely on the Pitot System for Air Data.

ATTITUDE INDICATOR
The **Attitude Indicator** (also known as an ***artificial horizon***) shows the aircraft's attitude relative to the horizon.
• From this the pilot can tell whether the wings are level and if the aircraft nose is pointing above or below the horizon.
• This is a primary instrument for instrument flight and is also useful in conditions of poor visibility.
• Pilots are trained to use other instruments in combination should this instrument or its power fail.

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AIRCRAFT AVIONICS SYSTEMS AND INSTRUMENTS
There are to many different types of Avionics System's to cover each system in detail.
•The following section will be on the System's and Instruments commonly used in today's Advance Digital Avionics Systems.
•In the previous section the Instruments describe are analog they use springs, bellows, baffles, vacuum and other mechanical means to show indication. (Direct Reading, analog)

•The Digital operation will depend on computers to give them Data.
•This data is transmitted on Data busses.

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AIRCRAFT AVIONICS SYSTEMS AND INSTRUMENTS

An Integrated Avionics System is automatic flight guidance, flight management, and electronic display system.

•These three functions are controlled and monitored with a system of cockpit controls, displays, sensors, and computers.

•This type system is centered on the Integrated Avionics Computer's (IAC), which performs the display and flight guidance functions normally associated with a symbol generator, flight director, and autopilot/yaw damper.

•These functions are all located within the IAC on separate circuit card assemblies. The IAC reduces the number of Line Replaceable Units (LRU's) by housing a number of independent functions in one unit.

•Line Replaceable Units (LRU's) are the separate parts of the Avionics systems, the boxes.

AIRCRAFT AVIONICS SYSTEMS AND INSTRUMENTS

An Integrated Avionics System is automatic flight guidance, flight management, and electronic display system.

•During normal operation the system displays heading, course, radio bearing, pitch and roll attitude, radio altitude, course deviation, glide-slope deviation, to-from, and DME indications.

• Lighted annunciations denote selected flight director modes.

• Pitch and roll flight director steering commands developed by the IAC, in conjunction with the Flight Guidance Controller, are displayed on the Primary Flight Display (PFD).

•When the autopilot is engaged and coupled to either the pilot's or copilot's flight director, the aircraft is controlled by the same commands that are displayed on the PFD.

Slide 25

AIRCRAFT AVIONICS SYSTEMS AND INSTRUMENTS

An Integrated Avionics System is automatic flight guidance, flight management, and electronic display system.

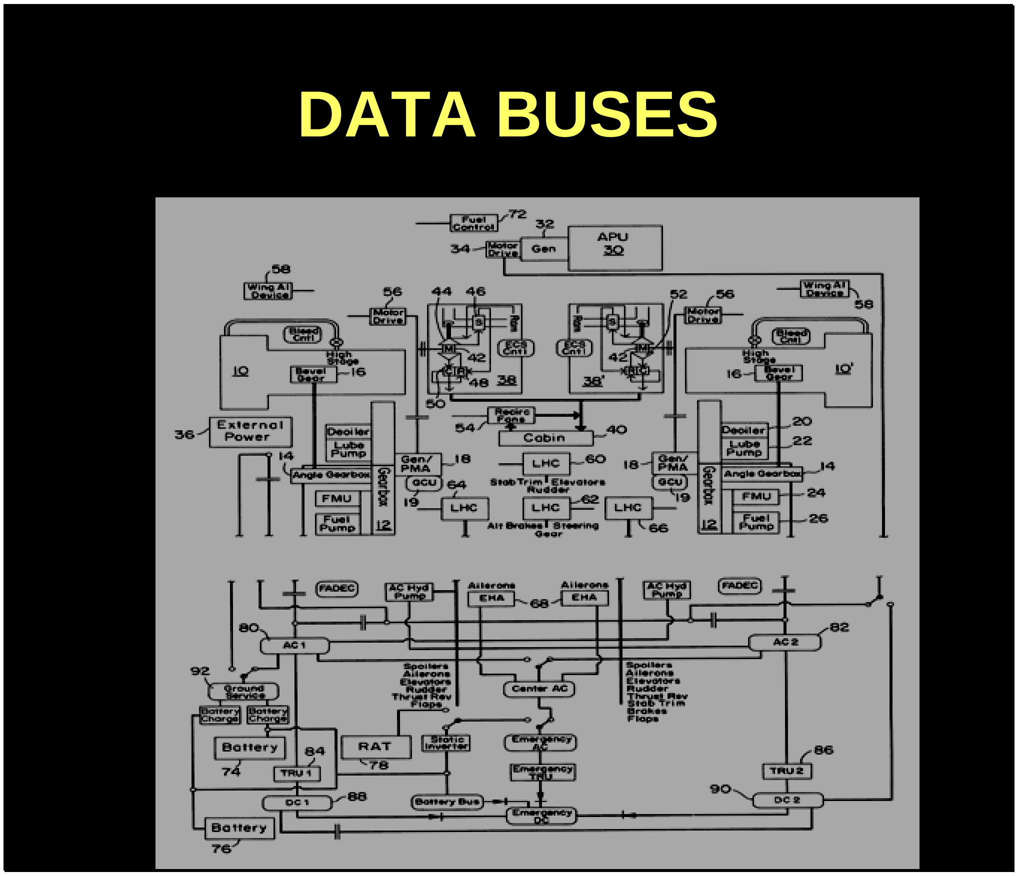
•When the autopilot is engaged and no flight director modes are active, the aircraft is controlled by the pilot in pitch and roll by inserting commands through Touch Control Steering (TCS), and/or the pitch wheel on the Flight Guidance Controller (FGC).

•The IAC uses software tests in combination with Built-In-Test (BIT) hardware to detect failures and determine In/Out (I/O) signal validity.

•Through these tests the IAC determines if the system is working correctly to provide proper Flight Director (FD), Auto-Pilot (AP), and Yaw Damper (YD) mode control and mode annunciation.

The following sections will be based mainly on Digital Avionics controlled by computers.

Slide 26



Most of the data transfer (**COMMUNICATION)** between computers Avionics System’s is accomplished by using digital data buses. The data buses below are a few types used in the **Integrated Avionics System**:

•Avionics Standard Communications Bus (ASCB) The ASCB is the primary communications network for the modern avionics system. Reliable data transfer is ensured by designed in redundancy, protection and isolation.

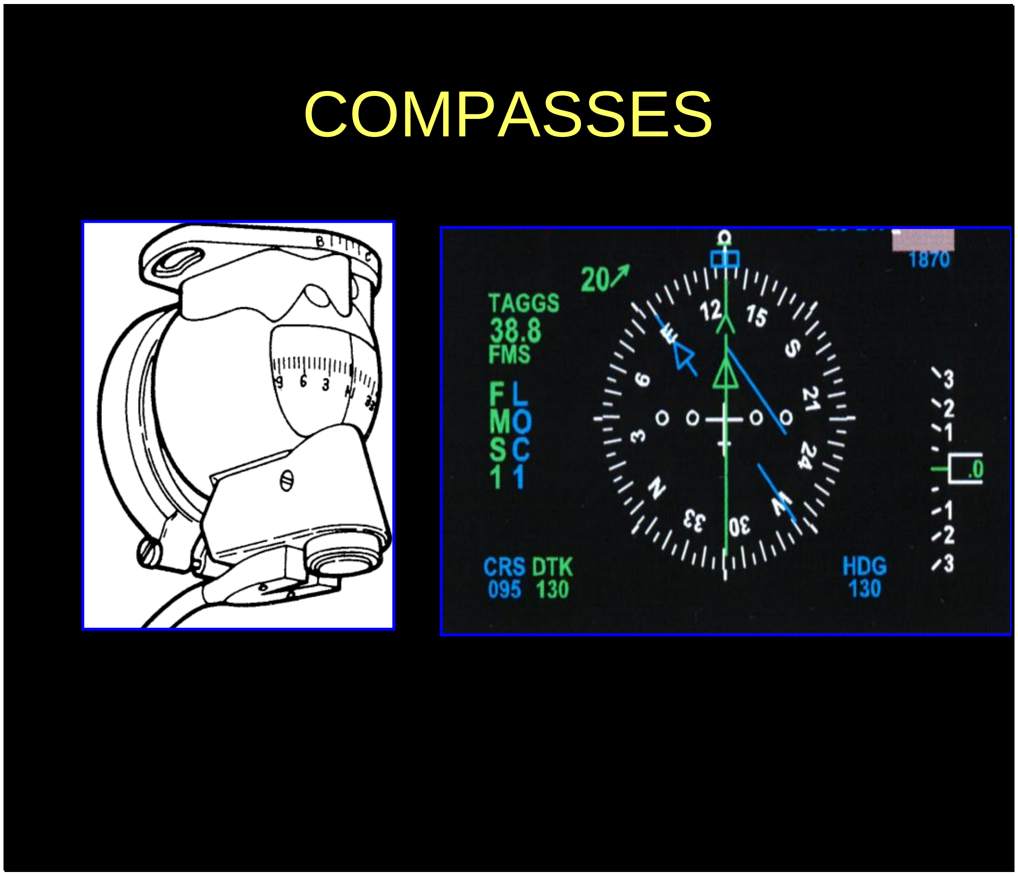
•The **ASCB** is a fail-operational data bus system that consists of four data buses if one system fails the other system takes over.

