T.C.
MİLLÎ EĞİTİM BAKANLIĞI

AIRCRAFT MAINTENANCE

TEKNİK YABANCI DİL (İNGİLİZCE) 2
222YDK010

Ankara 2011

CONTENTS

AÇIKLAMALAR

KOD	**222YDK010**
ALAN	**Uçak Bakım**
DAL/MESLEK	**Uçak Gövde Motor Teknisyenliği** **Uçak Elektronik Teknisyenliği**
MODÜLÜN ADI	**Teknik Yabancı Dil (İngilizce) 2**
MODÜLÜN TANIMI	Uçakla ilgili İngilizce dokümanları tekniğine uygun olarak okuyabilmeyi ve çeviri yapabilmeyi sağlayan öğretim materyalidir.
SÜRE	40 / 32
ÖN KOŞUL	Teknik İngilizce-I modülünü başarmış olmak.
YETERLİK	Uçakla ilgili İngilizce dokümanları tekniğine uygun olarak okumak ve Türkçeye çeviri yapmak
MODÜLÜN AMACI	**Genel Amaç** Uçak elektroniği ve bakımı ile ilgili teknik İngilizceyi okuyup çeviri yapabileceksiniz. **Amaçlar** **1.** Tekniğine uygun olarak uçak motorlarının parçalarını ve çalışmasını İngilizce okuyabileceksiniz. **2.** Tekniğine uygun olarak uçuş kontrol yüzeylerini İngilizce okuyabileceksiniz. **3.** Tekniğine uygun olarak uçak sistemlerini İngilizce okuyabileceksiniz. **4.** Tekniğine uygun olarak bakım el kitaplarını İngilizce okuyarak çeviri yapabileceksiniz.
EĞİTİM ÖĞRETİM ORTAMLARI VE DONANIMLARI	**Ortam:** Laboratuvar, atölye, işletme, kütüphane vb. gibi araştırmaya yönelik etkinlikler yapılabilecek tüm ortamlar ve sınıf. **Donanım:** TV, VCD, Video, Internet
ÖLÇME VE DEĞERLENDİRME	Modül içinde yer alan her öğrenme faaliyetinden sonra verilen ölçme araçları ile kendinizi değerlendireceksiniz. Öğretmen modül sonunda ölçme aracı (çoktan seçmeli test, doğru-yanlış testi, boşluk doldurma vb.) kullanarak modül uygulamaları ile kazandığınız bilgi ve becerileri ölçerek sizi değerlendirecektir.

INTRODUCTION

Dear Student,

Vocational and technical education fields are always equipped with improved and updated information. Aircraft technicians should arrive to new technical information. This can only be achieved with technical English. Because all the sources are in English.

For this reason, you should also read and understand English. English is a universal language. English skills will be a great advantage for you.

This module is the key for you. The right to use this key is in your hands. If you want to come to good position, you must use this key very well.

You must follow the rules to ensure maximum benefit. Carefully observe the examples given. Necessarily answer the questions. Check yourself often. If you didn't understand a topic, you must repeat that.

LEARNING ACTIVITY-1

AIM

According to information in this module and in suitable conditions, you can learn the aircraft engines. You can read these topics with English language.

SEARCH

Try to remember what you learn before about aircraft engines. Refresh the information on this subject.

1. AIRCRAFT ENGINES

Figure 1.1: An aircraft engine

1.1. Aircraft Engines

The invention of the aircraft was one of the most revolutionary inventions in human history. The various advancements in science and technology have created a variety of engines but the basic principle that drives them is very similar. All the aircraft engines work on the Principle of *Newton's third law of motion*. Aircraft engines require a system that can provide thrust so that the aircraft is propelled forward. In most aircraft engines the basic mechanism is to accelerate a working fluid that pushes the airplane forward, while the gas moves backwards with high force.

Because of the complexities of flight, aircraft engines need to satisfy several requirements to sustain prolonged flights. These engines must be:

Lightweight, as a heavy engine decreases the amount of excess power available.

Small and easily streamlined; large engines with substantial surface area, when installed, create too much drag, wasting fuel and reducing power output.

Powerful, to overcome the weight and drag of the aircraft.

Reliable, as losing power in an airplane is a substantially greater problem than an automobile engine seizing. Aircraft engines operate at temperature, pressure, and speed extremes, and therefore need to operate reliably and safely under all these conditions.

Repairable, to keep the cost of replacement down. Minor repairs are relatively inexpensive.

If a car engine fails you simply pull over to the side of the road. If the same occurs in a single-engine aircraft it will glide but, depending on the circumstances, may result in a fatal accident. For this reason the design of aircraft engines tend to favor reliability over performance. Even with this mindset, it took many years before the reliability was established to fly over the Atlantic or the Pacific Ocean.

“Long engine operation times” and high power settings, combined with the requirement for high-reliability means that engines must have large engine displacement to minimize over-stressing the engine. The engine, as well as the aircraft, needs to be lifted into the air, meaning it has to overcome lots of weight. The thrust to weight ratio is one of the most important characteristics for an aircraft engine.

