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Навчально-науковий інститут аеронавігації, електроніки та телекомунікацій

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**Module I Module №1“Airport. Aircraft Maintenance. Engines.”**

1. Airport. Airport design. Aerodrome services. Markings and vehicles in the airport.

2. Preflight check. Weather conditions at the airport.

3. Weather conditions influence on the airport services. Bad weather conditions influence elimination.

4. Types of aircraft engines. Piston engines. jet engines. gas turbine engines.turbofan and turboshaft.

5. Aircraft engine maintenance. Engine repairing and servicing.

6. Preflight maintenance of an aircraft. Postflight inspection. Flight control system maintenance.

**Module II. “Auxiliary Aircraft systems.”**

1. Auxiliary Aircraft systems. Oil and lubrication system. Maintenance.

2. Fuel system. Maintenance.

3. Fire fighting system. Maintenance.

4. Electrical system. Maintenance.

5. Air conditioning system. Maintenance.

6 Anti-icing system. Maintenance.

7. Hydraulic system. Maintenance.

8. Aircraft navigation system. Maintenance.

**Module III. “Communication systems. Hydraulic system. Firefighting system.”**

1. Communication. Advantages and disadvantages of using text and voice communication. Datalink communication system.

2. Flight control systems. Flight-by-wire. Flight-by-light.

3. Flight-by-wire. Flight-by-light. The causes of failure. Instrument blackout. A glass cockpit.

4. Gravity. Aircraft control in the gravity conditions. Air race.

5. Hydraulic loss. The causes and effects.

6. The causes of onboard fire. Fire fighting. Onboard firefighting systems. The sequences of fire onboard.

**Module IV. “Aviation and its influence on the environment. Fuel system. Air conditioning system.”**

1. Aviation and global warming. Noise pollution caused by aircraft. Modern technologies development against negative influence of aviation upon ecology prospective.

2. Causes of fuel system failure. Weather conditions influence on fuel system. Fuel spill.

3. Air conditioning system. Decompression. Types, causes and effects.

4. The causes of the fuselage destruction. Emergency landing. Passengers and crew safety during the flight.

5. Airport security. How to find out suspicious passengers.

6. Potential danger from the passengers during the flight.

**Module I**

**“Airport. Aircraft Maintenance. Engines.”**

**What Is a Flight Envelope?**

The term flight envelope refers collectively to the operating parameters and capabilities of a specific model or type of aircraft. The various parameters that make up a flight envelope include the aircraft’s maximum altitude, maximum and minimum speed, the maximum amount of g-forces the craft can withstand, climb rate, glide ratio and other factors that define the aircraft’s flight characteristics. Pilots are required to be familiar with an aircraft’s flight envelope before being certified to fly the aircraft in order to ensure its safe operation.

All aircraft have an approved flight manual, which contains the flight envelope's parameters. Common aspects of a flight envelope found in the flight manual include speed, stall speed, thrust, drag, maximum altitude, and other factors based on the specific wing and engine design. The range of these parameters often leads to an aircraft being described as having small or large flight envelopes.

Flight envelopes for commercial aircraft tend to be considered small, as these vehicles are intended to operate under moderate conditions efficiently. A small flight envelope means that the span of speeds and maneuvers the aircraft is capable of is fairly limited. The flight envelopes for civilian and commercial aircraft are often also called restricted, which refers to the fact that the local aeronautics authority, such as the FAA in the United States, has reduced the authorized flight envelope to add a margin of safety. Military aircraft, such as jet fighters, tend to have very large flight envelopes. Their envelopes are considered to be large because they are capable of a great range of speeds and maneuvers, and they need to function in extreme conditions.

Over time, a number of expressions have arisen relating to flight envelopes. For example, the expression pushing the envelope originally referred to military pilots taking their aircraft to the very limits of their performance capabilities, usually during combat. In testing the experimental aircraft of the 1950s and 1960s, pushing the envelope came to mean to increase the known capabilities of a test aircraft by demonstrating its new ability in flight. Proving an aircraft could go higher than it was previously thought to be capable of widened or pushed the aircraft’s known flight envelope to include the new capability. In the non-military world, the expression has come to mean doing something at the very edge of one's capability or thinking of a new way to do something that will exceed or surpass what are believed to be the absolute limits.

**ELECTRIC CIRCUITS**

An electric circuit or network is a pathway through which the electric current can flow. A simple circuit consists of a power source, two conducting wires, each one attached to a terminal of the source and a device through which electricity can flow. This device is called a load and it's attached to the wires. If all the parts are properly connected, the current flows and the lamp lights up. This kind of circuit is called 'closed'. On the contrary, if the wires are disconnected the circuit is called 'open' or 'broken'. The circuit can be opened and closed by a device called a switch. Loads can turn electrical energy into a more useful form. Some examples are:

* light bulbs, which change electrical energy into light energy;
* electric motors, which change electrical energy into mechanical energy;
* speakers, which change energy into sound.

The source provides the electrical energy used by the load. It can be a storage battery or a generator. The switch interrupts the current delivered to the load by the source and allows us to control the flow.

When an abnormally high amount of current passes through a network, you get a short circuit. This may occur when there is a drop in the resistance or a broken insulation. In order to prevent short circuits, it is best to use fuses, which melt when too much current flows through them, interrupting in this way the circuit.

**A capacitor**

A capacitor is one of the main elements of a circuit. It is used **to store** electric energy. A capacitor stores electric energy **provide**d that a voltage **source** is applied to it. The main parts of a capacitor are metal **plate**s and insulators. The function of **insulator**s is to isolate the metal plates and in this way to prevent a short.

 There are two common types of capacitors in use nowadays: a fixed capacitor and a **variable** one. Тhe plates of a fixed capacitor cannot be moved; for his reason its capacity does not change. The plates of a variable capacitor move and change its capacity. The greater the distance between the plates, the less is the capacity of a capacitor. Variable capacitors are commonly used by radiomen; their function is to vary the **frequency** in the circuit. Fixed capacitors are used in telephone and radio work.

Fixed capacitors have insulators produced of paper, ceramics and other materials; variable capacitors have air insulators. Paper capacitors are commonly used in radio and electronics; their advantage is their high capacity: it may be higher than 1,000 picofarad.

Besides, **electrolyte** capacitors are highly in use. They also have in very high capacity: it varies from 0.5 to 2,000 microfarad. Their disadvantage is that they change their **capacity** when the temperature changes. They can operate without a change only at temperatures not lower than -40" С.

