Acknowledgment

I would like to thank Air India for giving me the opportunity to participate in the Internship Program with their Engineering Division at the Indira Gandhi international Airport New Delhi.

I would also like to thank Mr Anil Kumar, Cheif manager(S.S.-Trg) for his guidance during the course of the internship. I would also like to thank all the staff at Instrumentation Shop, Radio Shop and ATEC shop for sharing their experiences and wisdom about Aircraft Engineering with me.

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31 January, 2012

Certificate of Internship

This is to certify that Akhil Guliani of Netaji Subhas Institute of Technology has completed his Industrial Training at Air India and has submitted this report in partial fulfillment of the requirements of the Internship Program at Air India.

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Date:

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Introduction

1.1 An overview of Aircraft Systems and Aviation

An aircraft is a vehicle that is able to fly by gaining support from the air, or, in general, the atmosphere of a planet. It counters the force of gravity by using either static lift or by using the dynamic lift of an airfoil, or in a few cases the downward thrust from jet engines.

1.2 Maintenance of Aircraft

1.2.1 Introduction

Aircraft maintenance is the overhaul, repair, inspection or modification of an aircraft or aircraft component.

Maintenance includes the installation or removal of a component from an aircraft or aircraft subassembly, but does not include:

1. Elementary work, such as removing and replacing tires, inspection plates, spark plugs, checking cylinder compression, etc.

2. Servicing, such as refueling, washing windows.

3. Any work done on an aircraft or aircraft component as part of the manufacturing process, prior to issue of a certificate of airworthiness or other certification document

1.2.2 Line or Routine maintenance

The maintenance carried out while an airplane is parked at an airport waiting for the next takeoff is generally refered to as Line maintenance. It is a 45 minute during which the aircraft is refuled and all critical instruments are checked for defects. Also a comprehensive post flight inspection is carried out to detect and possibly fix any problems faced by the pilot or the flight crew in general before the next flight. Once the engineereing staff have completed their checks the plane is handed over to the piolt after filling out the relevany paperwork. Pilots are required to follow up with their own preflight Inspection. The preflight inspection follows a checklist listing items that the pilot is to visually check for general condition as he or she walks around the airplane. Also, the pilot must ensure that fuel, oil and other items required for flight are at the proper levels and not contaminated. Additionally, it is the pilot's responsibility to review the airworthiness certificate, maintenance records, and other required paperwork to verify that the aircraft is indeed airworthy.

1.2.3 Base or Major maintenance

Aircraft maintenance checks are periodic inspections that have to be done on all commercial/civil aircraft after a certain amount of time or usage - the military aircraft normally follow specific maintenance programs which may be or not similar to the commercial/civil operators. Airlines and other commercial operators of large or turbine-powered aircraft follow a continuous inspection program approved by the Directorate General of Civil Aviation (DGCA) in India or by other airworthiness authorities such as Federal Aviation Agency (FAA) or the European Aviation Safety Agency (EASA). Airlines and airworthiness authorities casually refer to the detailed inspections as "checks", commonly one of the following: A check, B check, C check, or D check. A and B checks are lighter checks, while C and D are considered heavier checks.

1. Category A-Check:

   This is performed approximately every 500 - 800 flight hours. It needs about 20 man-hours and is usually performed overnight at an airport gate. The actual occurrence of this check varies by aircraft type, the cycle count (takeoff and landing is considered an aircraft "cycle"), or the number of hours flown since the last check. The occurrence can be delayed by the airline if certain predetermined conditions are met.

2. Category B-Check:

   This is performed approximately every 4-6 months. It needs about 150 man-hours and is usually performed within 1-3 days at an airport hangar. A similar occurrence schedule applies to the B check as to the A check. B checks may be incorporated into successive A checks, ie: A-1 through A-10 complete all the B check items.

3. Category C-Check:

   This is performed approximately every 15–21 months or a specific amount of actual Flight Hours (FH) as defined by the manufacturer. This maintenance check is much more extensive than a B Check, as pretty much the whole aircraft is inspected. This check puts the aircraft out of service and until it is completed, the aircraft must not leave the maintenance site. It also requires more space than A and B Checks - usually a hangar at a maintenance base. The time needed to complete such a check is generally 1-2 weeks and the effort involved can require up to 6000 man-hours. The schedule of occurrence has many factors and components as has been described, and thus varies by aircraft category and type.

4. Category D-check:

   This is - by far - the most comprehensive and demanding check for an airplane. It is also known as a Heavy Maintenance Visit (HMV). This check occurs approximately every 5–6 years. It is a check that, more or less, takes the entire airplane apart for inspection and overhaul. Also, if required, the paint may need to be completely removed for further inspection on the fuselage metal skin. Such a check will usually demand around 40.000 man-hours and it can generally take up to 2 months to complete, depending on the aircraft and the number of technicians involved. It also requires the most space of all maintenance checks, and as such must be performed at a suitable maintenance base. Given the requirements of this check and the tremendous effort involved in it, it is also the most expensive maintenance check of all, with total costs for a single visit being well within the million-dollar range. Because of the nature and the cost of such a check, most airlines - especially those with a large fleet - have to plan D Checks for their aircraft years in advance. Ofttimes, older aircraft being phased out of a particular airline's fleet are either stored or scrapped upon reaching their next D Check, due to the high costs involved in it in comparison to the aircraft's value. On average, a commercial aircraft undergoes 2-3 D Checks before it is retired. As such, only few of these shops offer D checks.

1.3 Overhaul Process

The following steps are taken by an engineer to service and overhaul a faulty instrument:

1. Check the testing equipment for:

   (a) Serviceability; weather in working condition or not.

   (b) Calibration or Error chart; the amount of error present in the readings last checked and when due.

   (c) Connectors; for damage so as to protect the equipment.

2. Test the testing equipment in self-test mode yourself to assure serviceability and avoid equipment failure.
3. Assure that the required power supply is available and in serviceable condition. [1]
4. Take proper ESDS (Electro-Static Discharge Sensitive) safety precautions for required equipment.
5. Connect Equipment to the tester and the power supply.
6. Read the technical manuals and documentation provided by the component manufacturer.
7. Follow step by step the overhaul and servicing instructions given in the documentation.
8. Check the error chart and correct the readings accordingly.
9. Fill the documentation with the relevant data and update the component service history to keep track of the components serviceability.

1.4 Objectives of Industrial Training

1.4.1 My Aims and objectives

1. To understand the underlying principles of the components available in the workshop.
2. To observe the ongoing process of component maintenance, repair and overhaul (MRO).
3. Get an engineer's perspective into role of an Instrumentation and Control Engineer in Avionics

1.4.2 The Roster provided by Air India

Table 1.1 gives details about the duration of posting at various labs during the course of the internship.

S.No.	Workshop Attended	Duration
1	Instrumentation Shop	21/12/2011 to 09/01/2012
2	Radio Shop	10/01/2012 to 24/01/2012
3	ATEC Shop	25/01/2012 to 31/01/2012

Table 1.1: Internship Roster

[1] According to a survey around 25% of all equipment failures that happen in the industry are caused due to the application of incorrect power supply.