•**ARINC 429** is an electrical and data format standard for a 2-wire serial bus with one sender and many listeners. This standard defines one of the most commonly used data buses on modern commercial aircraft. ARINC 429, is like the standard, is based on the data format.

•**RS-429** is an international standard file format for aircraft navigation data

•**RS-404** defines the Air Transport Radio (ATR) and Modular Component Unit (MCU) form factors for Line Replaceable Electronics Units (LRU's) in aircraft. These standards date back to the 1930s.

Slide 27

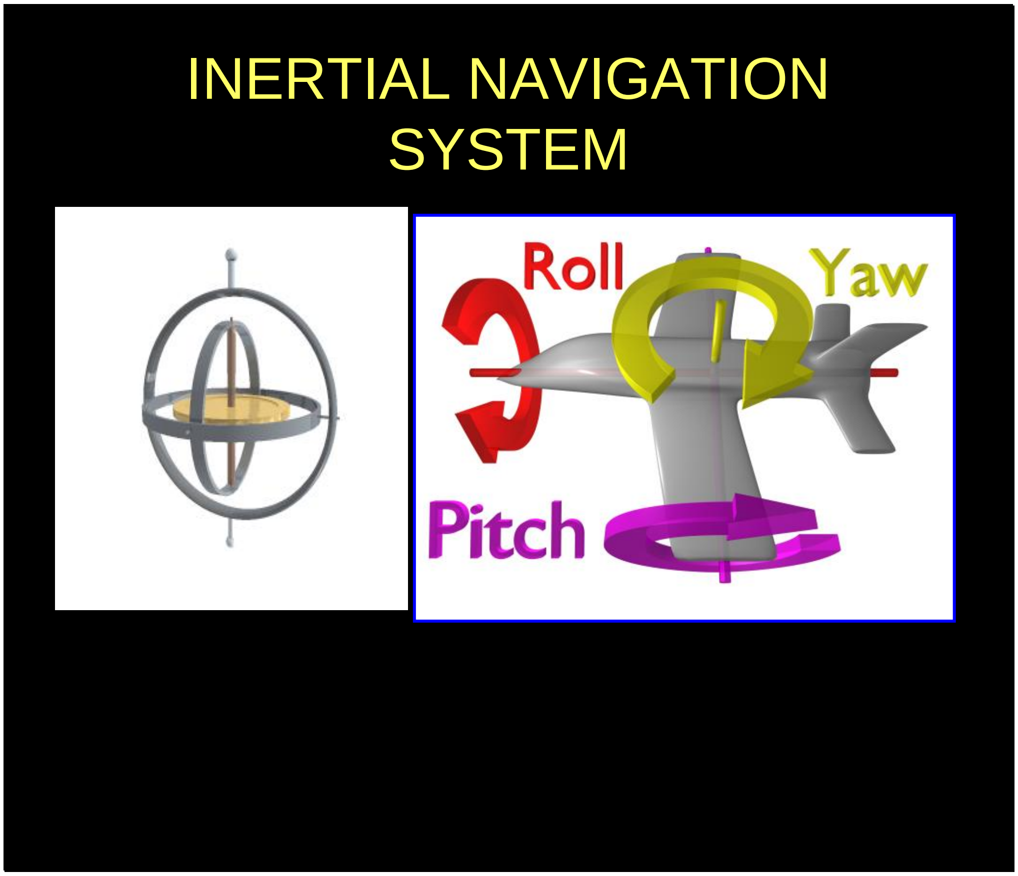


COMPASSES
The early aviators had instruments that figure out how high and how fast they were traveling, the early aviators next took a lesson from the early sailors and added a compass to their array of Flight Instruments.
•The compass shows the aircraft's heading relative to magnetic north. While reliable in steady level flight compass can give confusing indications during banking, climbing, descending, or accelerating due to the iincline of the earth's magnetic field.

•The most basic compass is oiled filled and gives the flight crew directional information.
•The heading indicator (also known as the directional gyro, or DG; sometimes also called the gyrocompass, though usually not in aviation applications) displays the aircraft's heading with respect to geographical north.
•The more advance compass Inertial Navigation System (INS) Utilizes the principles of gyroscopic precession and accelerometer inputs to calculate the position of the aircraft from a known starting point.

•These systems can provide position data to the Flight Management System.
•This can be the back up data for the GPS system as we will describe.

Slide 28



INERTIAL REFERENCE

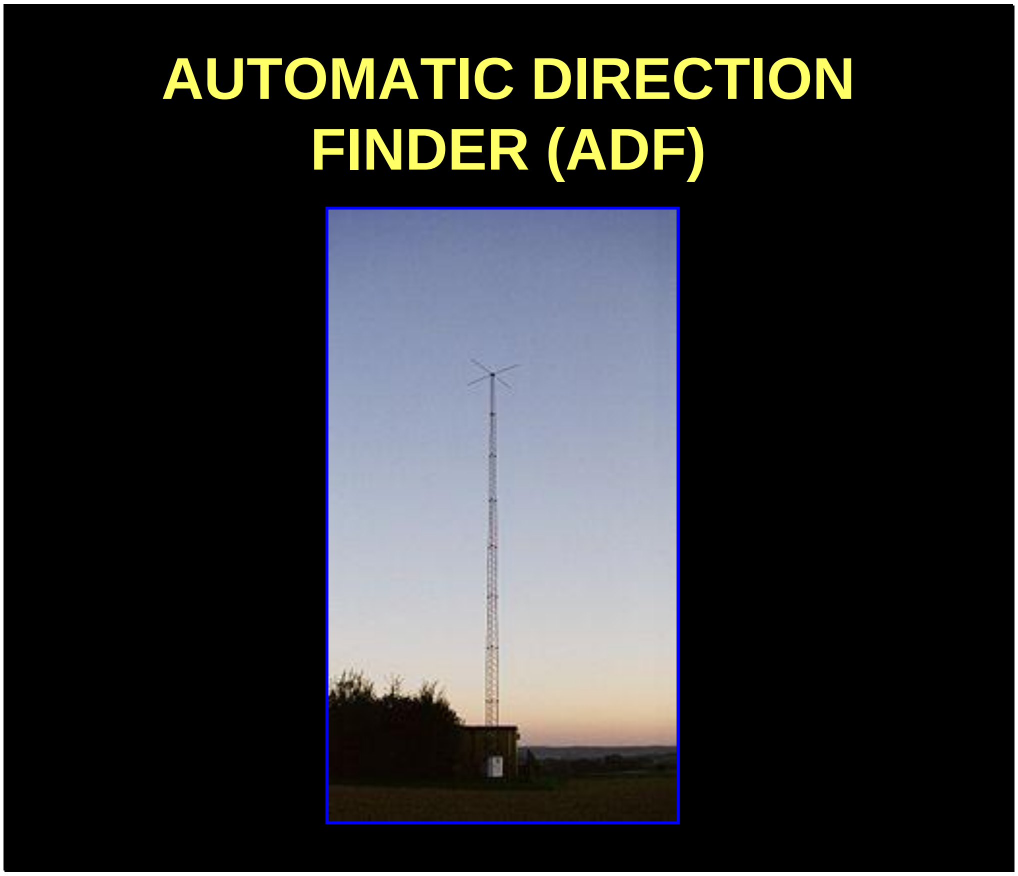
•The **Inertial Navigation System** (INS) includes at least a computer and a platform containing accelerometers, gyroscopes (motion-sensing devices.)