A capacitor stops operating and does not store energy in case it has a trouble. A capacitor with a trouble should be **substituted** by a new one.

**POWER SOURCE**

1) About 10% of the world's electric power is produced by nuclear power plants. Nuclear power requires little fuel and causes much less air **pollution** than other power plants, but it can cause severe health and environmental problems when accidents occur, with a consequent release of radioactive material. This type of energy is produced by the **splitting** of atoms of uranium, which **releases** heat. This process - called fission - produces large amounts of **steam**, which is used to turn the blades of turbines thus creating energy. The main problems with nuclear power are linked to the location of the power plants, as people are not **willing** to have these plants near their homes, and the **disposal** of **waste** material, which stays radioactive for centuries.

2) They provide about 2/3 of the world's electricity. These plants burn fossil fuels, such as coal, oil or natural gas, which are all non-**renewable** resources. This means that in the future there will be a limited **supply** of these resources. The main advantage of thermoelectric power plants is that they are **reliable** and can meet the demand in peak periods. Electricity is generated by heating water in a boiler to create steam, which is then pressurized and used to turn the blades of giant turbines that produce electricity. These power plants cause environmental pollution because of the combustion of fossil fuels which release carbon dioxide.

3) The energy produced by water can be captured and turned into electricity. The use of a **dam** on a river allows hydroelectric power plants to store water in an artificial lake, or reservoir. When released, the force of the water spins the blades of giant turbines, which are connected to a generator producing energy. Hydropower is one of the most important renewable energy resources, because it is re liable, efficient and does not pollute the air. Although it has high initial costs, it is cheap to operate. Unfortunately, it has a great impact on the **environment**, as humans, animals and plants may lose their natural habitats.

SOLAR ENERGY

Sunlight can be directly converted into electricity by solar cells made of silicon. When light strikes the cells, a part of it is absorbed by the semiconductor material. The energy of the absorbed light **knocks** electrons loose, allowing them to flow freely and produce electricity. The process of converting light (photons) into electricity (voltage) is known as the photo-voltaic process (PV). Solar cells are usually combined into panels and grouped into **arrays.** Even if the initial costs can be high, the PV system provides an independent, reliable electrical power source. It can produce energy for more than 15 years and its routine **maintenance** is simple and cheap.

WIND ENERGY

Wind energy is one of the cheapest renewable technologies available today. The wind turns the blades of giant turbines, producing in this way kinetic energy which is then converted into mechanical power and electricity by a generator. The main disadvantage of wind energy is that there are few suitable wind sites where it is possible to have a constant production of electricity.

TIDAL ENERGY

This alternative power source, which is typically used in coastal areas, turns the potential energy of **tides** into electricity. Tidal power generators use rising and falling tides in much the same manner as hydroelectric power plants. Large underwater turbines are placed in areas with high tidal movements and are designed to capture the kinetic energy of rising and falling tides. The turbines are driven by the power of the sea both when the tide comes in and when it goes out. The problem with tidal power is that only massive increases in tides can produce energy and there are very few places where this occurs. Moreover, the aquatic ecosystem and the **shoreline** can be **damaged** by the changes in the tidal flow.

GEOTHERMAL ENERGY

In the past, people used **hot springs** for bathing, cooking and heating. Geothermal energy is based on the fact that the Earth is hotter below the surface. The hot water which is stored in the Earth can be brought to the surface and used to drive turbines to produce electricity or it can be **piped** through houses as heat. This energy is cheap and has a low impact on the environment, but there are few sites where it can be extracted at low cost.

BIOMASS ENERGY

Biomass is a renewable energy source deriving from plant material and animal waste. When it is burnt, it releases its chemical energy as heat. Biomass fuels include forest residues (such as dead trees, branches and tree **stumps), straw, manure** and even municipal solid waste. Biomass energy is a natural process, it is carbon neutral and has low initial costs. It used to be the main source of heating at home in the past and it continues to be highly exploited in the developing world. The main disadvantage of biomass is that it has a smaller potential than other energy sources and requires excellent maintenance skills.

Solar batteries work by converting the AC energy being produced by solar panels and storing it as DC power for later use. In some cases, solar batteries have their own inverter and offer integrated energy conversion. The higher your battery's capacity, the larger the solar system it can charge.

Solar batteries are the arteries of any [efficient solar panel](http://www.solarpoweristhefuture.com/how-efficient-is-solar-energy.shtml) system. Without the batteries, the system is powerless. Batteries store the energy produced by the sun and solar panels, allowing the energy to be used as needed through an inverter. So [how does a solar battery work](http://www.solarpoweristhefuture.com/how-does-a-solar-battery-work.shtml)? A quick explanation of [solar panel](http://www.solarpoweristhefuture.com/build-your-own-solar-panel.shtml) systems might be helpful to start with.

There are several types of [solar panel systems](https://www.amazon.com/gp/search/ref%3Das_li_qf_sp_sr_tl?ie=UTF8&tag=solarpoweristhefuture-20&keywords=solar%20panel%20system&index=aps&camp=1789&creative=9325&linkCode=ur2&linkId=1ed174f115fa9a300a0b58b95da3b733). Some require a battery backup (or bank) and others are directly wired from solar panels to the solar powered device. With regards to the solar powered systems that require or utilize a battery, there are a few different types:

- 12-volt DC used for RV lighting, boat lighting, and appliances.

- Inverter battery systems that are capable of converting 12, 24, or 48-volt DC battery voltage into a 120-volt AC that can operate regular household appliances such as a stove, refrigerator, water heater, TV, etc.

- [Hybrid solar power systems](https://www.amazon.com/gp/search/ref%3Das_li_qf_sp_sr_tl?ie=UTF8&tag=solarpoweristhefuture-20&keywords=hybrid%20solar%20power&index=aps&camp=1789&creative=9325&linkCode=ur2&linkId=60a09133b5583fb916b3422073da6290) utilize several energy providing components such as a battery bank powered by solar panels, solar array, generators, and [wind turbine](https://www.amazon.com/gp/search/ref%3Das_li_qf_sp_sr_tl?ie=UTF8&tag=solarpoweristhefuture-20&keywords=wind%20turbine&index=aps&camp=1789&creative=9325&linkCode=ur2&linkId=8a1ae6f8316fbbab6f5a9552152061a9) used to provide energy on a 24/7 basis.

When it comes to solar battery banks, each is designed for a specific charge or discharge level. Some are manufactured wet cells where are manufactured sealed or gel cells, each coming with their own set of requirements.