1.5 Organization of the report

This report is organized in the following manner:

Chapter 1 gives an overview of the knowledge gathered during the course of internship and aims and objectives of the internship.

Chapter 2 explains in breif a few critical concepts about an aircrafts

Chapter 3 gives details about the Instrument shop and aircraft instrument systems.

Chapter 4 gives details about the Radio shop and aircraft communication and navigation systems.

Chapter 5 gives details about the ATEC shop,and equipment testing.

The rest of the report is contained in the appendices, due to the simple reason that aviation is a field having immense depth which cannot be covered entirely in any one document or chapter hence to keep the report to the point and properly informative I decided to include relevant additional information as part of the appendix, which has been organized as follows:

Appendix A gives details about the internship at Air India

Appendix B talks about the ESDS (Electro-Static Discharge Sensitive) devices and related precautions to be taken during the MRO process for them.

Appendix C gives a breif overview of the cockpit.

Appendix D gives a brief about the author.

Chapter 2

Aircraft Fundamentals

2.1 Introduction

An aircraft is a vehicle that is able to fly by gaining support from the air, or, in general, the atmosphere of a planet. It counters the force of gravity by using either static lift or by using the dynamic lift of an airfoil, or in a few cases the downward thrust from jet engines. The human activity that surrounds aircraft is called aviation. The following sections give a breif account of the aircraft.

2.2 Overveiw of an Aircraft

The parts of an aircraft are generally divided into three categories:

1. The airframe comprises the mechanical structure and associated equipment.
2. The propulsion system (if it is powered) comprises the engine or engines and associated equipment.
3. The avionics comprise the electrical flight control and communication systems.

2.2.1 Airframe

The airframe of an aircraft is its mechanical structure. The main parts of the airframe are the fuselage, wing, stabilising tail or empennage, and undercarriage.

Fuselage is an aircraft's main body section containing the crew cockpit or flight deck, and any passenger cabin or cargo hold. In single- and twin-engine aircraft, it will often also contain the engine or engines. The fuselage also serves to position control and stabilization surfaces in specific relationships to lifting surfaces, required for aircraft stability and maneuverability.

Wing The wings of an aircraft produce lift. Many different styles and arrangements of wings have been used on heavier-than-air aircraft, and some lighter-than-air craft also have wings. Most early fixed-wing aircraft were biplanes, having wings stacked one above the other.

Stabilising and control surfaces Most aircraft need horizontal and vertical stabilisers which act in a similar way to the feathers on an arrow. These stabilising surfaces allow equilibrium of aerodynamic forces and to stabilise the flight dynamics of pitch and yaw. Flight control surfaces enable the pilot to control an aircraft's flight attitude and are usually part of the wing or mounted on, or integral with, the associated stabilising surface.

Undercarriage, or landing gear, is the structure that supports an aircraft when it is not flying and allows it to taxi, take off and land. Most commonly, wheels are used but skids, floats, or a combination of these and other elements can be used, depending on the surface. Many aircraft have undercarriage that retracts into the wings and/or fuselage to decrease drag during flight.

2.2.2 Engine

An aircraft engine is the component of the propulsion system for an aircraft that generates mechanical power. The most comman type of engine used in commercial aircrafts are jet engines. A jet engine is a reaction engine that discharges a fast moving jet which generates thrust by jet propulsion. The exhaust nozzle produces thrust for the jet; the hot airflow from the

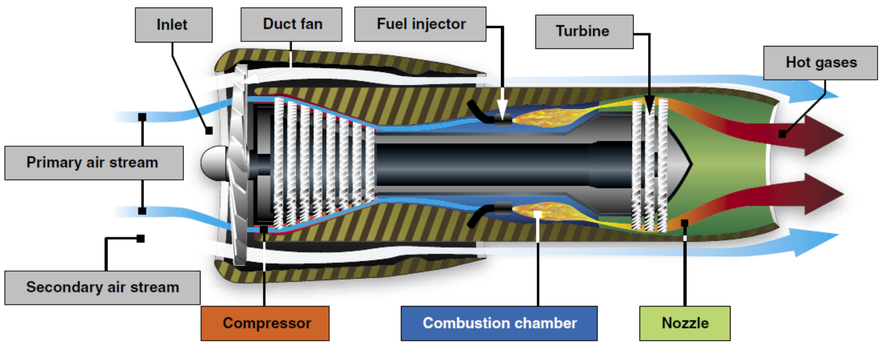


Figure 2.2.1: Jet Engine Cut-away diagram

engine is accelerated when exiting the nozzle, creating thrust, which, in conjunction with the pressures acting inside the engine which are maintained and increased by the constriction of the nozzle, pushes the aircraft forward. The primary engine maintained at the MRO was the IAE V2500; which is a turbofan variety of jet engine.

2.2.3 Avionics

Avionics is a term used to describe all of the electronic systems used on aircraft, artificial satellites and spacecraft. Avionic systems include communications, navigation, the display and management of multiple systems and the hundreds of systems that are fitted to aircraft to meet individual roles.

The cockpit of an aircraft is a typical location for avionic equipment, including control, monitoring, communication, navigation, weather, and anti-collision systems. The majority of aircraft power their avionics using 14 or 28 volt DC electrical systems; however, larger, more sophisticated aircraft have AC systems operating at 400 Hz, 115 volts AC. International standards for avionics equipment are prepared by the Airlines Electronic Engineering Committee (AEEC).

the following gives a brief about some typical avionics equipments:

1. Communications connect the flight deck to the ground and the flight deck to the passengers. On-board communications are provided by public address systems and aircraft intercoms.

2. Aircraft flight control systems; today automated flight control is common to reduce pilot error and workload at key times like landing or takeoff.Autopilot was first invented by Lawrence Sperry during World War II to fly bomber planes steady enough to hit precision targets from 25,000 feet. Today it's equipped on most commercial planes to reduce pilot error and workload at key times such as landing or takeoff.

3. Flight recorder; commercial aircraft cockpit data recorders, commonly known as a "black box", store flight information and audio from the cockpit. They're often recovered from a plane crash to determine the cause of the incident.

4. Weather systems such as weather radar and lightning detectors are important for aircraft flying at night or ininstrument meteorological conditions, where it is not possible for pilots to see the weather ahead. Heavy precipitation (as sensed by radar) or severe turbulence are both indications of strong convective activity and severe turbulence, and weather systems allow pilots to deviate around these areas.

2.3 Flight Dynamics and Control

2.3.1 Flight dynamics

is the science of air vehicle orientation and control in three dimensions. The three critical flight dynamics parameters are the angles of rotation in three dimensions about the vehicle's center of mass, known as pitch, roll, and yaw (quite different from their use as Tait-Bryan angles).

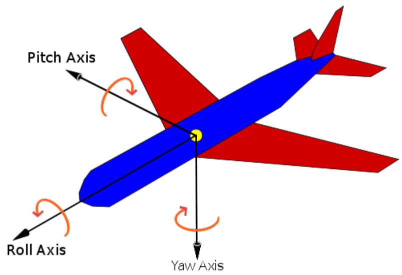


Figure 2.3.1: Flight Dynamics

Roll is a rotation about the longitudinal axis (equivalent to the rolling or heeling of a ship) giving an up-down movement of the wing tips measured by the roll or bank angle.