• The INS is initially provided with its position and velocity from another source (GPS satellite receiver), and then computes its own updated position and velocity by integrating information received from the motion sensors to determine location and speed.

•The advantage of an INS is that it requires no external references in order to determine its position, orientation, or speed once it has been initialized.

•This system ties into the **Auto Pilot** system. (Removes the work load from the flight crew) This system in conjunction with other avionics system will control, **Roll**, **Yaw** and **Pitch**.

Slide 29



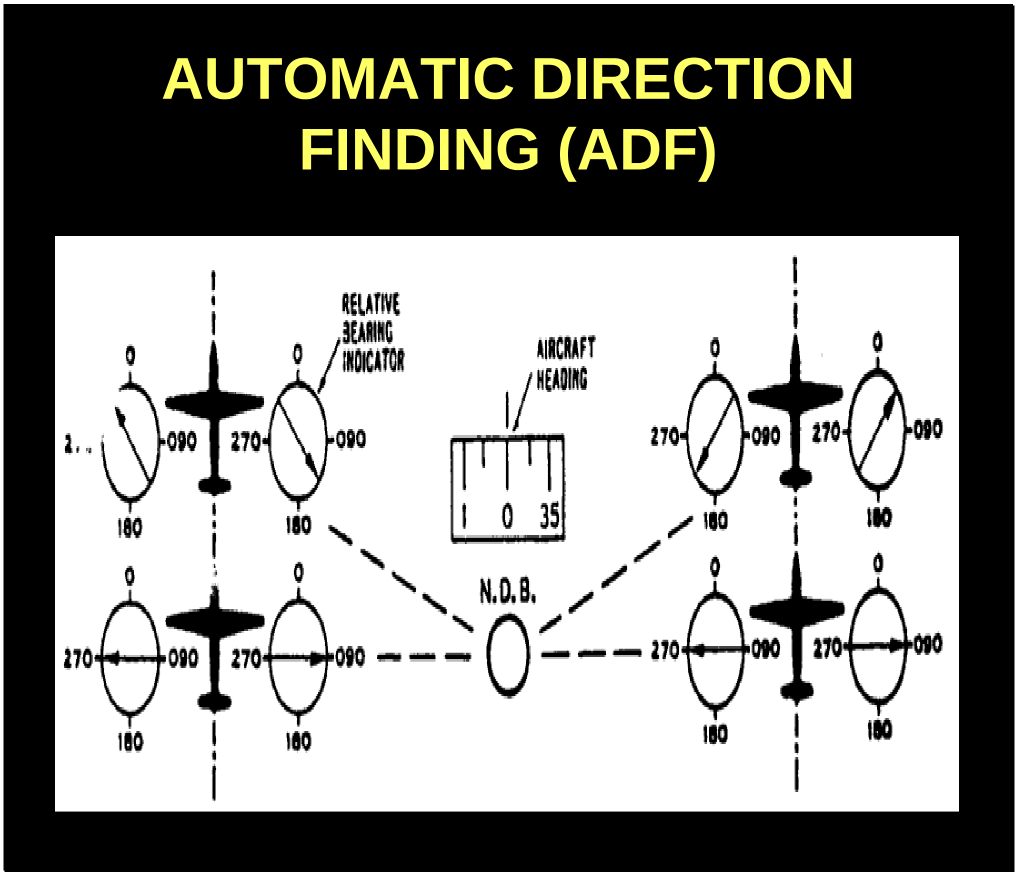
AUTOMATIC DIRECTION FINDER (ADF)

•An **Automatic Direction Finder** (ADF) is an aircraft radio-navigation instrument which displays the relative bearing from the aircraft to a suitable radio station.(**Non-Directional Beacons (NDB)**

•ADF receivers are normally tuned to aviation **Non-directional Beacons (NDB),** low-power AM radio transmitters operating in the low frequency band between 190 to 535 kHz.

• Most ADF receivers can also receive AM broadcast stations but because their location and identity is not controlled like aviation NDB.

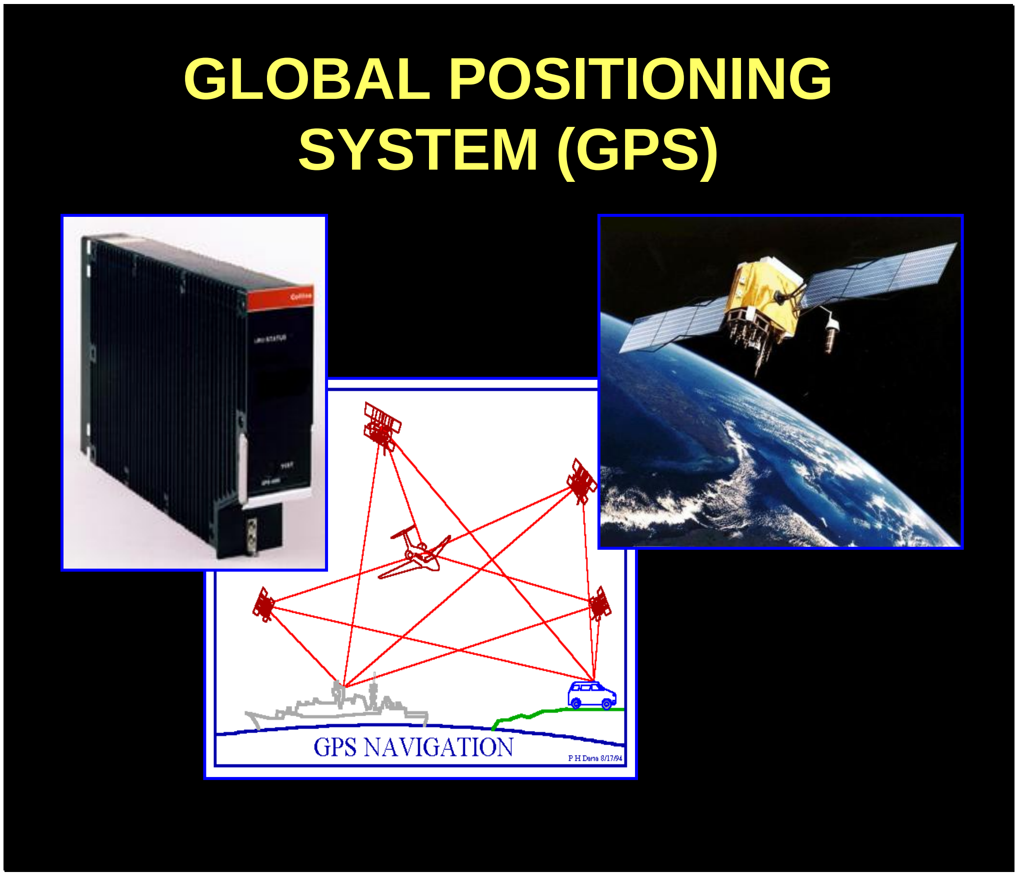
Slide 30



AUTOMATIC DIRECTION FINDING (ADF)

- •The **Non-Directional Beacons (NDB)** is basically a simple transmitter (Radio Station) radiating an omni directional signal which is modulated at intervals with the identification code.
- •The basic signal is known as a carrier and is radiated at the frequency specified for the particular aid.
- •The system calculates the aircraft angle from the **Non-Directional Beacons (NDB)** to determine bearing.
- •NDBs are most commonly used as markers for an instrument landing system (ILS) approach and standard approaches.
- •These systems are being replaced with the more advance Distance Measuring Equipment. (DME)
- •To maintain heading you would keep the needle on zero until that station is reached.