**ELECTRONICS**

Electronics is the branch of science which controls electricity in order to convey a signal using semiconductor materials. These signals represent numbers, letters, sounds, pictures, computer instructions or other information. Radio systems were developed to read and understand the signals and in 1920 radio broadcasting started, making it possible for electromagnetic waves to travel long distances. More sophisticated devices were needed during the Second World War and the invention of radar (Radio Detection and Ranging) represented a further step in electronics, making it possible to determine the altitude, direction and speed of moving and fixed objects.

The invention of television in the 1920s was one of the most revolutionary and popular inventions in history and it showed the importance of electronics in certain branches of industry. For the first time in history it became possible to transmit images and sound over wire circuits.

The first computer appeared in 1946. This machine, which could solve a wide range of computing problems, was built over a period of three years by a team of American scientists working at the University of Pennsylvania. It was a huge machine weighing almost 50 tons.

The first bipolar transistor was assembled in 1948 by a team of scientists working at the Bell Laboratories in the U.S.A, and it was a real coming of age in the science of electronics because it replaced the use of valves. Transistors are very small, easy to handle, cheap, and they use little power.

The silicon chip - which followed the transistor in the 1960s - can contain up to several thousand transistors packed and interconnected in layers beneath the surface. It is really tiny (usually less than one centimeter square and about half a millimeter thick) and it has paved the way to microelectronics.

Electronics has influenced and improved the way information is stored, processed and distributed. Social and personal life has been deeply affected by these inventions and many financial, business, medical, education and political routines have been speeded up.

The **integrated circuit**, also known as a chip, is one of the most important inventions of the 20th century. Integrated circuits are used in almost all electronic equipment today, for example watches, calculators and microprocessors. It consists of millions of transistors and other electronic. A conventional electronic circuit is made of separate components attached to a base called a printed circuit board (PCB). Before being finalized and manufactured, the electronic circuit must be tested many times on an experimentation board called a breadboard. It consists of a perforated block of plastic with several spring clips connected by copper wires. It doesn’t require soldering as its components can be pushed straight into the holes, so it is easy change connections and replace pieces. It is generally used to temporary prototypes and experiment with circuit design components combined to form a complex set on a thin slice of silicon or other semiconductor material. Chips are becoming tinier and tinier and they are produced in large quantities so that costs are reduced. Since signals have to travel a short distance, they work faster, consume less power and generate less heat. They are also more reliable given the limited amount of connections which could fail. The microprocessor is the heart of any normal computer: it is a logic integrated circuit chip which can carry out a sequence of operations when it receives instructions from different input devices. As it doesn’t contain a large memory, it can’t work alone but needs to be supported by other integrated circuits to be connected with peripherals. Most microprocessors are found inside computers and are called the CPU (Central Processing Unit). In order to work properly, the microprocessor needs to receive instructions from a memory chip. These instructions are then decoded, executed and ' elaborated so as to get the results available. The most sophisticated microprocessors can contain up to 10 million transistors and run 300 million cycles per second. It means that the computer can perform about a billion instructions every

A **mobile phone**, known as a **cell phone** in North America, is a portable telephone that can make and receive calls over a radio frequency link while the user is moving within a telephone service area. The radio frequency link establishes a connection to the switching systems of a mobile phone operator, which provides access to the public switched telephone network (PSTN). Modern mobile telephone services use a cellular network architecture, and, therefore, mobile telephones are called *cellular telephones* or *cell phones*, in North America. In addition to telephony, 2000s-era mobile phones support a variety of other services, such as text messaging, MMS, email, Internet access, short-range wireless communications (infrared, Bluetooth), business applications, video games, and digital photography. Mobile phones offering only those capabilities are known as feature phones; mobile phones which offer greatly advanced computing capabilities are referred to as smartphones.

The first handheld mobile phone was demonstrated by John F. Mitchelland Martin Cooper of Motorola in 1973, using a handset weighing c. 2 kilograms (4.4 lbs) In 1979, Nippon Telegraph and Telephone (NTT) launched the world's first cellular network in Japan. In 1983, the DynaTAC 8000x was the first commercially available handheld mobile phone. From 1983 to 2014, worldwide mobile phone subscriptions grew to over seven billion, penetrating virtually 100% of the global population and reaching even the bottom of the economic pyramid. In first quarter of 2016, the top smartphone developers worldwide were Samsung, Apple, and Huawei (and "[s]martphone sales represented 78 percent of total mobile phone sales"). For feature phones (or "dumbphones") as of 2016, the largest were Samsung, Nokia, and Alcatel.

**Module II.**

**“Auxiliary Aircraft systems.”**

**Ice Protection Systems**

Aircraft and engine ice protection systems are generally of two designs: either they remove ice after it has formed, or they prevent it from forming. The former type of system is referred to as a de-icing system and the latter as an anti-icing system.

De-Icing Systems
A de-icing system has two very attractive attributes. First, it can utilize a variety of means to transfer the energy used to remove the ice. This allows the consideration of mechanical (principally pneumatic), electrical and thermal methods. The second attribute is that it is energy efficient, requiring energy only periodically when ice is being removed, with some mechanical designs requiring relatively little energy overall. This is a significant consideration when designing ice protection for aircraft with limited excess power.
The principal drawback to the de-icing system is that, by default, the aircraft will operate with ice accretions for the majority of the time in icing conditions. The only time it will be free of ice accretions will be the time during and immediately after the cycling of the de-ice system. This requires an understanding on the part of the designer and the pilot of what effects the ice accretions will have on aircraft performance, both prior to and during system operation.
Any design which utilizes either a mechanical means of breaking the bond of ice to the surface, or which operates on a periodic cycle, is necessarily a de-ice system.
Anti-Icing Systems
Anti-icing systems reverse this paradigm. Properly used, they prevent the formation of ice continuously, resulting in a clean wing with no aerodynamic penalties. An anti-icing system must have a means of continuously delivering energy or chemical flow to a surface in order to prevent the bonding of ice. The typical thermal anti-icing system does this at significant energy expense. The concept is not viable for aircraft that do not have the requisite excess energy available during all flight phases. An exception to this is the use of a chemical system such as TKS.

**Glass-Cockpit Blackout**

*Dealing with electrical failure while trying to maintain aircraft control. By Peter Katz*

The NTSB doesn’t just investigate accidents; it also routinely examines incidents to determine whether they expose an underlying safety problem, which, if not addressed, could set the stage for future accidents. Recently, it examined an incident involving an Airbus A320 operated by United Airlines. This led to the discovery that there had been at least 49 similar incidents in the United States and the United Kingdom. In response to its own investigation, the NTSB issued a safety recommendation, hoping to encourage FAA action.