Pitch is a rotation about the sideways horizontal axis giving an up-down movement of the aircraft nose measured by the angle of attack.

Yaw is a rotation about the vertical axis giving a side-to-side movement of the nose known as sideslip.

2.3.2 Flight control

Aerospace engineers develop control systems for a vehicle's orientation (attitude) about its center of mass. The control systems include actuators, which exert forces in various directions, and generate rotational forces or moments about the aerodynamic center of the aircraft, and thus rotate the aircraft in pitch, roll, or yaw. For example, a pitching moment is a vertical force applied at a distance forward or aft from the aerodynamic center of the aircraft, causing the aircraft to pitch up or down. Control systems are also sometimes used to increase or decrease drag, for example to slow the aircraft to a safe speed for landing.

The two main forces acting on any aircraft are lift supporting it in the air and drag opposing its motion. Control surfaces may also be used to affect these forces directly, without inducing any rotation.

The main control surfaes of an aircraft are :

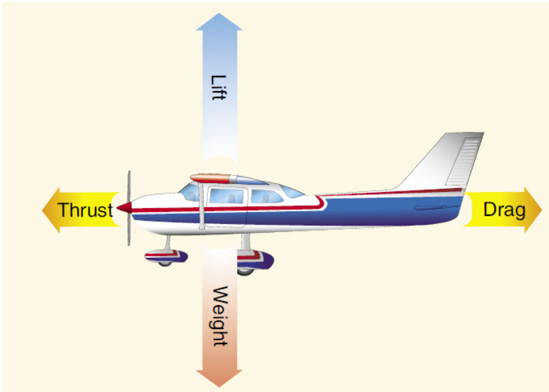
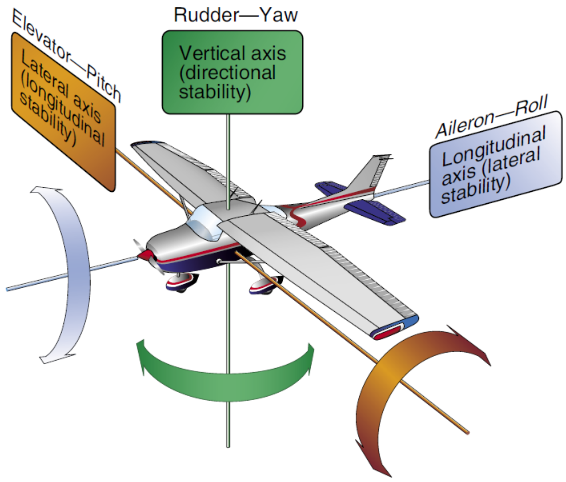


Figure 2.3.2: Forces acting on an Aircraft

Ailerons Ailerons are mounted on the trailing edge of each wing near the wingtips and move in opposite directions. When the pilot moves the stick left, or turns the wheel counter-clockwise, the left aileron goes up and the right aileron goes down. A raised aileron reduces lift on that wing and a lowered one increases lift, so moving the stick left causes the left wing to drop and the right wing to rise. This causes the aircraft to roll to the left and begin to turn to the left. Centering the stick returns the ailerons to neutral maintaining the bank angle. The aircraft will continue to turn until opposite aileron motion returns the bank angle to zero to fly straight.

Elevator An elevator is mounted on the trailing edge of the horizontal stabilizer on each side of the fin in the tail. They move up and down together. When the pilot pulls the stick backward, the elevators go up. Pushing the stick forward causes the elevators to go down. Raised elevators push down on the tail and cause the nose to pitch up. This makes the wings fly at a higher angle of attack, which generates more lift and more drag. Centering the stick returns the elevators to neutral and stops the change of pitch. Many aircraft use a stabilator — a moveable horizontal stabilizer — in place of an elevator. Some aircraft, such as an MD-80, use a servo tab within the elevator surface to aerodynamically move the main surface into position. The direction of travel of the control tab will thus be in a direction opposite to the main control surface. It is for this reason that an MD-80 tail looks like it has a 'split' elevator system.

Rudder The rudder is typically mounted on the trailing edge of the vertical stabilizer, part of the empennage. When the pilot pushes the left pedal, the rudder deflects left. Pushing the right pedal causes the rudder to deflect right. Deflecting the rudder right pushes the tail left and causes



Primary Control Surface	Airplane Movement	Axes of Rotation	Type of Stability
Aileron	Roll	Longitudinal	Lateral
Elevator/ Stabilator	Pitch	Lateral	Longitudinal
Rudder	Yaw	Vertical	Directional

Figure 2.3.3: Aircraft Control surfaces

the nose to yaw to the right. Centering the rudder pedals returns the rudder to neutral and stops the yaw.

2.4 Overveiw of Airbus A-320 Family of Aircrafts

The Airbus A320 family consists of short- to medium-range, narrow-body, commercial passenger jet airliners manufactured by Airbus Industrie.[Nb 1] The family includes the A318, A319, A320 and A321, and the ACJ business jet. Final assembly of the family in Europe takes place in Toulouse, France, and Hamburg, Germany. Since 2009, a plant in Tianjin in the People's Republic of China has also started producing aircraft for Chinese airlines.[3] The aircraft family can accommodate up to 220 passengers and has a range of 3,100 to 12,000 km (1,700 to 6,500 nmi), depending on model.

The first member of the A320 family—the A320—was launched in March 1984, first flew on 22 February 1987, and was first delivered in 1988. The family was soon extended to include the A321 (first delivered 1994), the A319 (1996), and the A318 (2003). The A320 family pioneered the use of digital fly-by-wire flight control systems, as well as side stick controls, in commercial aircraft. There has been a continuous improvement process since

Figure 2.4.1: A320

introduction.

The A319/A320/A321 are narrow body, twin-engined, short / medium-range aircraft, the A319 being the shortened version of the A320, and the A321 being the stretched version of the A320. They both offer an increased fuselage cross-section leading to an increased revenue potential through greater passenger comfort with wider seats and aisle, greater overhead baggage volume, greater cargo capacity, wide-body compatible container capability, quicker turnrounds. Introduced for airline service in March 1988, the A320 represents the largest single advance in civil aircraft technology since the introduction of the jet engine and results in a major stride forward in airline profitability. A computer-managed system gives complete protection against excursions outside the normal flight envelope and greatly improves the man / machine interface.

Chapter 3

Instrument Shop

3.1 Introduction

Aircraft Instrumentation – Any electronic or mechanically-based instrument or instrument system designed for detecting, measuring, displaying, recording, telemetering, processing, or analyzing different values or quantities encountered in the flight of an aircraft; often supporting the general control of the aircraft.

The instrumentation systems used in aircrafts are the eyes and ears of the pilot. they help him navigate the airways safely and efficiently. The array of instruments used on an aircraft also help in indicating the status of the various measures of an aircraft from the basic fuel indicators to the ultra advanced systems which check for suggest preventive mainteance measures in case of system failure under any situation.