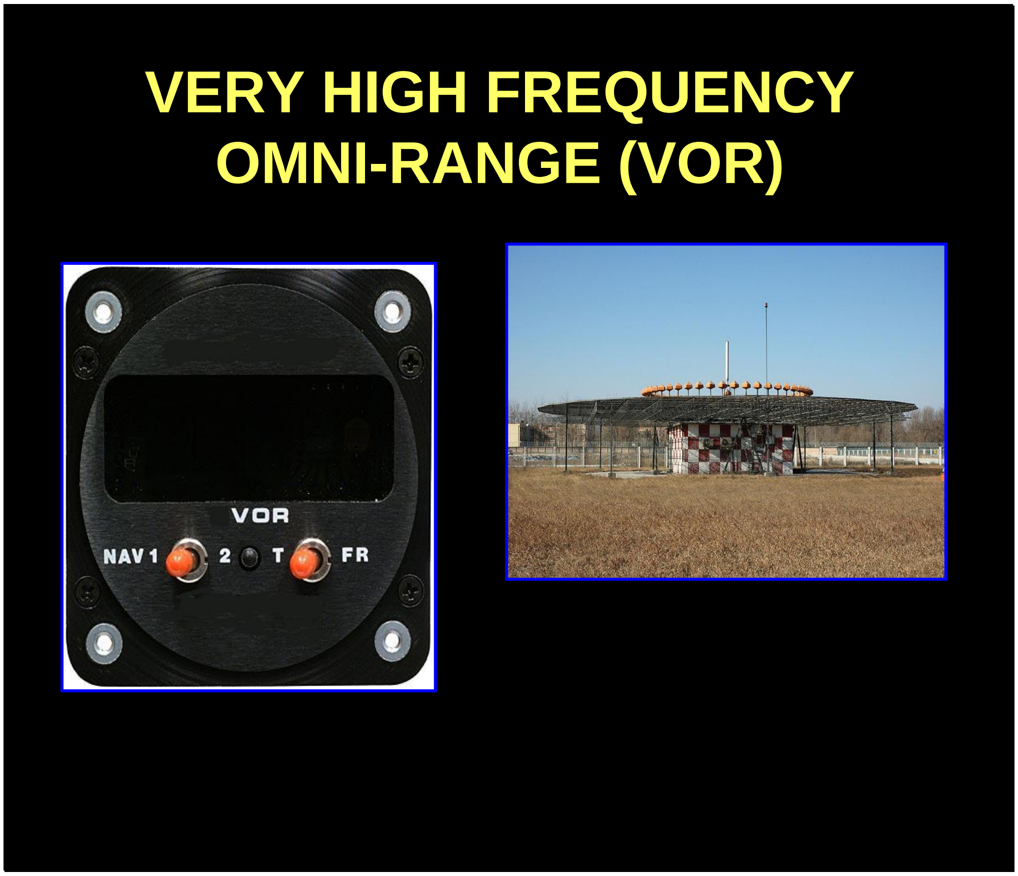
Slide 31



•**Global Navigation Satellite Systems** (**GNSS**) is the standard generic term for **Global Positioning systems** that provide autonomous geo-spatial positioning with global coverage.

•The GPS is a U.S. satellite based radio navigational , positioning, and time transfer system operated by the DoD.
•GNSS allows small receivers to determine their location (Longitude, Latitude, and Altitude to within a few feet using time signals transmitted along a line of sight by radio from satellites.
•Do you see the connection building on all these different systems working together to create a single Aircraft Avionics System.
•GPS system can replace ADF and/or DME For further details see- 14 CFR 91.205 (e)
•FAA Advisory Circular AC 90-94 "Guidelines for using GPS for IFR.

Slide 32



•**VERY HIGH FREQUENCY OMNI-RANGE (VOR)**
VOR, short for VHF Omni-directional Radio Range, is a type of radio navigation system for aircraft.
•A VOR ground station broadcasts a VHF radio composite signal including the station's identifier in Morse code (and sometimes a voice identifier), and data that allows the airborne receiving equipment to derive a magnetic heading from the station to the aircraft (direction from the VOR station in relation to the Earths magnetic north.)
•VOR typical range is below 18,000 feet and approx 40 nautical miles from the station.
•The system transmits on VHF AT 108.00 to 117.95 MHZ

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INSTRUMENT LANDING SYSTEM (ILS)
•The **INSTRUMENT LANDING SYSTEM (ILS)** is a ground-based instrument approach system that provides precision guidance to an aircraft approaching/landing.
•This system uses a combination of radio signals and high-intensity lighting arrays to enable a safe landing during instrument meteorological conditions, (IMC) such as low ceiling or reduced visibility due to fog, rain, or blowing snow
•The aircraft systems locks on to the Glide slope and follows it down.
•The Pilot releases the auto pilot at a given height from the runway and manually lands the aircraft. There are aircraft with auto-land systems.

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DISTANCE MEASURING EQUIPMENT (DME)
Aircraft use DME to determine their distance from a land-based transponder (DME Antenna) by sending and receiving pulse pairs - two pulses of fixed duration and separation.

•The ground stations are typically collocated with VORs. A typical DME ground transponder system for enroute or terminal navigation will have a 1 kW peak pulse output on the assigned UHF channel.

•A low-power DME can also be collocated with an ILS Localizer where it provides an accurate distance function, similar to that otherwise provided by ILS Marker Beacons.

•The DME system operates on UHF at 962 to 1213 MHZ.

•It is required when flying above 24,000 feet see 14 CFR 91.205 for further details about requirement.

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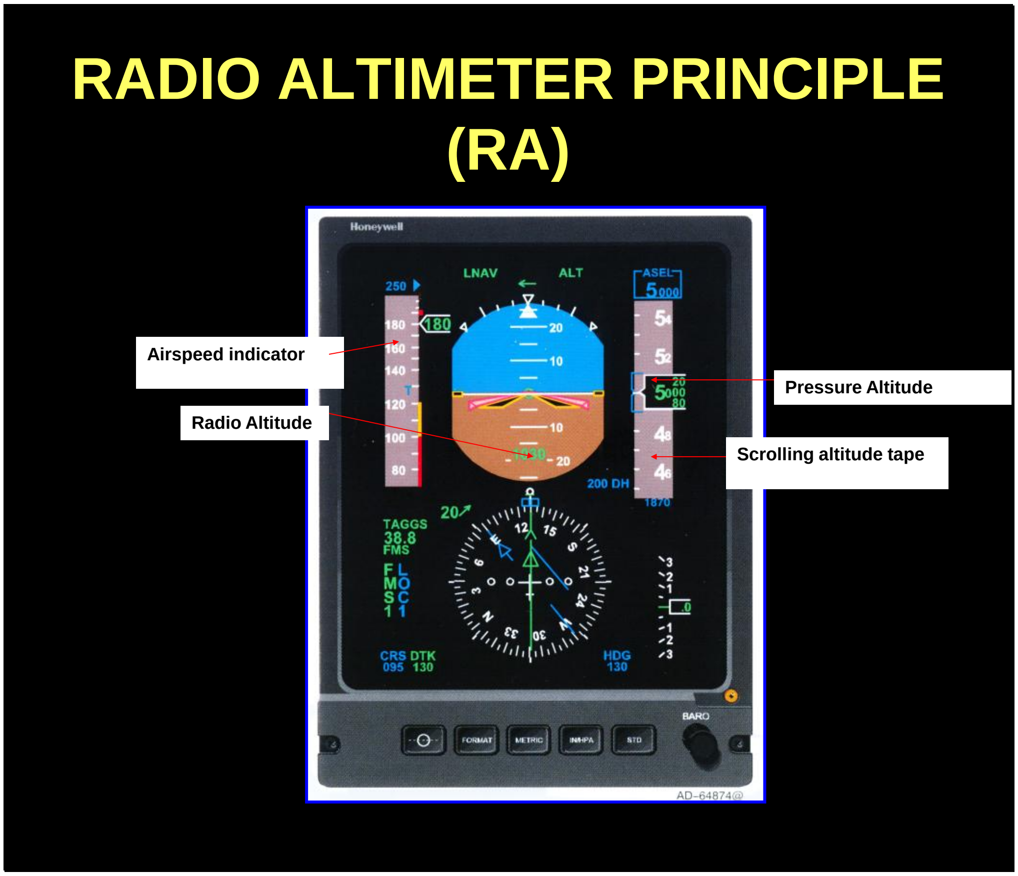

RADIO ALTIMETER PRINCIPLE (RA)

The RAD ALT provides an indication of absolute height above terrain that is displayed on the pilots and co-pilots Primary Flight Display (PFD).