Regardless of the FAA’s reaction, the recommendation should raise awareness of a broader issue for pilots flying technologically advanced aircraft (TAA): How to best deal with electrical failure and the subsequent loss of vital information from display screens while maintaining aircraft control and situational awareness. Pilots must be thoroughly trained in equipment operations, particularly with respect to emergency procedures. They must also learn not to become overly reliant on modern equipment, allowing it to replace basic flying, navigation and judgment capabilities.

In the past, many electrical-failure incidents became accidents not because of the loss of panel information, but because pilots didn’t realize that there wouldn’t be enough power to operate the flaps and landing gear until it was too late to plan a no-flaps landing and perform emergency procedures.

On July 11, 2007, at Washington’s Roche Harbor Airport, a Cessna 172RG’s landing gear collapsed just after touchdown, resulting in substantial damage. Nobody was injured. The pilot said that as he approached the vicinity of Roche Harbor, the airplane experienced a partial electrical failure. He decided not to attempt to troubleshoot the problem, and elected to land quickly for fear of a possible electrical fire. After activating the landing-gear handle, he was able to ascertain that the gear was extended by looking in mirrors affixed to the wings. The landing-gear lights on the panel, which would have indicated whether the gear had locked down, didn’t illuminate because of the electrical problem. (The pilot didn’t perform the emergency-gear-extension procedure, which involves using a hand pump until there’s heavy resistance.)

Although the focus of the NTSB’s safety recommendation was an Airbus A320, reports filed by pilots to NASA’s Aviation Safety Reporting System (ASRS) prove that there’s a broader issue in play. [Turn to “True Confessions” on page 64 for more information about the ASRS and its role in maintaining air safety.] Some of the more than 400 reports I found show the importance of carrying portable equipment to provide communication and navigation redundancy. While not all of these reports involve aircraft with glass cockpits, they do serve to establish that in-flight electrical problems aren’t exactly rare.

The pilot of a Cherokee Six and his family were about an hour into a pleasure flight (in instrument conditions) when the plane experienced an electrical failure. The pilot decided to return to the departure airport. He had a handheld GPS unit as a backup he could use for navigating and for viewing weather radar, and also a handheld transceiver. He declared an emergency using the handheld radio, but couldn’t get a response from the controller who had been handling the flight. The pilot tried using the emergency frequency, 121.5, but was unsuccessful. His wife dialed (800) WXBRIEF on her cell phone, but she couldn’t get through; she did, however, reach a 911 operator. She asked the operator to call the FAA and tell them that the flight had experienced an electrical failure and was returning to the departure airport. About 10 minutes out, the pilot made contact with the airport’s control tower and was cleared for a straight-in approach. The pilot wasn’t sure whether the gear had extended, and requested a flyby of the tower. The controller advised that the gear was up and cleared a block of airspace for the pilot to use in the hopes of getting the gear to drop. A repeat flyby confirmed that the gear was down, and an uneventful landing followed.

The electrical system on an Airbus A320 consists of two main alternating current (AC) busses that are connected to several other busses to carry AC throughout the airplane. There are also direct current (DC) busses that carry DC, which is produced by passing AC through a transformer-rectifier unit. The auxiliary power unit (a small jet engine) can also produce electrical power, as can an air-driven emergency generator. If there’s a problem with one of the electrical busses, the system can be reconfigured to get power from other busses to where it’s needed. Reconfiguration must be performed manually by the pilots.

The electrical system on a light GA aircraft is simpler than that of a transport-category jet. Still, the pilot should have a solid understanding of how the system is designed and what procedures to follow in case of a malfunction. Power sources generally consist of a storage battery and an alternator or generator on each engine. If the airplane has a glass cockpit, then there will generally be a standby battery for the flight displays and various processors that gather and process the data in order to produce the images. Backup instruments, such as an attitude indicator, may have their own standby batteries. A systemic power loss will generally cause the standby batteries to switch on so that one or more display screens keep operating with basic information. How long they’ll last depends on factors such as system design, battery age and charge, and operating environment.

Even though an Airbus A320’s electrical system is markedly different from that of most light GA aircraft, the overall experience for the pilots of the A320 operated by United Airlines was similar to what pilots of a GA aircraft with a glass cockpit might undergo. The pilots had to figure out what was going on, whether it was worthwhile to find a solution by troubleshooting, and the best way to maintain aircraft control while getting back on the ground as expeditiously as possible.

At 9:45 a.m. on January 25, 2008, United Flight 731 departed from Newark Liberty Airport in Newark, N.J., on a flight to Denver, Colo., with 107 people on board. Shortly, after lifting off, three of the six electronic panel displays went blank—including the captain’s PFD and navigational display, plus the upper electronic centralized aircraft monitoring (ECAM) display—and a number of systems became inoperative. The attitude information on the first officer’s PFD became unusable, though it eventually returned. The landing-gear handle had been moved to the “retract” position (as is normally done after takeoff), but the gear stayed down.

All radios became inoperative and the airplane’s transponder, traffic alert and collision avoidance system (TCAS) and standby attitude indicator all went dead. One interesting (and perhaps frightening) bit of information is that the A320’s standby attitude indicator is designed to function for only five minutes after it loses power. (Its usefulness is particularly limited in the event of a catastrophic electrical failure while in night VFR over the middle of the ocean.) The NTSB wants the FAA to require that the standby attitude indicators run for at least 30 minutes.

The first officer reported that the standby attitude indicator began to present false information about three minutes after takeoff, rolling about 45 degrees and pitching up about 20 degrees. Eventually, an orange “failure” flag appeared. The first officer stated, “If Newark had low ceilings and visibility that day, and if my attitude indication on my PFD hadn’t returned, the aircraft may have been lost as the attitude gyro failed.” In a report to ASRS, the first officer stated, “As I continued to fly straight ahead, I had little idea what was wrong with the aircraft… The captain told me of his confusion with what was happening to the airplane. Neither of us really understood what had happened.”

The pilots leveled Flight 731 at 2,500 feet, the first assigned altitude on their IFR flight plan. Crew members reported feeling a very real urgency to land because the aircraft was at low altitude in VFR conditions, not in contact with ATC, had an inoperative transponder and was heading roughly in the direction of downtown Manhattan. (We all remember September 11, 2001: Two airliners, one a Newark departure, flew to downtown at low altitude in VFR conditions without radio or radar contact with ATC.) “I made a comment to the captain about staying clear of the metropolitan area, not wanting to get shot down by military fighters,” reported the first officer. “I wasn’t joking at all. Operating this ‘no radio’ aircraft with no ‘squawk’ at low altitude made me quite uncomfortable.”