Figure 3.1.1: A Generalized Instrumentation system used in Aviation

3.2 Observations

The instrument shop had a huge variety of instruments being repaired and maintined. I was able to get a basic understanding of what is aviation and the role of Instrumentation in Aircraft safety and operation. The following are some Instruments I was able to observe and learn about in detail.

3.2.1 Laser gyros

A ring laser gyro splits a beam of laser light into two beams in opposite directions through narrow tunnels in a closed optical circular path around the perimeter of a triangular block of temperature-stable Cervit glass with reflecting mirrors placed in each corner. When the gyro is rotating at some angular rate, the distance traveled by each beam becomes different—the shorter path being opposite to the rotation. The phase-shift between the two beams can be measured by an interferometer, and is proportional to the rate of rotation (Sagnac effect).

In practice, at low rotation rates the output frequency can drop to zero after the result of back scattering causing the beams to synchronize and lock together. This is known as a lock-in, or laser-lock. The result is that there is no change in the interference pattern, and therefore no measurement change.

To unlock the counter-rotating light beams, laser gyros either have independent light paths for the two directions (usually in fiber optic gyros), or the laser gyro is mounted on a piezo-electric dither motor that rapidly vibrates the laser ring back and forth about its input axis through the lock-in region to decouple the light waves.

The shaker is the most accurate, because both light beams use exactly the same path. Thus laser gyros retain moving parts, but they do not move as far.

3.2.2 Attitude Indicator (Artificial Horizon)

An attitude indicator (AI), also known as gyro horizon or artificial horizon, is an instrument used in an aircraft to inform the pilot of the orientation of the aircraft relative to earth. It indicates pitch (fore and aft tilt) and bank or roll (side to side tilt) and is a primary instrument for flight in instrument meteorological conditions.

The essential components of the indicator are:

1. "miniature wings", horizontal lines with a dot between them representing the actual wings and nose of the aircraft. the center horizon bar separating the two halves of the display, with the top half usually blue in color to represent sky and the bottom half usually dark to represent earth.

2. degree marks representing the bank angle. They run along the rim of the dial. On a typical indicator, the first 3 marks on both sides of the center mark are 10 degrees apart. The next is 60 degrees and the mark in the middle of the dial is 90 degrees.

If the symbolic aircraft dot is above the horizon line (blue background) the aircraft is nose up. If the symbolic aircraft dot is below the horizon line (brown background) the aircraft is nose down. When the dot and wings are on the horizon line, the aircraft is in level flight.

3.2.3 Flight Recorders

A flight recorder is an electronic recording device placed in an aircraft for the purpose of facilitating the investigation of an aircraft accident or incident.

Figure 3.2.1: Attitude Indicator

For this reason, flight recorders are required to be capable of surviving the conditions likely to be encountered in a severe aircraft accident. They are typically specified to withstand an impact of 3400 g and temperatures of over 1,000 °C (1,832 °F) (as required by EUROCAE ED-112). There are two common types of flight recorder, the flight data recorder (FDR) and the cockpit voice recorder (CVR). In some cases, the two recorders may be combined in a single FDR/CVR unit.

Figure 3.2.2: FDR

Since the 1970s most large civil jet transports have been additionally equipped with a "quick access recorder" (QAR). This records data on a removable storage medium. Access to the FDR and CVR is necessarily difficult because of the requirement that they survive an accident. They also require specialized equipment to read the recording. The QAR recording medium is readily removable and is designed to be read by equipment attached to a standard desktop computer. In many airlines the quick access recordings are scanned for 'events', an event being a significant deviation from normal operational parameters. This allows operational problems to be detected and eliminated before an accident or incident results.

Many modern aircraft systems are digital or digitally controlled. Very often the digital system will include Built-In Test Equipment which records information about the operation of the system. This information may also be accessed to assist with the investigation of an accident or incident.

3.2.4 Altimeter

An altimeter is an instrument used to measure the altitude of an object above a fixed level. The altitude of most aircraft is determined based on the measurement of atmospheric pressure. The greater the altitude the lower the pressure. In it, an aneroid barometer measures the atmospheric pressure from a static port outside the aircraft. Air pressure decreases with an increase of altitude—approximately 100 hectopascals per 800 meters or one inch of mercury per 1000 feet near sea level.

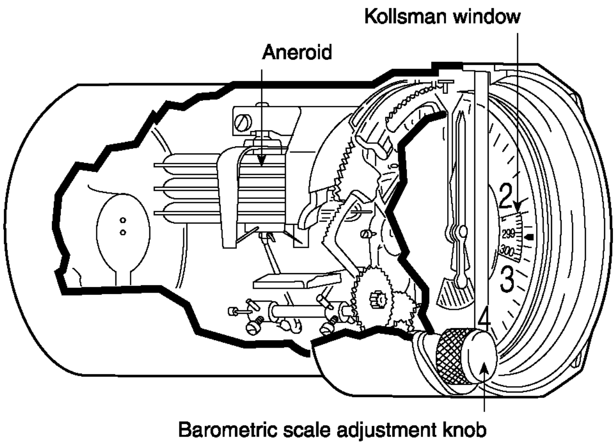


Figure 3.2.3: Internal View of an Aneroid Altimeter

The aneroid altimeter is calibrated to show the pressure directly as an altitude above mean sea level, in accordance with a mathematical model defined by the International Standard Atmosphere (ISA).

3.2.5 Air Speed Indicator

The airspeed indicator or airspeed gauge is an instrument used in an aircraft to display the craft's airspeed, typically in knots, to the pilot. The airspeed indicator is used by the pilot during all phases of flight, from take-off, climb, cruise, descent and landing in order to maintain airspeeds specific to the aircraft type and operating conditions as specified in the Operating Manual. During instrument flight, the airspeed indicator is used in addition to the Artificial horizon as an instrument of reference for pitch control during climbs, descents and turns.

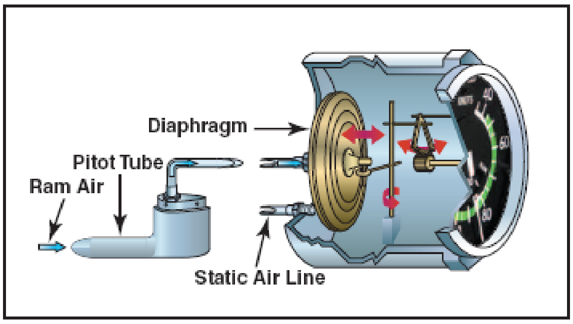


Figure 3.2.4: Internal View of an Air Speed Indicator

Airspeed indicators work by measuring the difference between static pressure, captured through one or more static ports; and stagnation pressure due to "ram air", captured through a pitot tube. This difference in pressure due to ram air is called impact pressure.

3.2.6 Primary Flight Display

A primary flight display or PFD is a modern aircraft instrument dedicated to flight information. Much like multi-function displays, primary flight displays are built around an LCD or CRT display device. Representations of older six pack or "steam gauge" instruments are combined on one compact display, simplifying pilot workflow and streamlining cockpit layouts. Most airliners built since the 1980s — as well as many business jets and an increasing number of newer general aviation aircraft — have glass cockpits equipped with primary flight and multi-function displays. Mechanical gauges have not been completely eliminated from the cockpit with the onset of the PFD; they are retained for backup purposes in the event of total electrical failure.