•For single systems (standard) the reversionary controller is inoperative and the data is processed by Data Acquisition Unit (DAU)

•For dual systems (optional) the reversionary controller is operative and the data is processed by the on-side DAU.

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AIR DATA SYSTEMS
AIR DATA SYSTEM and AIR DATA COMPUTERS (ADCs)
The air data system uses external air pressures to the ADC to calculate aircraft altitude and airspeed. This system uses the Pitot Static system to obtain that required Data. The micro air data computers use this pitot data for Altitude, Airspeed to relay this digital data to other various Avionics systems.

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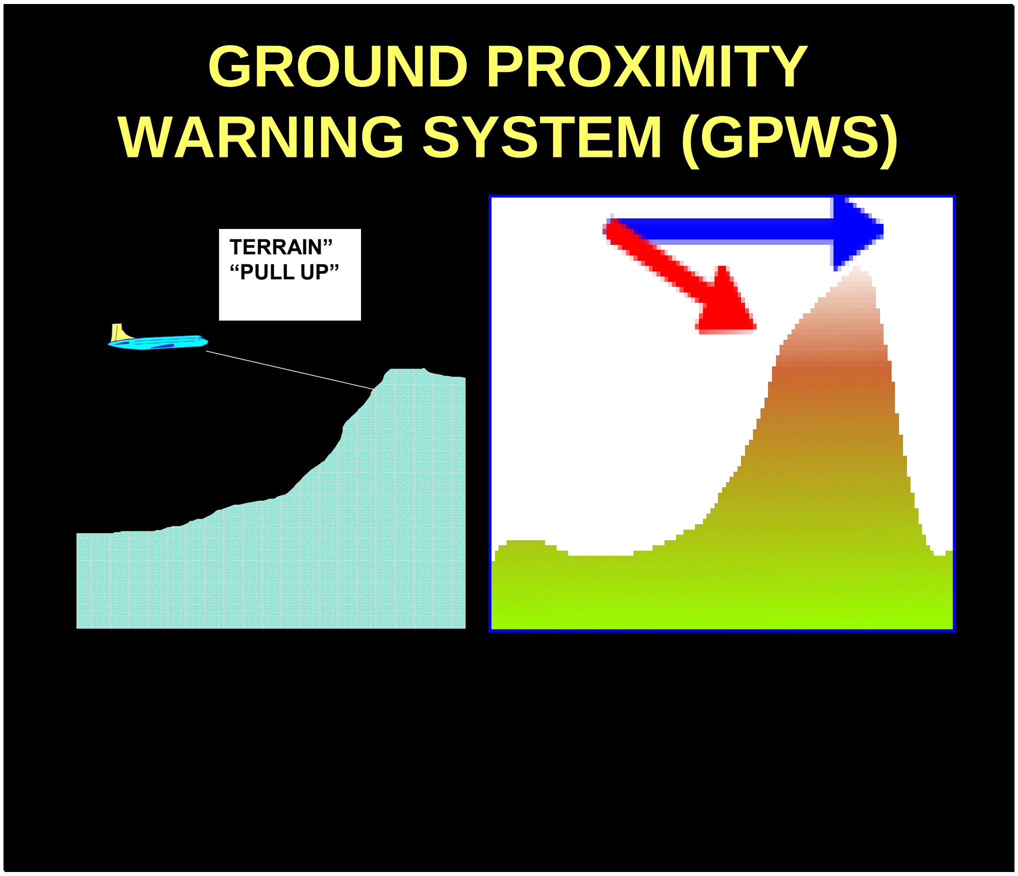

GROUND PROXIMITY WARNING SYSTEM (GPWS)

The purpose of GPWS is to prevent accidents caused by severe wind-shear and Controlled Flight Into Terrain (CFIT).
The system operates by accepting a variety of aircraft parameters as inputs, determining that a conflict exists and supplying the flight crew with audio warnings, messages on the PFD and graphic display on the Main Flight Display (MFD).
GPWS contains a worldwide terrain database. The accuracy of this database varies with the location and also with proximity to airports. The system uses this information and inputs from the Flight Management System (FMS) and radio altimeter to supply enhanced terrain awareness information to the pilots**.**

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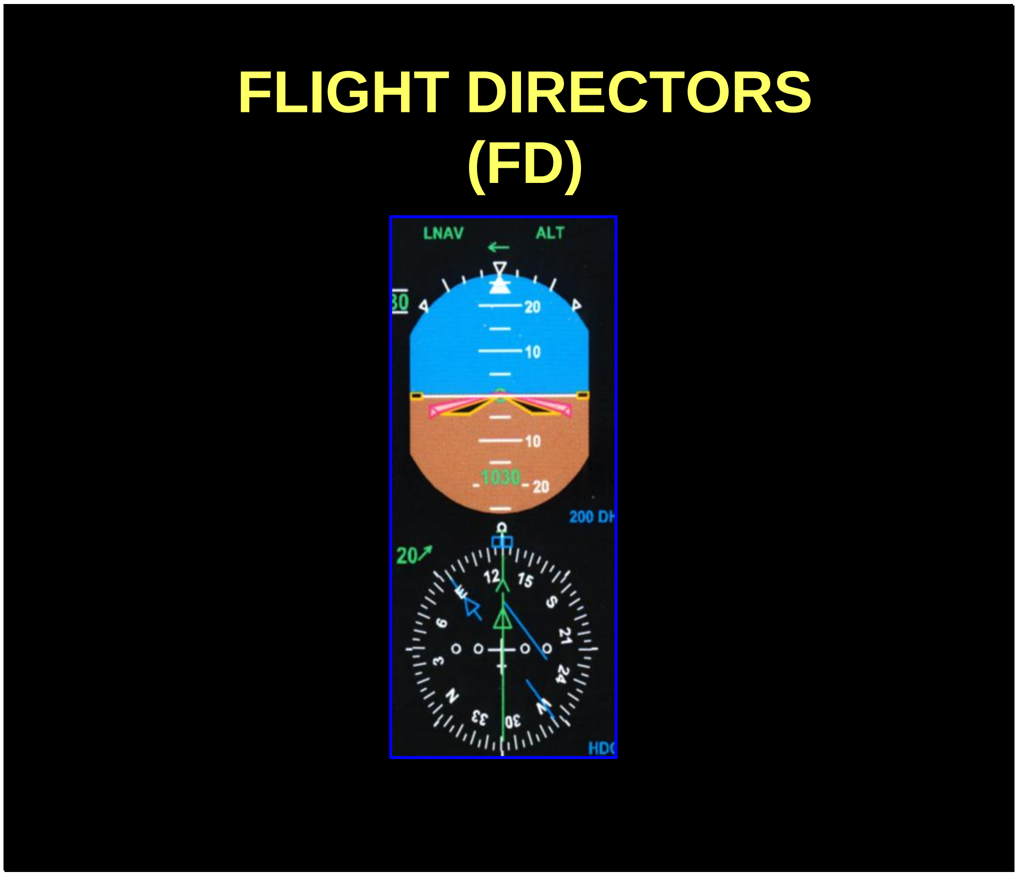

FLIGHT DIRECTORS

•The Flight Director (FD) looks at true airspeed, vertical speed, and glide-slope deviation to determine when to capture the glide-slope beam.

•When captured, the FD resets any other selected vertical mode and tracks the glide-slope beam.

• The FD develops an error signal by comparing actual glide-slope to the incoming signal.

•The error signal is used to drive the command bars and by the autopilot to fly the aircraft to the glide-slope beam.