The crew felt that the sense of urgency may have led them to devote most of their efforts toward returning to Newark rather than troubleshooting the aircraft’s problems. After a safe landing at Newark, the crew was able to focus on troubleshooting; they manually moved one of the AC bus feeds to “alternate,” which reconfigured the power supply. At this point, the captain’s instruments and most of the failed aircraft systems started working again.

The NTSB found that in May 2007, Airbus had issued a service bulletin to modify the electrical system so that the AC power supply would be automatically reconfigured in the event of a failure affecting the #1 bus. The FAA didn’t issue an airworthiness directive to mandate compliance, which the NTSB says it should now do. The Flight 731 aircraft hadn’t been modified. The NTSB also said the FAA should require better guidance and more simulator training about dealing with electrical malfunctions for Airbus A320 pilots.

# Fueling Flight: Means of Propulsion

When it comes to propelling an airplane through the sky, different designs depend on different means of propulsion to provide thrust. Most methods, however, work along the same basic principle: An engine accelerates a gas.

**Propeller engine**: In a typical propulsion system, an engine mixes fuel with air and burns the fuel to release the energy. The resulting heated gas moves a piston, which is attached to a crankshaft. This spins a **propeller**, or **prop**, which is essentially an array of spinning wings. Each blade is an airfoil with an angle of attack. The angle is greater toward the center because the speed of the propeller through the air is slower close to the hub. Many larger prop-driven aircraft boast propellers with adjustable pitch mechanisms. These mechanisms let the pilot adjust the propeller's angle of attack depending on air speed and altitude. There are, of course, variations. For example, in **turbo prop planes**, a gas turbine spins the propeller, and electric aircraft designs don't employ combustion.

[**Rocket engine**](http://science.howstuffworks.com/rocket.htm): While a propeller engine uses the surrounding air as the working fluid of its propulsion, all a rocket needs is the thrust of its own combustion exhaust gas. This is why a rocket can provide thrust in space, but a propeller cannot. A rocket engine combines fuel and an internal source of oxygen called an **oxidizer**. The oxygen and fuel ignite in a **combustion chamber,** exploding in a hot exhaust. These gases pass through a nozzle to produce thrust.

[**Gas turbine engine**](http://science.howstuffworks.com/transport/flight/modern/turbine.htm): Also known as a jet engine, this means of propulsion works a lot like a rocket engine, only it obtains the necessary air from the surrounding atmosphere rather than a tank. As such, jet engines don't work in space either. Many variants of gas turbine engines, such as those seen on most airliners, collect the necessary air through fanlike rotary compressors. A **ramjet**, however, doesn't use a compressor. Instead, the airplane builds up speed, which forces air through forward-facing vents in the engine. In this model, the aircraft's speed naturally compresses the air necessary for combustion.

**How can airplanes fly through lightning storms?**

It is estimated that on average, each airplane in the U.S. commercial fleet is struck lightly by lightning more than once each year. In fact, aircraft often trigger lightning when flying through a heavily charged region of a cloud. In these instances, the lightning flash originates at the airplane and extends away in opposite directions. Although record keeping is poor, smaller business and private airplanes are thought to be struck less frequently because of their small size and because they often can avoid weather that is conducive to lightning strikes.

The last confirmed commercial plane crash in the U.S. directly attributed to lightning occurred in 1967, when lightning caused a catastrophic fuel tank explosion. Since then, much has been learned about how lightning can affect airplanes. As a result, protection techniques have improved. Today, airplanes receive a rigorous set of lightning certification tests to verify the safety of their designs.

Although passengers and crew may see a flash and hear a loud noise if lightning strikes their plane, nothing serious should happen because of the careful lightning protection engineered into the aircraft and its sensitive components. Initially, the lightning will attach to an extremity such as the nose or wing tip. The airplane then flies through the lightning flash, which reattaches itself to the fuselage at other locations while the airplane is in the electric “circuit” between the cloud regions of opposite polarity. The current will travel through the conductive exterior skin and structures of the aircraft and exit off some other extremity, such as the tail. Pilots occasionally report temporary flickering of lights or short-lived interference with instruments.

Most aircraft skins consist primarily of aluminum, which conducts electricity very well. By making sure that no gaps exist in this conductive path, the engineer can assure that most of the lightning current will remain on the exterior of the aircraft. Some modern aircraft are made of advanced composite materials, which by themselves are significantly less conductive than aluminum. In this case, the composites contain an embedded layer of conductive fibers or screens designed to carry lightning currents.

Modern passenger jets have miles of wires and dozens of computers and other instruments that control everything from the engines to the passengers’ headsets. These computers, like all computers, are sometimes susceptible to upset from power surges. So, in addition to safeguarding the aircraft’s exterior, the lightning protection engineer must make sure that no damaging surges or transients can reach the sensitive equipment inside the aircraft. Lightning traveling on the exterior skin of an aircraft has the potential to induce transients into wires or equipment beneath the skin. These transients are called lightning indirect effects. Careful shielding, grounding and the application of surge suppression devices avert problems caused by indirect effects in cables and equipment when necessary. Every circuit and piece of equipment that is critical or essential to the safe flight and landing of an aircraft must be verified by the manufacturers to be protected against lightning in accordance with regulations set by the Federal Aviation Administration (FAA) or a similar authority in the country of the aircraft’s origin.

The other main area of concern is the fuel system, where even a tiny spark could be disastrous. Engineers thus take extreme precautions to ensure that lightning currents cannot cause sparks in any portion of an aircraft’s fuel system. The aircraft skin around the fuel tanks must be thick enough to withstand a burn through. All of the structural joints and fasteners must be tightly designed to prevent sparks, because lightning current passes from one section to another. Access doors, fuel filler caps and any vents must be designed and tested to withstand lightning. All the pipes and fuel lines that carry fuel to the engines, and the engines themselves, must be protected against lightning. In addition, new fuels that produce less explosive vapors are now widely used.

The aircraft’s radome (the nose cone that contains radar and other flight instruments) is another area to which lightning protection engineers pay special attention. In order to function, radar cannot be contained within a conductive enclosure. Instead, lightning diverter strips applied along the outer surface of the radome protect this area. These strips can consist of solid metal bars or a series of closely spaced buttons of conductive material affixed to a plastic strip that is bonded adhesively to the radome. In many ways, diverter strips function like a lightning rod on a building.