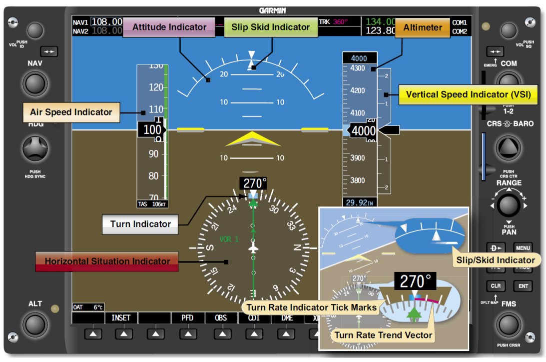


Figure 3.2.5: PFD

While the PFD does not directly use the pitot-static system to physically display flight data, it still uses the system to make altitude, airspeed, vertical speed, and other measurements precisely using air pressure and barometric readings. An air data computer analyzes the information and displays it to the pilot in a readable format. A failure of a PFD deprives the pilot of an extremely important source of information. While backup instruments will still provide the most essential information, they may be spread over several locations in the cockpit, which must be scanned by the pilot, whereas the PFD presents all this information on one display.

Chapter 4

Radio Shop

4.1 Introduction

The Radio Shop at Air India was responsible for the upkeep of Communication and navigational instruments used in the Airbus A-320. During my posting at the workshop I was able to observe numerous of these equipments such as the radar, microphones and other navigational aids usch as ILS, VOR, radio altimeter,etc. These are disscused in the sections to follow.

4.2 Communication Systems in Aviation

4.2.1 Introduction

Communication systems are an essential part of any organizational system where coordination of any scale is required. The aviation industry in by far the most coordinated operation in the world, which makes the communication channels used in the industry its backbone. The communications between airplane and ground stations are genrally done using VHF range radio equipmen when within150-200 Km of the station and HF otherwise. Generally, VHF is the prefered band for communication beacuase of more precision in message delivery than HF. The following sections disscuss the two dominant communication systems in the industry in breif.

4.2.2 VHF

Very high frequency (VHF) is the radio frequency range from 30 MHz to 300 MHz. Frequencies immediately below VHF are denoted high frequency (HF), and the next higher frequencies are known as ultra high frequency (UHF). Common uses for VHF are FM radio broadcast, television broadcast, land mobile stations (emergency, business, private use and military), long range data communication with radio modems, amateur radio, marine communications, air traffic control communications and air navigation systems (e.g. VOR, DME & ILS).

VHF propagation characteristics are ideal for short-distance terrestrial communication, with a range generally somewhat farther than line-of-sight from the transmitter (see formula below). Unlike high frequencies (HF), the ionosphere does not usually reflect VHF radio and thus transmissions are restricted to the local area (and don't interfere with transmissions thousands of kilometres away). VHF is also less affected by atmospheric noise and interference from electrical equipment than lower frequencies. Whilst it is more easily blocked by land features than HF and lower frequencies, it is less affected by buildings and other less substantial objects than UHF frequencies.

The VHF aviation communication system works on the airband of 118.000 MHz to 136.975 MHz. Each channel is spaced from the adjacent ones by 8.33 kHz. VHF is also used for line of sight communication such as aircraft-to-aircraft and aircraft-to-ATC. Amplitude modulation (AM) is used, and the conversation is performed in simplex mode.

4.2.3 HF

High frequency (HF) radio frequencies are between 3 and 30 MHz. Also known as the decameter band or decameter wave as the wavelengths range from one to ten decameters (ten to one hundred metres). Frequencies immediately below HF are denoted Medium-frequency (MF), and the next higher frequencies are known as Very high frequency (VHF). The Shortwave range (2.310 - 25.820 MHz) used by international broadcasters is part of the HF frequency spectrum. In aviation virtually the entire spectrum (2 - 30 MHz) is used for HF communications. The ionosphere often refracts HF radio waves quite well. This phenomenon is known as skywave propagation. Because of these characteristics this range is extensively used for medium and long range radio communication.

4.2.4 Cockpit voice recorder

A cockpit voice recorder (CVR), often referred to as a "black box",[1] is a flight recorder used to record the audio environment in the flight deck of an aircraft for the purpose of investigation of accidents and incidents. This is typically achieved by recording the signals of the microphones and earphones of the pilots headsets and of an area microphone in the roof of the cockpit. A standard CVR is capable of recording 4 channels of audio data for a period of 2 hours. The original requirement was for a CVR to record for 30 minutes, but this has been found to be insufficient in many cases, significant parts of the audio data needed for a subsequent investigation having occurred more than 30 minutes before the end of the recording.the CVR is typically mounted in the tail section (the empennage) of an airplane to maximize the likelihood of its survival in a crash.

4.3 Navigation systems in Aviation

4.3.1 Introduction

Navigation is the determination of position and direction on or above the surface of the Earth. Navigation systems may be entirely on board a vehicle or vessel, or they may be located elsewhere and communicate via radio or other signals with a vehicle or vessel, or they may use a combination of these methods. Navigation systems are capable of:

1. containing maps, which may be displayed in human readable format via text or in a graphical format
2. determining a aircrafts's location via sensors, maps, or information from external sources
3. providing suggested directions to the pilot
4. providing directions directly to the autopilot sub system
5. providing information on nearby aircrafts, or other hazards or obstacles
6. providing information on traffic conditions and suggesting alternative directions

Avionics can use satellite-based systems (such as GPS and WAAS), ground-based systems (such as VOR or ILS), or any combination thereof. Navigation systems calculate the position automatically and display it to the flight crew on moving map displays.

The following sub-sections disscuss a few navigational aids used in aviation.

4.3.2 DME

Distance measuring equipment (DME) is a transponder-based radio navigation technology that measures distance by timing the propagation delay of VHF or UHF radio signals.

Aircraft use DME to determine their distance from a land-based transponder by sending and receiving pulse pairs - two pulses of fixed duration and separation. The ground stations are typically co-located with VORs. A typical DME ground transponder system for en-route or terminal navigation will have a 1 kW peak pulse output on the assigned UHF channel.

A low-power DME can also be co-located with an ILS glide slope or localizer where it provides an accurate distance function, similar to that otherwise provided by ILS Marker Beacons.

The DME system is composed of a UHF transmitter/receiver (interrogator) in the aircraft and a UHF receiver/transmitter (transponder) on the ground. A typical DME transponder can provide distance information to 100 aircraft at a time. Above this limit the transponder avoids overload by limiting the gain of the receiver. Replies to weaker more distant interrogations are ignored to lower the transponder load. The technical term for overload of a DME station caused by large numbers of aircraft is station saturation.

4.3.3 VOR

VOR, short for VHF omnidirectional 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, voice, and navigation signal. The identifier is typically a two- or three-letter string in Morse code. . The navigation signal allows the airborne receiving equipment to determine a magnetic bearing from the station to the aircraft (direction from the VOR station in relation to the Earth's magnetic North at the time of installation). VOR stations in areas of magnetic compass unreliability are oriented with respect to True North. This line of position is called the "radial" from the VOR. The intersection of two radials from different VOR stations on a chart provides the position of the aircraft.