Attitude indicator;

•a fixed aircraft symbol;
•pitch and bank command bars;
•glide slope indicator;
•localizer deviation indicator;
•slip indicator;
•warning flag for gyro, computer and glide slope

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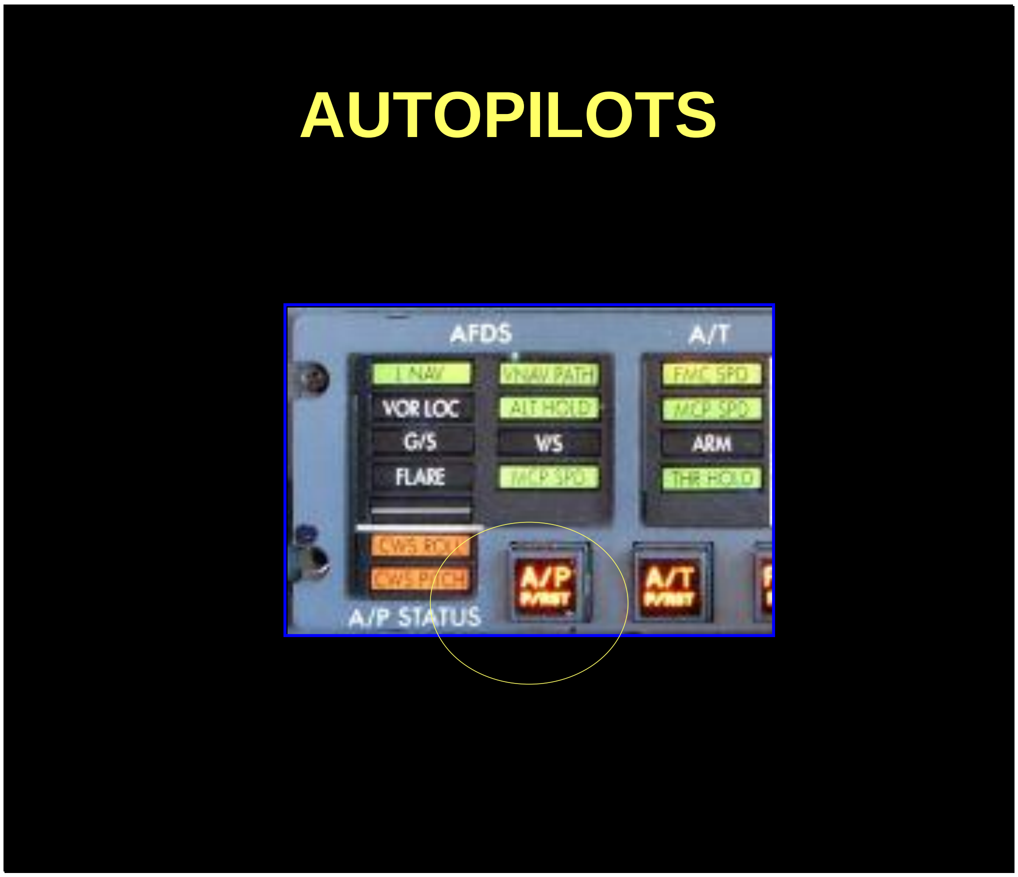

AUTOPILOT

Auto-Pilot Flight control system is used to reduce pilot workload such as attitude control systems to maintain pitch, roll or heading; altitude hold control system to maintain a desired altitude.

•Auto-throttle speed control system to maintain a constant speed or Mach, also improves fuel burn.

•An auto-throttle (Automatic Throttle) allows a pilot to control the power setting of an aircraft's engines by specifying a desired flight characteristic, rather than manually controlling fuel flow.

•These systems can conserve fuel and extend engine life by metering the precise amount of fuel required to attain a specific targeted air speed, or the assigned power for different phases of flight. Auto Throttle (A/T) and AFDS (Auto Flight Director System) work together to fulfill the whole flight plan and greatly reduce pilots' work load.

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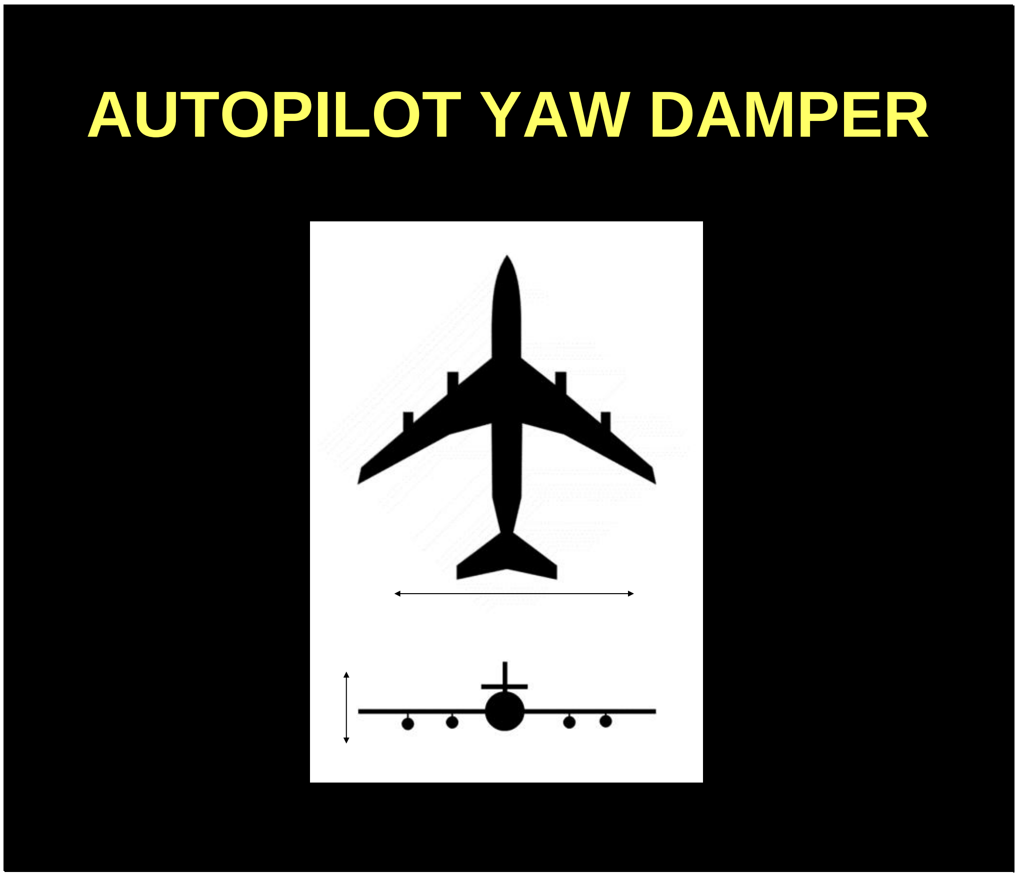

AUTOPILOT YAW DAMPER

•An **Auto-Yaw Damper** is a device used on many aircraft (usually jets and turboprops) to reduce the rolling and yawing oscillations due to *Dutch roll mode.

•It involves yaw rate sensors and a processor that provides a signal to an actuator connected to the rudder.

•The use of the yaw damper helps to provide a better ride for passengers.

•***Dutch roll** is a type of aircraft motion, consisting of an out-of-phase combination of "tail-wagging" and rocking from side to side.

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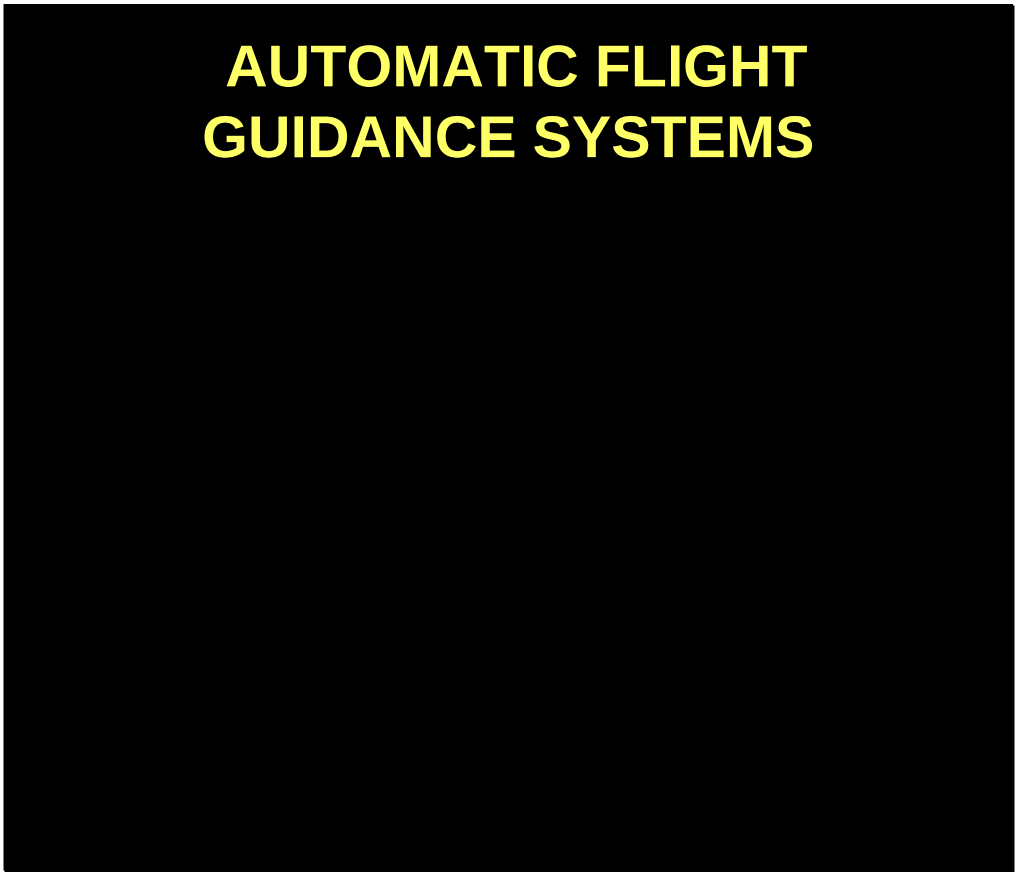