Private general aviation planes should avoid flying through or near thunderstorms. The severe turbulence found in storm cells alone should make the pilot of a small plane very wary. The FAA has a separate set of regulations governing the lightning protection of private aircraft that do not transport passengers. A basic level of protection is provided for the airframe, fuel system and engines. Traditionally, most small, commercially made aircraft have aluminum skins and do not contain computerized engine and flight controls, and they are thus inherently less susceptible to lightning; however, numerous reports of noncatastrophic damage to wing tips, propellers and navigation lights have been recorded.

The growing class of kit-built composite aircraft also raises some concerns. Because the FAA considers owner-assembled, kit-built aircraft “experimental,” they are not subject to lightning protection regulations. Many kit-built planes are made of fiberglass or graphite-reinforced composites. At LTI we routinely test protected fiberglass and composite panels with simulated lightning currents. The results of these tests show that lightning can damage inadequately protected composites. Pilots of unprotected fiberglass or composite aircraft should not fly anywhere near a lightning storm or in other types of clouds, because nonthunderstorm clouds may contain sufficient electric charge to produce lightning.

**What happens when lightning strikes an airplane?**

Edward J. Rupke, senior engineer at Lightning Technologies, Inc., (LTI) in Pittsfield, Mass., provides the following explanation:

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**COMPUTER TECHNOLOGY**

A computer is an electronic device that performs high-speed mathematical or logical operations and executes instructions in a program. Its main functions are to accept and process data to produce results, store information and programs and show results.

The main characteristics of these powerful machines are:

* speed, as they can execute billions of operations per second;
* high reliability in the elaboration and delivery of data;
* storage of huge amounts of information;

A computer consists of hardware and software. The word hardware refers to all the components you can physically see such as the CPU (Central Processing Unit), the internal memory system, the mass storage system, the peripherals (input and output devices) and the connecting system. Software, instead, comprises all the computer programs and related data that provide the instructions for a computer to work properly.

The CPU is the brains of your computer and consists of ALU (Arithmetic Logic Unit), which carries out the instructions of a program to perform arithmetical and logical operations, and CU (Control Unit), which controls the system and coordinates all the operations. In order to memorize input and output data, there is an internal memory that can be distinguished into volatile and non-volatile. Volatile memory is memory that loses its contents when the computer or hardware device is off. Computer RAM (Random Access Memory) is a good example of volatile memory. It is the main memory of the computer where all data can be stored as long as the machine is on. On the contrary, a non-volatile memory contains information, data and programs that cannot be modified, or can be modified only very slowly and with difficulty. Computer ROM (Read Only Memory), for example, contains essential and permanent information and software which allow the computer to work properly. Memory storage devices are available in different options, sizes and capacities. These devices are extremely useful; they can be rewritten and offer incredible storage capacity, up to 256 GB. They can be magnetic (hard disks), optical (CDs and DVDs) or solid (flash memory cards). Mass storage devices are available in an incredible number of options with different storage capacity up to 256 GB for some portable drives. A very popular type of removable device is represented by USB flash drives, which are much smaller and lighter than other portable drives, but which can still provide a huge storage capacity.

**THE INTERNET**

The Internet is a worldwide information system consisting of countless networks and computers, which allow millions of people to share information and data. Thanks to the Internet it is now possible for people all over the world to communicate with one another in a fast and cheap way.

The Internet was first invented in the 1960s in the USA by the Department of Defence as an internal project to link computers. The Department wanted an extremely safe way of sending messages in case of nuclear attack. It was a British physicist, Sir Timothy Berners-Lee, who used it to make information available to everyone and created the most important media of the 21st century. In 1 980 while working at CERN in Geneva - the largest particle physics laboratory in the world - he first thought of using hypertext to share and update information among researchers. Then in 1989-90 he produced a plan to link hypertext to the Internet to create the World Wide Web. He designed and built the first site browser and editor, as well as the first web server called httpd (Hypertext Trasfer Protocol Deamon). Hypertext are the words or chains of words in a text we can click on to be linked to new sites whose content is related to the words. But how does this global system work? It is a network of people and information linked together by telephone lines which are connected to computers. The applications are based on a client/server relationship, in which your computer is the client and a remote computer is the server. All you need to join this system is a computer, a normal telephone line, a modem and an account with an Internet Service Provider (ISP), a company that provides access to the Internet. A user buys a subscription to a service provider, which gives him/her an identifying username, a password and an email address. With a computer and a modem, the user can connect to the service provider's computer which gives access to many services, such as WWW (world wide web), emails and FTP (file transfer protocol).

**ELECTRONICS IN USE**

 GPS is a device that is capable of receiving information from GPS satellites and then to calculate the device's geographical position. Using suitable software, the device may display the position on a map, and it may offer directions. The Global Positioning System (GPS) uses a global navigation satellite system (GNSS) made up of a network of a minimum of 24, but currently 30, satellites placed into orbit by the U.S. Department of Defense.

The GPS was originally developed for use by the United States military, but in the 1980s, the United States government allowed the system to be used for civilian purposes. Though the GPS satellite data is free and works anywhere in the world, the GPS device and the associated software must be bought or rented.

A GPS device can **retrieve** from the GPS system location and time information in all weather conditions, anywhere on or near the Earth. A GPS reception requires an unobstructed line of sight to four or more GPS satellites, and is subject to poor satellite signal conditions. In exceptionally poor signal conditions, for example in urban areas, satellite signals may **exhibit** multipath propagation where signals **bounce** off structures, or are weakened by meteorological conditions. Obstructed lines of sight may arise from a tree canopy or inside a structure, such as in a building, garage or tunnel. Today, most standalone GPS receivers are used in automobiles. The GPS capability of smartphones may use assisted GPS (A-GPS) technology, which can use the base station or cell towers to provide the device location tracking capability, especially when GPS signals are poor or unavailable. However, the mobile network part of the A-GPS technology would not be available when the smartphone is outside the range of the mobile reception network, while the GPS aspect would otherwise continue to be available.

**2)** SoC is the short term for System on a Chip. A System on a Chip is an electronic integrated circuit that contains various electronic components designed to work together to achieve a common goal. The first part of the term - System - says that it’s all about a complex electronic assembly, while the last part - Chip - tells you that all the components of that system are squeezed together on a single integrated circuit. To get a better idea of what a System on a Chip is, imagine it as a full computer that’s miniaturized and compressed to fit on a single chip. For instance, a SoC could be compared to a miniature system that has a motherboard, a processor, a graphics card, a network card and so on.