VORs are assigned radio channels between 108.0 MHz (megahertz) and 117.95 MHz (with 50 kHz spacing); this is in the VHF (very high frequency) range. The first 4 MHz is shared with the ILS band. To leave channels for ILS, in the range 108.0 to 111.95 MHz, the 100 kHz digit is always even, so 108.00, 108.05, 108.20, and so on are VOR frequencies but 108.10, 108.15, 108.30, and so on, are reserved for ILS.

The VOR encodes azimuth (lateral direction from the station) as the phase relationship of a reference and a variable signal. The omni-directional signal contains a modulated continuous wave (MCW) 7 wpm Morse code station identifier, and usually contains an amplitude modulated (AM) voice channel. The conventional 30 Hz reference signal is on a 9960 Hz frequency modulated (FM) subcarrier. The variable amplitude modulated (AM) signal is conventionally derived from the lighthouse-like rotation of a directional antenna array 30 times per second. Although older antennas were mechanically rotated, current installations scan electronically to achieve an equivalent result with no moving parts. When the signal is received in the aircraft, the two 30 Hz signals are detected and then compared to determine the phase angle between them. The phase angle by which the AM signal lags the FM subcarrier signal is equal to the direction from the station to the aircraft, in degrees from local magnetic north, and is called the "radial."

This information is then fed to one of four common types of indicators:

1. An Omni-Bearing Indicator (OBI) is the typical light-airplane VOR

indicator and is shown in the accompanying illustration. It consists of a knob to rotate an "Omni Bearing Selector" (OBS), and the OBS scale around the outside of the instrument, used to set the desired course.A "course deviation indicator" (CDI) is centered when the aircraft is on the selected course, or gives left/right steering commands to return to the course. An "ambiguity" (TO-FROM) indicator shows whether following the selected course would take the aircraft to, or away from the station.

2. A Horizontal Situation Indicator (HSI) is considerably more expensive and complex than a standard VOR indicator, but combines heading information with the navigation display in a much more user-friendly format, approximating a simplified moving map.

3. A Radio Magnetic Indicator (RMI), developed previous to the HSI, features a course arrow superimposed on a rotating card which shows the aircraft's current heading at the top of the dial. The "tail" of the course arrow points at the current radial from the station, and the "head" of the arrow points at the reciprocal (180° different) course to the station.

4. An Area Navigation (RNAV) system is an onboard computer, with display, and up-to-date navigation database. At least two VOR stations, or one VOR/DME station is required, for the computer to plot aircraft position on a moving map, or display course deviation relative to a waypoint (virtual VOR station).

4.3.4 ILS

An instrument landing system (ILS) is a ground-based instrument approach system that provides precision guidance to an aircraft approaching and landing on a runway, using a combination of radio signals and, in many cases, high-intensity lighting arrays to enable a safe landing during instrument meteorological conditions (IMC), such as low ceilings or reduced visibility due to fog, rain, or blowing snow.

Instrument approach procedure charts (or approach plates) are published for each ILS approach, providing pilots with the needed information to fly an ILS approach during instrument flight rules (IFR) operations, including the radio frequencies used by the ILS components or navaids and the minimum visibility requirements prescribed for the specific approach.

Radio-navigation aids must keep a certain degree of accuracy (set by international standards of CAST/ICAO); to assure this is the case, flight inspection organizations periodically check critical parameters with properly equipped aircraft to calibrate and certify ILS precision.

the ILS, follows two signals: a localizer for lateral guidance (VHF); and a glide slope for vertical guidance (UHF). When Navigation receiver is tuned to a localizer frequency a second receiver, the glide-slope receiver, is automatically tuned to its proper frequency. The pairing is automatic. They are explained as follows:

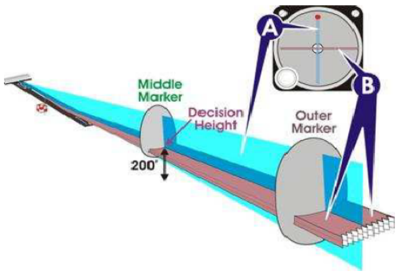


Figure 4.3.1: ILS Sketch

1. Localizer : The localizer signal provides lateral information to guide the aircraft to the centerline of the runway. It is similar to a VOR signal except that it provides radial information for only a single course; the runway heading. Localizer information is displayed on the same indicator as the VOR information.

2. Glide Slope: The Glide Slope is the signal that provides vertical guidance to the aircraft during the ILS approach. The standard glide-slope path is 3° downhill to the approach-end of the runway. Follow it faithfully and your altitude will be precisely correct when you reach the touchdown zone of the runway.

3. Marker Beacons : Marker beacons are used to alert the pilot that an action (e.g., altitude check) is needed. This information is presented to the pilot by audio and visual cues. The ILS may contain three marker beacons: inner, middle and outer. The inner marker is used only for Category II operations. The marker beacons are located at specified intervals along the ILS approach and are identified by discrete audio and visual characteristics.

4.3.5 Radar

Radar is an object-detection system which uses radio waves to determine the range, altitude, direction, or speed of objects. The name RADARis a contraction of the words RAdio Detection And Ranging. It can be used to detect aircraft, motor vehicles, weather formations, and terrain. The radar dish or antenna transmits pulses of radio waves or microwaves which bounce

Category	Decision Height	Minimum Visibility
I	200 feet	2400 feet
I	200 feet	1800 feet with lighting
II	100 feet	1200 feet
IIIa	100 feet	700 feet
IIIb	50 feet	150-700 feet
IIIc	No DH	no limitation

Table 4.1: Categories of ILS Approaches

off any object in their path. The object returns a tiny part of the wave's energy to a dish or antenna which is usually located at the same site as the transmitter. The aviation ueses of radar are air traffic control, aircraft anticollision systems, meteorological precipitation monitoring; altimetry and flight control systems.

The following are some uses and features of on-board Radar explained in brief;

Principle

A radar system has a transmitter that emits radio waves called radar signals in predetermined directions. When these come into contact with an object they are usually reflected or scattered in many directions. Radar signals are reflected especially well by materials of considerable electrical conductivity—especially by most metals, by seawater, by wet land, and by wetlands. Some of these make the use of radar altimeters possible. The radar signals that are reflected back towards the transmitter are the desirable ones that make radar work. If the object is moving either closer or farther away, there is a slight change in the frequency of the radio waves, caused by the Doppler effect.

Radar receivers are usually, but not always, in the same location as the transmitter. Although the reflected radar signals captured by the receiving antenna are usually very weak, these signals can be strengthened by electronic amplifiers. More sophisticated methods of signal processing are also used in order to recover useful radar signals.

The weak absorption of radio waves by the medium through which it passes is what enables radar sets to detect objects at relatively long ranges—ranges at which other electromagnetic wavelengths, such as visible light, infrared light, and ultraviolet light, are too strongly attenuated. Such things as fog, clouds, rain, falling snow, and sleet that block visible light are usually transparent to radio waves. Certain radio frequencies that are absorbed or scattered by water vapor, raindrops, or atmospheric gases (especially oxygen) are avoided in designing radars except when detection of these is intended.