AUTOMATIC FLIGHT GUIDANCE SYSTEMS
This puts all the avionics systems together for the purpose of safe flight.
The **Auto Flight Guidance** systems uses a multiple avionics systems to auto control flight and direction of the aircraft, the following is a list of the Items required for Auto Flight:
Pitch and roll attitude
Indicated airspeed and Mach
Selected target airspeed
Barometric altitude
Selected alert altitude
Decision height and minimum descent altitude
Flight director mode annunciations
Flight director commands
Comparison monitor warnings
Heading and heading source

Course/Desired track orientation
Bearing pointers
Navigation source
Vertical speed
TCAS display
Weather radar

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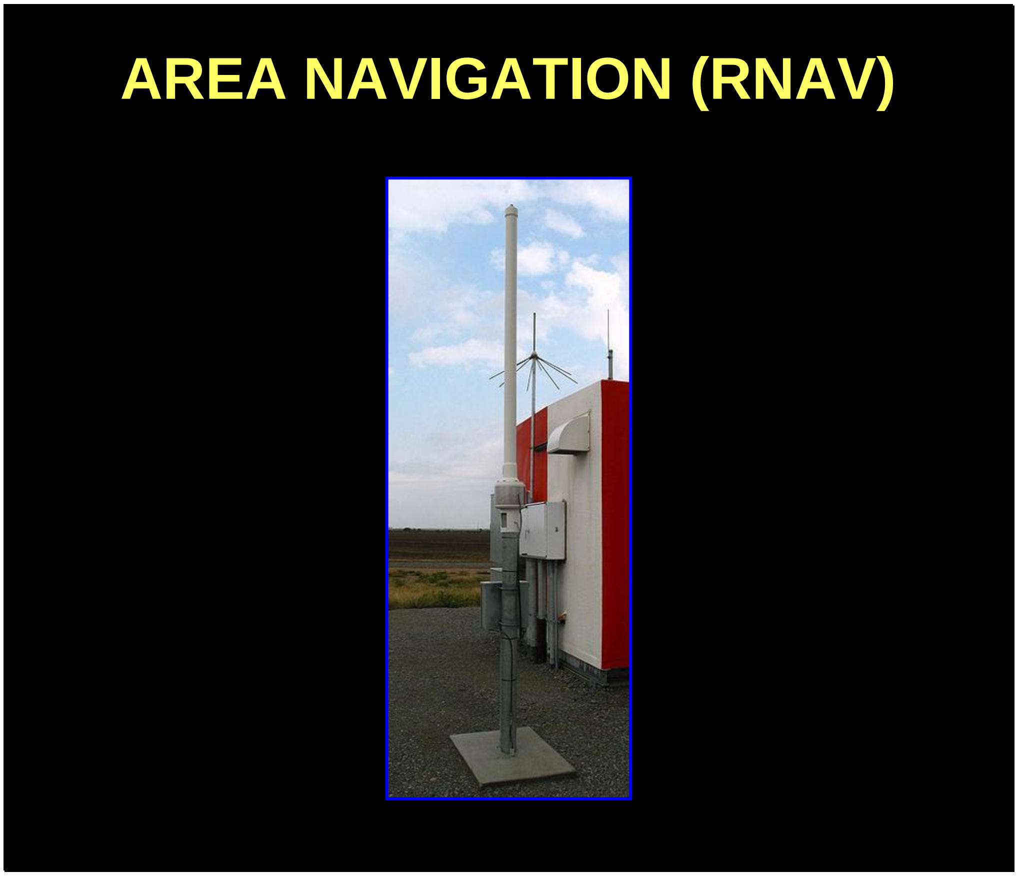

AREA NAVIGATION (RNAV)
Area Navigation (RNAV) is a method of navigation that allows an aircraft to choose any course within a network of navigation signal beacons.

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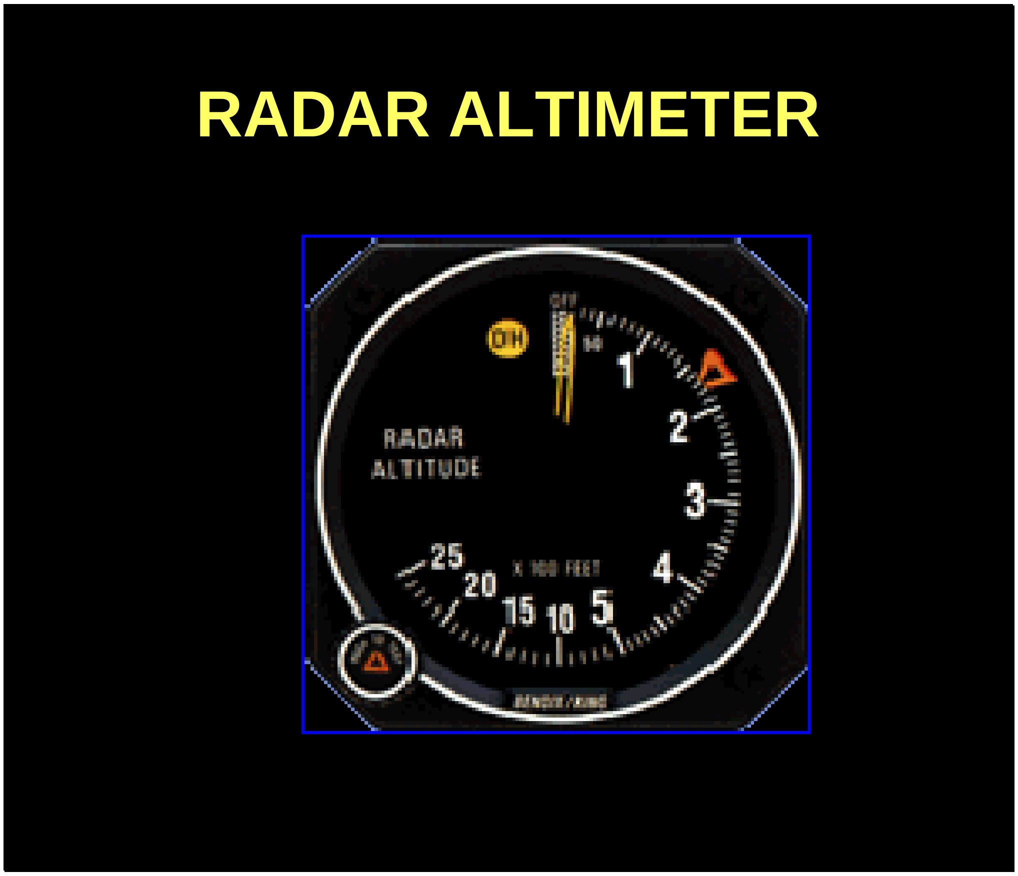

RADAR ALTIMETER

•A **RADAR ALTIMETER** (RA) measures altitude above the terrain beneath the aircraft. The system use an antenna to transmit a signal down and times it back to the aircraft, then the system uses that data to calculate the distance.

•This type of instrument provides the distance between the plane and the ground directly below the aircraft, as opposed to a barometric altimeter which provides the distance above a pre-determined datum, usually sea level.