Systems on Chips are widely used in many industries for all kinds of purposes such as for smart phones, tablets, digital cameras, wireless routers and so on. However, probably their most common uses today are for powering smart phones. Smart phones and tablets are small devices that need a lot of processing power to work and they all need to meet users’ requirements, which are increasingly more demanding. For instance, people want to be able to use their smart phones to browse the internet, listen to music, watch videos, use GPS navigation, shoot photos and film videos, play games, be always connected to social networks, and so on. All these are things that need not only a good processor, but also a good graphic chip, a fast wireless and Bluetooth chip, support for connecting to 4G networks, a GPS chip and the list can go on. And all that must happen with the least power consumption possible. After all, nobody wants their devices to shut down after very few hours of use. The answer is to miniaturize everything that can be miniaturized and squeeze as many components as possible on a smaller surface. The consequence is a higher processing power and a lower power consumption. That is exactly what a System on a Chip offers.

**Module III.**

**Communication systems. Hydraulic system. Firefighting system.**

 **Communication in the Skies**

At the very beginning of this article, we discussed the thousands upon thousands of aircraft that fill the sky regularly. How do they avoid crashing into each other and landing without unleashing absolute chaos? Well, we have the field of **avionics** to thank.

Avionics entails all of an aircraft's electronic flight control systems: communications gear, navigation system, collision avoidance and meteorological systems. An overarching aerospace and air traffic control system ensures the safety of commercial and private aircraft as they take off, land and traverse vast distances without incident. Through the use of radar, computerized flight plans and steady communication, air traffic controllers ensure planes operate at safe distances from each other and redirect them around bad weather.

Needless to say, global air traffic control is a colossal task. It essentially involves governance of the skies, so we tackle that operation similarly to how we would on the ground: We divide things up. U.S. airspace, for example, breaks down into 21 air route traffic control centers (**ARTCCs**), each a designated territory that spans whole states and more. Internationally, you'll also hear these airspaces called **area control centers** (**ACCs**). Depending on a country's size, they may employ one or several ACCs.

If a flight takes a plane across several countries, it passes through various ACCs, each monitored by different air traffic controllers who give instructions to the [pilot](http://science.howstuffworks.com/transport/flight/modern/pilot.htm) as needed. If a flight takes a plane into international airspace (the air above international waters), the crew will still depend on the assistance of an ACC, though the ground controllers may have to forgo the use of radar and depend on pilot reports and computer models.

**Computers in Aviation**

Just as computers have affected every aspect of modern life, from medicine to education, they have also had a major impact on aviation. Computers are now used in all parts of aviation. They are used to design airplanes, to control them in flight, and to ensure that they reach their destinations safely and (more or less) on time.

Calculating machines were first used in the 1930s to aid researchers in their work, sometimes to perform complicated calculations of airflow over airfoils. By the 1950s, as IBM developed better calculating and tabulating machines for office use, more and more powerful computers were used to assist in wind tunnel tests and in trying to predict some of the results before actual models were placed into wind tunnels. Computers and wind tunnels both had an impact on each other: More powerful computers allowed designers not only to process wind tunnel test results better and faster, but to determine some of those test results before a model was even built, and wind tunnel data allowed designers to develop better programs for their computers to predict airflow. In the 1970s, an hour of wind tunnel testing could cost thousands of dollars, so designers wanted to gain as much data about their aircraft as they could before they ever put a model in a wind tunnel. By the end of 1980s, computers had become so powerful that for some applications, they actually began replacing wind tunnels entirely. This saved tremendous amounts of money. Aeronautical engineers began developing advanced computer programs to conduct computational fluid dynamics (CFD) experiments. This demand played a major role in pushing the development of new, powerful, so-called "supercomputers" capable of conducting millions of calculations per second.

An important early computer, not only for aviation but for computers in general, was the Whirlwind computer started at the Massachusetts Institute of Technology (MIT) in 1944. Whirlwind was a flight simulator. It was the first computer to respond immediately to actions taken by its operator. Previous computers simply took inputs and then made calculations and eventually produced an output, sometimes hours later. But Whirlwind responded in "real time."

Aircraft during the 1950s and early 1960s carried analog computers as part of their radar equipment. These were used to provide targeting information for guns and missiles. The Heads Up Display (HUD) that projected information onto a piece of glass in front of the pilot relied upon computer input to help the pilot aim his guns or select his weapons.

Nowadays computers are used everywhere in aviation. Aircraft engines use them to control fuel flow to save money and make engines run efficiently. They are used for navigation in global positioning systems (GPS) and inertial navigation systems (INS). Autopilots use computers to fly a plane enroute to the destination on the correct course and at the correct altitude. Automatic Landing Systems use computers that can fly an approach to an airport, land the plane, and taxi off the runway. Glass cockpits consist of computer monitors that have replaced most of the mechanical flight indicators used in earlier airlines. The monitors can display a wide range of information including engine performance, fuel levels in the various tanks, the route to the destination. Fly-By-Wire aircraft control systems are now being used in Airbus Industries and Boeing planes. Three computers crosscheck each other. If one of the three is not in agreement with the other two computers, it is automatically removed from the control system. These systems take input from the pilot and copilot controls in the cockpit and send electrical signals to motors on the wings and in the tail to move the control surfaces. This eliminates the need to run hydraulic lines to the ailerons, rudder, and elevator. Air Traffic Control centers use computers to display aircraft paths across the country. Information boxes can be displayed beside the flight path of each airplane that show the direction, flight number, and other data. Anti-Collision System Computers are installed in air traffic control centers and in most large airplanes. These systems warn if airplane paths are converging and could result in a midair collision or a near miss. Airline Reservation Systems use computers to issue seat reservations and keep track of them throughout each passenger’s trip. The Military now uses computer-controlled smart bombs, cruise missiles, and reconnaissance aircraft. It is experimenting with computer-controlled, unmanned fighter and bomber aircraft.