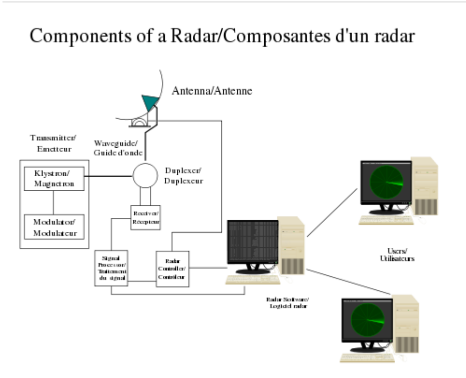


Figure 4.3.2: Block Diagram of RADAR

Components

A radar's major components are:

1. A transmitter that generates the radio signal with an oscillator such as a klystron or a magnetron and controls its duration by a modulator.

2. A waveguide that links the transmitter and the antenna.

3. A duplexer that serves as a switch between the antenna and the transmitter or the receiver for the signal when the antenna is used in both situations.

4. A receiver. Knowing the shape of the desired received signal (a pulse), an optimal receiver can be designed using a matched filter.

5. An Antenna. A parab

6. An electronic section that controls all those devices and the antenna to perform the radar scan ordered by software.

7. A link to the Navigational Display Unit.

Applications

The major applications of radar in aviation are as follows:

1. Plan Position Indicator (PPI) : The plan position indicator (PPI), is the most common type of radar display. The radar antenna is usually represented in the center of the display, so the distance from it and height above ground can be drawn as concentric circles. As the radar antenna rotates, a radial trace on the PPI sweeps in unison with it about the center point.

2. Weather Indicator: Weather systems such as weather radar are important for aircraft flying at night or in instrument meteorological conditions, where it is not possible for pilots to see the weather ahead. Heavy precipitation (as sensed by radar) or severe turbulence (as sensed by lightning activity) are both indications of strong convective activity and severe turbulence, and weather systems allow pilots to deviate around these areas.

3. Radar altimeter : The radar altimeter is a more high-tech altimeter which uses radar to detect the plane's altitude. This type of altimeter is not affected by differences in air pressure, because it does not measure air pressure at all. It measures your true altitude above whatever terrain you are currently flying over. Rather than measuring altitude ASL, it measures altitude AGL (Above Ground Level). A radar altimeter is highly accurate and thus of extreme importance to any airplane pilot. Unfortunately, many smaller civilian aircraft still do not have one, instead relying on a pressure-based altimeter.

Chapter 5

ATEC Shop

5.1 Introduction

The ATEC shop is named after the ATEC series of computers, which are placed within the shop. Air India has two ATEC's a Series 5 and a Series 6. Togather both of these can test all the computers used in the Airbus A-320 Family of Aircrafts. During my posting at the shop I was able to observe and learn about componenet testing procedures and get an overveiw of the role of computers in modern aircrafts. the following sections give a brief account of those observations.

5.2 Equipment Testing

5.2.1 ATEC

ATEC, is a general purpose automatic test system that has been used for

Figure 5.2.1: ATEC series 6

more than 30 years to support commercial airliners, as well as military aircraft, helicopters and ground vehicles. It is the world's leading test solution for Airbus and Boeing jetliners – utilized by some 160 organizations worldwide, including airlines, original equipment manufacturers, and MRO (maintenance, repair and overhaul) service providers. The latest model avialable, ATEC Series 6 VXI-based automatic test equipment, provides all of the resources and technologies required to test the latest-generation avionics on Airbus A320s, A330s, A340s and A380s, as well as later model Boeing 737s and the 777.

The ATEC Series 6 is used for maintenance testing of every major equipment family: flight control systems, primary and secondary flight displays, engine control systems, fuel monitoring systems, landing/brake control systems, auxiliary power units and new generation avionics.

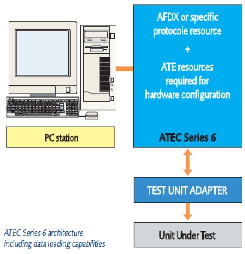


Figure 5.2.2: ATEC Modular architecture

The ATEC Series 6 is fully compliant with international norms and standards. It is designed as a modular architecture using off-the-shelf resources and is available in different configurations adapted to users' needs.

5.2.2 Procedure

The Components which have been serviced or have reached their periodic check limit are tested as follows :

1. First the component is cleaned and it is made sure that no dust or rust is present on or in the component connectors.
2. Then the components testbench is attached to the ATEC Station.
3. Then the ATEC computer is used to configure the station for the particular testbench.
4. A self test for the testbench is performed to confirm its servicability.
5. After the selftest the component is conected to the testbench.
6. Once the connections are tested the test procedure is initiated.
7. The test may take upto24 hours for completion depending upon the type of equipment and level of testing.

8. On completion of the test a report is generated detailing all the faults detected in the equipment, if any.
9. The test report is attached to the Service sheet of the equipment and all necessary paperwork is updated.
10. finally the component is dispatched to the relevant servicing shop, if faulty. Else it is sent to the store.

Bibliography

1. Component Service Manuals, reveant Manufacturer.
2. FAA Pilot Handbook
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Appendix A

About the Internship

A.1 Introduction

Air India's Engineering division's Engineering Training School, New Delhi offers undergraduate students an opportunity to work and observe the ongoing maintenance, repair and overhaul(MRO) process at their hangers and workshop at the IGI Airport, New Delhi. During the Internship the intern is posted at various workshops in accordance to his engineering trade and field of interest. The internship opportunity at Air India's Engineering division is one of the best places in the country to enhance one's knowledge about aviation and aircrafts.

Figure A.1.1: Air India Logo

A.2 About Air India

Air India is India's national flag carrier. Although air transport was born in India on February 18, 1911 when Henri Piquet, flying a Humber bi-plane, carried mail from Allahabad to Naini Junction, some six miles away, the scheduled services in India, in the real sense, began on October 15, 1932. It was on this day that J.R.D. Tata, the father of Civil Aviation in India and founder of Air India, took off from Drigh Road Airport, Karachi, in a tiny, light single-engined de Havilland Puss Moth on his flight to Mumbai (then known as Bombay) via Ahmedabad.

Air India is largest operating commercial airline in India. Air India operates nearly (get number form internet) flights daily; making its engineering division of the most critical departments to ensure proper functioning of the fleet. Having three regional centers; in New Delhi, Mumbai, Calcutta and Chennai; for overhaul and maintenance of popular aircrafts such as the Airbus A-320 series and the Boeing 737 series has made the Engineering department one of the most experienced and sought after aircraft maintenance crews in the country.

Aircraft Type	Fleet Size
Wide Body Aircrafts:	27
B777-200LR	8
B777-300ER	12
B747-400	5
A330-200	2
Narrow Body Aircrafts:	94
B-737-800(AIX)	21
A320	18
A319	24
A321	20
CRJ-700	4
ATR42	7
Total Fleet Size:	121

Table A.1: Air India Fleet details

Air India has major infrastructure in Mumbai and Delhi, with 5,610 skilled engineers and technicians capable of undertaking maintenance of all aircraft and engines currently in its fleet. There are in addition three more major ports at Chennai, Kolkata, Hyderabad and Bangaluru.