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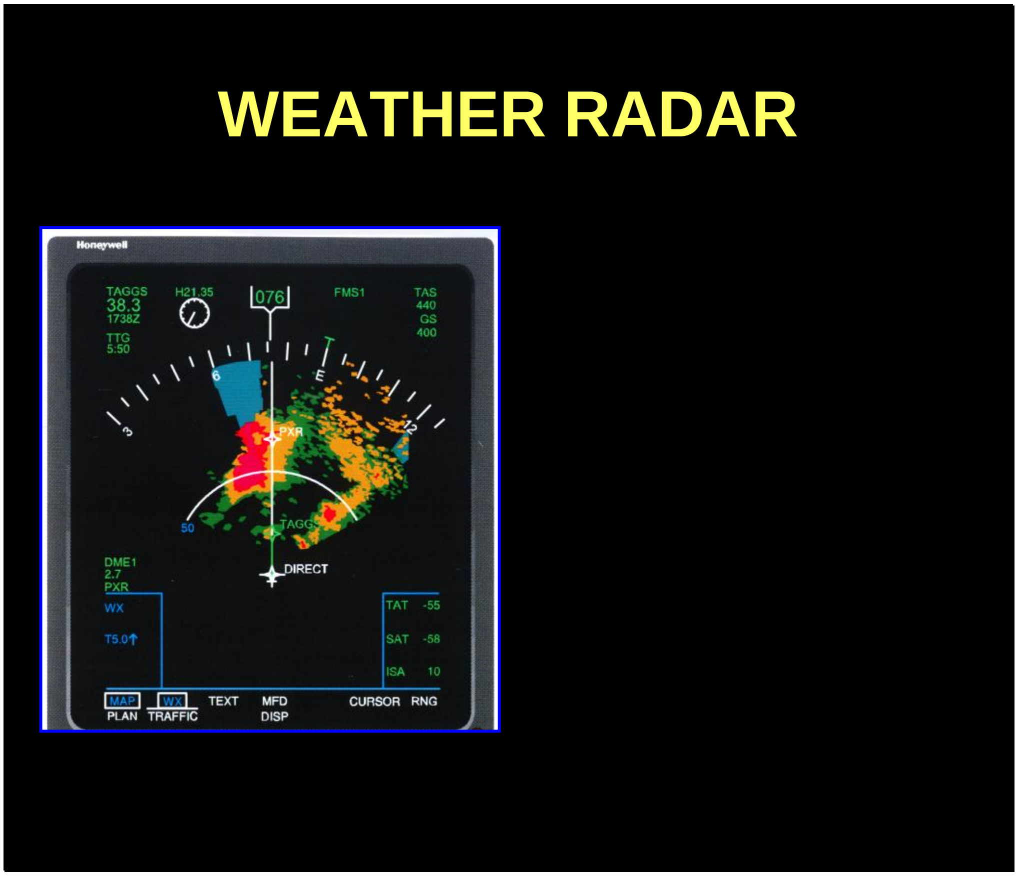

WEATHER RADAR

WEATHER RADAR is a type of radar used to locate , precipitation calculate its motion, estimate its type (rain, snow, hail etc.) and forecast its future position and intensity.

•The radar shows snow rain, hail in different colors based on intensity. Red is high intensity, Green is severe, Blue is a little less, yellow is lesser. These are just examples of function.

•Strong returns (red or magenta) may indicate not only heavy rain but also thunderstorms, hail, strong winds.

When describing weather radar returns, pilots, dispatchers, and air traffic controllers will typically refer to three return levels:

•**level 1** corresponds to a green radar return, indicating usually light precipitation and little to no turbulence, leading to a possibility of reduced visibility.

•**level 2** corresponds to a yellow radar return, indicating moderate precipitation, leading to the possibility of very low visibility, moderate turbulence and an uncomfortable ride for aircraft passengers.

•**level 3** corresponds to a red radar return, indicating heavy precipitation, leading to the possibility of thunderstorms and severe turbulence and serious structural damage to the aircraft.

•Aircraft will try to avoid level 2 returns when possible, and will always avoid level 3 unless they are specially-designed research aircraft.

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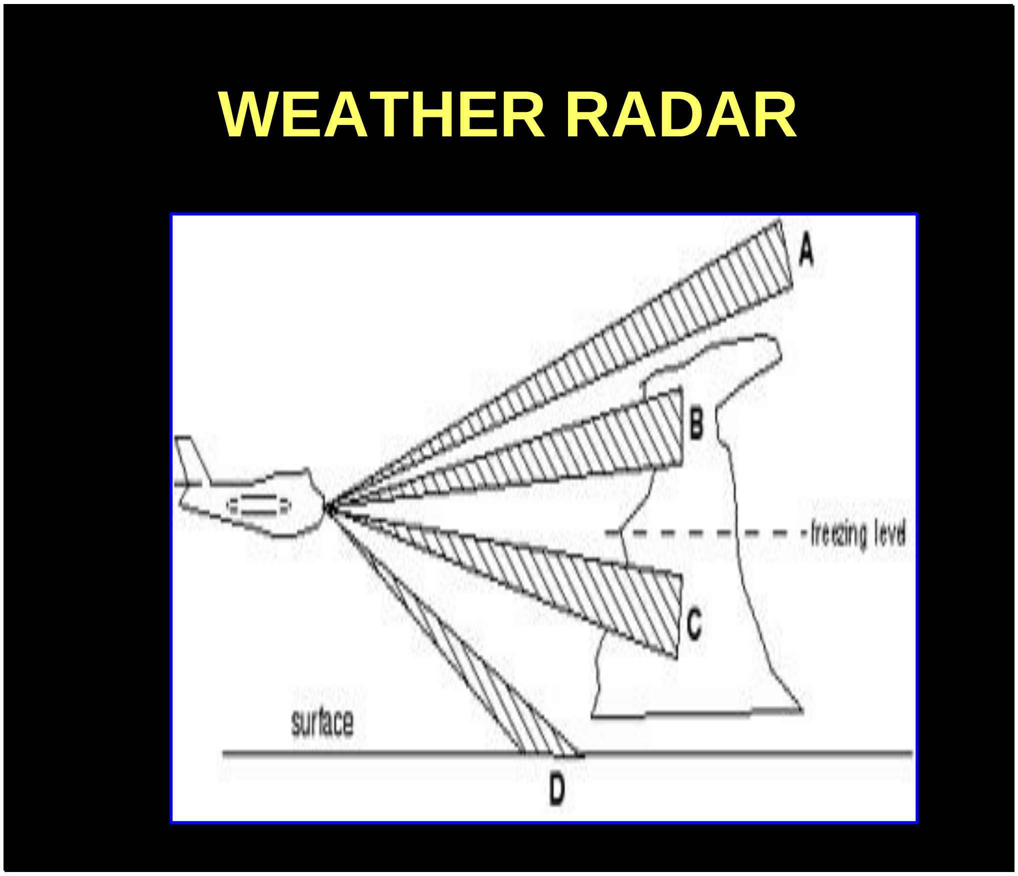

WEATHER RADAR

•One of the least understood to imagine about a airborne weather radar is the **antenna tilt**. The display on the panel has a control that allows the pilot to tilt the antenna up or down. This can be the most critical adjustment of all. The radar antenna platform up in the nose is stabilized in the roll mode.
•The antenna platform is tied into the horizontal gyro circuit so that the platform remains level in reference to the Earth's horizon as the aircraft turns. **A** and **D** shown in the picture is Proper antenna tilt, when pinging a thunderstorm, is what makes the difference between good information, and bad information being dispalyed.

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TRAFFIC COLLISION AVOIDANCE SYSTEM

•The **Traffic Alert and Collision Avoidance System** (or TCAS) is an aircraft collision avoidance system for reducing the incidence of mid-air collisions between aircraft.

• It monitors the airspace around an aircraft for other aircraft equipped with a corresponding active transponder, independent of Air Traffic Control, and warns pilots of the presence of other transponder-equipped aircraft which may present a threat of mid-air collision (MAC).

•The system pings other aircraft for position by its TCAS. system.

•To avoid an mid-air collision One aircraft will be told by the system to dive, dive the other aircraft will be given the opposite information pull-up, pull-up ex.