**What is a fly-by-wire system?**

 How does this clever technology help a pilot fly an aeroplane? Instead of the mechanical systems that used to transmit control impulses around a plane, fly-by-wire (FBW) systems convert movements of the controls into electrical impulses. These signals are sent to flight-control computers that reconvert the electrical impulses into instructions for control surfaces like wing flaps or the tail. Potentiometers, or pots, in the control surfaces measure their position and transmit that data back to the flight computer.
Once a control surface is in the correct place, the computer freezes the component, ensuring the pilot’s commands are followed. This electronic system, while complex, not only makes the controls more precise but also means aeroplanes no longer have to be fitted with the cranks, gears, pulleys and cables on which older aviation systems relied.
 Fly-by-wire systems also make the aircraft substantially safer to fly, as the flight computers can be programmed to carry out adjustments to control surfaces automatically. This helps keep the flight much more stable, as the plane is – to some extent – ‘helping’ fly itself. This is largely as a result of gyroscopes fitted in the aircraft which are connected to the on-board computers. The gyroscopes measure fluctuations in pitch, roll and yaw and, if the plane strays from its pre-programmed settings.

**Module IV.**

**Aviation and its influence on the environment. Fuel system. Air conditioning system.**

**Ice Protection Systems**

 Aircraft and engine ice protection systems are generally of two designs: either they remove ice after it has formed, or they prevent it from forming. The former type of system is referred to as a de-icing system and the latter as an anti-icing system.
A de-icing system has two very attractive attributes. First, it can utilize a variety of means to transfer the energy used to remove the ice. This allows the consideration of mechanical (principally pneumatic), electrical and thermal methods. The second attribute is that it is energy efficient, requiring energy only periodically when ice is being removed, with some mechanical designs requiring relatively little energy overall. This is a significant consideration when designing ice protection for aircraft with limited excess power.
 The principal drawback to the de-icing system is that, by default, the aircraft will operate with ice accretions for the majority of the time in icing conditions. The only time it will be free of ice accretions will be the time during and immediately after the cycling of the de-ice system. This requires an understanding on the part of the designer and the pilot of what effects the ice accretions will have on aircraft performance, both prior to and during system operation.
Any design which utilizes either a mechanical means of breaking the bond of ice to the surface, or which operates on a periodic cycle, is necessarily a de-ice system.
Anti-icing systems reverse this paradigm. Properly used, they prevent the formation of ice continuously, resulting in a clean wing with no aerodynamic penalties. An anti-icing system must have a means of continuously delivering energy or chemical flow to a surface in order to prevent the bonding of ice. The typical thermal anti-icing system does this at significant energy expense. The concept is not viable for aircraft that do not have the requisite excess energy available during all flight phases. An exception to this is the use of a chemical system such as TKS.

**Fuel System Problems**

Leaks

Major leaks in the fuel system are a concern to the flight crew because they may result in engine fire, or, eventually, in fuel exhaustion. A very large leak can produce engine flameout.

Engine instruments will only indicate a leak if it is downstream of the fuel flowmeter. A leak between the tanks and the fuel flowmeter can only be recognized by comparing fuel usage between engines, by comparing actual usage to planned usage, or by visual inspection for fuel flowing out of the pylon or cowlings. Eventually, the leak may result in tank imbalance.

In the event of a major leak, the crew should consider whether the leak needs to be isolated to prevent fuel exhaustion.

It should be noted that the likelihood of fire resulting from such a leak is greater at low altitude or when the airplane is stationary; even if no fire is observed in flight, it is advisable for emergency services to be available upon landing.

Inability to shutdown Engine

If the engine fuel shut-off valve malfunctions, it may not be possible to shut the engine down by the normal procedure, since the engine continues to run after the fuel switch is moved to the cutoff position. Closing the spar valve by pulling the fire handle will ensure that the engine shuts down as soon as it has used up the fuel in the line from the spar valve to the fuel pump inlet. This may take a couple of minutes.

Fuel filter Clogging

Fuel filter clogging can result from the failure of one of the fuel tank boost pumps (the pump generates debris which is swept downstream to the fuel filter), from severe contamination of the fuel tanks during maintenance (scraps of rag, sealant, etc., that are swept downstream to the fuel filter), or, more seriously, from gross contamination of the fuel. Fuel filter clogging will usually be seen at high power settings, when the fuel flow through the filter (and the sensed pressure drop across the filter) is greatest. If multiple fuel filter bypass indications are seen, the fuel may be heavily contaminated with water, rust, algae, etc. Once the filters bypass and the contaminant goes straight into the engine fuel system, the engine fuel control may no longer operate as intended. There is potential for multiple-engine flameout. The Airplane Flight or Operating Manual provides the necessary guidance.

**Under (Cabin) Pressure**

Sure, humans [evolved](http://science.howstuffworks.com/environmental/life/evolution/how-does-life-evolve.htm) to thrive in Earth's atmosphere, but it's important to realize that we only evolved to thrive in a thin layer of the planet's gaseous outer layer. Air pressure changes depending on altitude. In the same way that the water pressure in the [ocean](http://science.howstuffworks.com/environmental/earth/oceanography/ocean-current.htm) is greater on the seafloor than it is just below the surface, air pressure decreases the higher you ascend through the atmosphere.

When humans breathe thinner, high-altitude air, they have a harder time taking in enough oxygen. And when we hang out at heights higher than 9,800 feet (3,000 meters), our bodies become susceptible to a host of unpleasant or even deadly illnesses, like these:

**Altitude sickness**: Also the bane of high-altitude mountain climbers, reduced air pressure and lower oxygen concentration levels can cause extreme shortness of breath due to fluid buildup in the lungs. In extreme cases, this can lead to brain swelling, resulting in confusion, coma or death.

**Ear barotrauma**: The Eustachian tube connects your middle ear to the outside world. If this tube becomes blocked, changes in atmospheric pressure can cause a pressure differential that can result in dizziness, discomfort, hearing loss, ear pain and nose bleeds.

**Decompression sickness**: Divers know this condition as the [bends,](http://adventure.howstuffworks.com/outdoor-activities/water-sports/question101.htm) and it can occur in the air, as well as in the water. Exposure to low barometric pressures can cause dissolved nitrogen in the blood stream to form harmful bubbles that can cause everything from drowsiness to stroke.

**Hypoxia**: As low pressure means less oxygen in every breath you breathe, the brain receives less oxygen at high altitudes. The physiological results often include cognitive impairment or light-headedness, which can seriously impair a pilot's ability to fly the plane.

Pressurized cabins enable pilots, crew and passengers to avoid these pitfalls of flying at high altitude. While the air outside the cabin thins out the higher a plane climbs,  compressed air inside the cabin maintains more surface-level air pressure and oxygen-rich air. In the event of accidental loss of cabin pressure, emergency oxygen masks provide the necessary air quality.

Pressurized flight suits achieve the same effect as pressurized cabins, only on an individual basis. Characterized by enclosed helmets, these suits typically see use in military and high-performance aircraft.