Appendix B

ESDS : Electro-Static Discharge Sensitive Devices

B.1 Introduction

An electrostatic-sensitive device (often abbreviated ESD) is any component (primarily electrical) which can be damaged by common static charges which build up on people, tools, and other non-conductors or semiconductors. ESD commonly also stands for electrostatic discharge.

Figure B.1.1: ESDS Warning Label

Electrostatic discharge is a serious issue in solid state electronics, such as integrated circuits. Integrated circuits are made from semiconductor materials such as silicon and insulating materials such as silicon dioxide. Either of these materials can suffer permanent damage when subjected to high voltages; as a result, there are now a number of antistatic devices that help prevent static build up.

B.2 Causes of ESD

One of the causes of ESD events is static electricity. Static electricity is often generated through turbocharging, the separation of electric charges that occurs when two materials are brought into contact and then separated. Examples of turbocharging include walking on a rug, rubbing a plastic comb against dry hair, rubbing a balloon against a sweater, ascending from a fabric car seat, or removing some types of plastic packaging. In all these cases, the friction between two materials results in turbocharging, thus creating a difference of electrical potential that can lead to an ESD event.

Another cause of ESD damage is through electrostatic induction. This occurs when an electrically charged object is placed near a conductive object isolated from ground. The presence of the charged object creates an electrostatic field that causes electrical charges on the surface of the other object to redistribute. Even though the net electrostatic charge of the object has not changed, it now has regions of excess positive and negative charges. An ESD event may occur when the object comes into contact with a conductive path. For example, charged regions on the surfaces of styrofoam cups or bags can induce potential on nearby ESD sensitive components via electrostatic induction and an ESD event may occur if the component is touched with a metallic tool.

B.3 Safety precautions while handling ESDS components

The preventive measures for ESD are based on an Electrostatic Protective Area (EPA). The EPA can be a small working station or a large manufacturing area. The principle behind an EPA is that there are no highly charging materials in the vicinity of ESD sensitive electronics, all conductive materials are grounded, workers are grounded, and charge build-up on ESD sensitive electronics is prevented. The International standards used to define typical EPA are provided by International Electrotechnical Commission (IEC) or American National Standards Institute (ANSI). The standards used at Air India are specified as follows:

B.3.1 Identification

- There is a yellow Label on Component/Packing
- The component is wrapped in static protecting pink poly-packing

B.3.2 Dont's for handling

- Donot touch the component directly. Touch the metal rack first.
- Donot touch the connectors and pins by hand.
- Donot use hydraulic fluid spilled bag/package for packing.
- Donot bring the component in contact with any object which may have static charge.
- Donot use ordinary plastic and Styrofoam in proximity of ESDS devices.
- Donot use ordinary adhesive tapes on ESDS devices.

B.3.3 Do's for handling

- Touch metal rack first so that static charge on your body is discharged.
- ESDS units must be stored/placed only on anti-static sheets.
- Unserviceable units must be handled with same care a serviceable ones.
- Blanking of all connectors should be done before handling ESDS units.
- Packing material and boxes used foe serviceable units should be reused on unserviceable units removed from the aircraft.
- ESDS components should be issued with boxes and packing.
- Transportation trollies should have cushion on the bottom to avoid damages to the component due to jerks.

B.3.4 Advantages of proper handling

- Reduced damage to the component.
- Reduced down-time and savings on repair of components.
- Improved technical reliability.

Appendix C

Cockpit overveiw

C.1 Introduction

A cockpit or flight deck is the area, usually near the front of an aircraft, from which a pilot controls the aircraft. The cockpit of an aircraft contains flight instruments on an instrument panel, and the controls which enable the pilot to fly the aircraft. Most modern cockpits are enclosed, except on some small aircraft, and cockpits on large airliners are also physically separated from the cabin. From the cockpit an aircraft is controlled on the ground and in the air. Cockpit as a term for the pilot's compartment in an aircraft first appeared in 1914. Most Airbus cockpits are computerised glass cockpits featuring fly-by-wire technology. The control column has been replaced with an electronic sidestick.

The following sections give an overvew of the instruments present in a cockpit and the egrnomics of its design.

C.2 Cockpit Layout

Ergonomics and human factors concerns are important in the design of modern cockpits. The layout and function of cockpit displays controls are designed to increase pilot situation awareness without causing information overload. The layout of control panels in modern airliners has become largely unified across the industry. The majority of the systems-related controls (such as electrical, fuel, hydraulics and pressurization) for example, are usually located in the ceiling on an overhead panel. Radios are generally placed on a panel between the pilot's seats known as the pedestal. Automatic flight controls such as the autopilot are usually placed just below the windscreen and above the main instrument panel on the glareshield. A central concept in the design of the cockpit is the Design Eye Position or "DEP", from which point all displays should be visible.

Figure C.2.1: An Airbus A-320 Cockpit

C.3 Instrument Panel

In the modern electronic cockpit, the flight instruments usually regarded as essential are MCP, PFD, ND, EICAS, FMS/CDU and back-up instruments.

MCP

A mode control panel, usually a long narrow panel located centrally in front of the pilot, may be used to control heading, speed, altitude, vertical speed, vertical navigation and lateral navigation. It may also be used to engage or disengage both the autopilot and the autothrottle. The panel as an area is usually referred to as the "glareshield panel". MCP is a Boeing designation (that has been informally adopted as a generic name for the unit/panel) for a unit that allows for the selection and parameter setting of the different autoflight functions, the same unit on an Airbus aircraft is referred to as the FCU (Flight Control unit).

PFD

The primary flight display is usually located in a prominent position, either centrally or on on either side of the cockpit. It will in most cases include a digitized presentation of the attitude indicator, air speed and altitude indicators (usually as a tape display) and the vertical speed indicator. It will in many cases include some form of heading indicator and ILS/VOR deviation indicators. In many cases an indicator of the engaged and armed autofight system modes will be present along with some form of indication of the selected values for altitude, speed, vertical speed and heading. It may be pilot selectable to swap with the ND.

ND

A navigation display, which may be adjacent to the PFD, shows the current route and information on the next waypoint, current wind speed and wind direction. It may be pilot selectable to swap with the PFD.

EICAS/ECAM

The Engine Indication and Crew Alerting System (used for Boeing) or Electronic Centralized Aircraft Monitor (for Airbus) will allow the pilot to monitor the following information: values for N1, N2 and N3, fuel temperature, fuel flow, the electrical system, cockpit or cabin temperature and pressure, control surfaces and so on. The pilot may select display of information by means of button press.

FMS

The flight management system/control unit may be used by the pilot to enter and check for the following information: flight plan, speed control, navigation control, and so on.

Back-up instruments

In a less prominent part of the cockpit, in case of failure of the other instruments, there will be a set of back-up instruments, showing basic flight information such as speed, altitude, heading, and aircraft attitude.

Appendix D

Author Profile