Aircraft engines also tend to use the simplest parts and include two sets of anything needed for reliability, including ignition system (spark plugs and magnetos) and fuel pumps. Independence of function lessens the likelihood of a single malfunction causing an entire engine to fail. Thus magnetos are used because they do not rely on a battery. Two magnetos were originally installed so a pilot can switch off a faulty magneto and continue the flight on the other—but, later, dual ignition was found to offer some detonation protection too. Similarly, a mechanical engine-driven fuel pump is often backed-up by an electric one.

There are basically three types of engines used on aircraft: piston engines, jet engines, and rocket engines. All three are used to generate thrust, a force that pushes the aircraft forward. Thrust's counteracting force is mainly caused by wind resistance, which is why aircraft are streamlined.

Exercise: Interpretation of words and phrases: Circle the letter next to the best answer.

1. Because of the complexities of flight, aircraft engines need to satisfy several requirements to ***sustain*** prolonged flights.

A) Cause
B) Support
C) Finish

2. Small and easily ***streamlined.***

A) Aerodynamic shape
B) Made line by line.
C) Designed as stream shape.

3. Engines must have large ***engine displacement*** to minimize over-stressing the engine.

A) Changing places of the engines.
B) Size of petrol tank.
C) The total volume of air/fuel mixture an engine can draw in during one complete engine cycle.

4. Independence of function lessens the likelihood of a single ***malfunction*** causing an entire engine to fail.

A) Effect
B) Fault
C) Thing

5. Later, dual ignition was found to offer some ***detonation*** protection too.

A) Explosion
B) Burn
C) Crash

Exercise: Vocabulary:

Use each word or phrase in a sentence.

1. Malfunction
2. High reliability
3. To overcome
4. Generate
5. To operate

1.2. Piston Engines

Piston engines are internal combustion engines that burn a mixture of fuel and air inside a combustion chamber. The chamber is provided with a piston that moves within the compression chamber. The energy for the movement of the piston is provided by the air-fuel mixture. Piston engines operate similar to the car and other automobile engines. In its basic operation, a valve in the engine permits air into the chamber (called the cylinder) which is compressed by the moving piston. When an appropriate compression is reached, fuel is allowed into the compressed air through another inlet as a fine spray. Finally, the compressed fuel-air mixture is ignited with a spark provided by a spark plug, which causes the mixture to explode violently. The explosive power is used to move the piston back, and remove the exhaust gases from the compression chamber. The return movement of the piston is conveyed to the wheel and fans of the aircraft which causes it to rotate at high speed. In a propeller powered aircraft, much of the thrust is created by the propellers, which creates the upward lift for the aircraft.

Until World War II, this was the only type of engine available for use on aircraft: the Wright Brothers' Flyer used a piston engine, as did the B-29 Super fortress forty years later.

The piston engines were used to rotate the fans at high speeds which provide the thrust for the aircraft to move forward. Since the thrust that could be developed by the piston engine is limited, they cannot be used in aircrafts that need high speed and thrust. Hence, piston engines are mostly restricted to training flights and slow flights. There were many modifications like the supercharger that were added to the piston engine which provided extras thrust to the existing engines. The supercharger pumped in more air into the cylinder for better compression and burn ratios.

Figure 1.2: A simple aircraft piston engine

Piston engines are less costly, easier to maintain and consumes lesser fuel. They are a favorite with hobbyists and recreational users who use such engines to power hand gliders and miniature aircrafts. They are limited by the altitude and speed to which they can climb because as the sir gets thinner, lesser air enters the cylinder thereby chocking their efficiency to burn fuel.

An internal combustion engine burns fuel in an enclosed chamber – the *cylinder* – which is integral to the engine. Most aviation piston engines are of the reciprocating piston type in which a piston moves back and forth in a cylinder. The engine's power is generated by the force exerted on the piston by the rapid expansion of gases resulting from the combustion of a compressed fuel-air mixture. The power from the motion of the piston is transmitted through a connecting rod to a crankshaft, which is coupled to the propeller.

One complete movement of the piston in either direction is called a *stroke*. A piston at the point of its nearest approach to the cylinder head is at *top dead center* (TDC). Conversely, a piston at the other end of its stroke is at *bottom dead center* (BDC). The region of a cylinder below the piston crown at TDC and above it at BDC is the *swept volume*. An engine's *displacement* is the total swept volume of all cylinders. The *compression ratio* of an engine is the ratio between the volume in a cylinder when the piston is at BDC and the volume of the cylinder when the piston is at TDC. *Valves* are used to control gas flow into or out of the cylinder volume above the piston.

1.2.1. Four-Stroke Combustion Cycle

One combustion cycle is made up of four piston strokes, which turn the crankshaft through two complete rotations (720 degrees). Figure 1.3 pictorially summarizes the four strokes – intake, compression, power, and exhaust. The first downward motion of the piston in the cycle – the *intake* stroke – draws the fuel-air mixture into the combustion chamber through the open intake valves. As the piston reverses direction and begins to move back up, the intake valves close. This upward motion of the piston is the *compression* stroke. Compression raises the pressure and temperature of the mixture. Near the top of the compression stroke, the spark plug produces a spark, igniting the mixture. The mixture burns and expands, which drives the piston downward for the third, or *power*, stroke. As the piston reaches BDC and begins to move back up again, the exhaust valves open, beginning the *exhaust* stroke. The upward motion of the piston pushes the burned gases out of the engine into the exhaust manifold and eventually out the exhaust pipe.

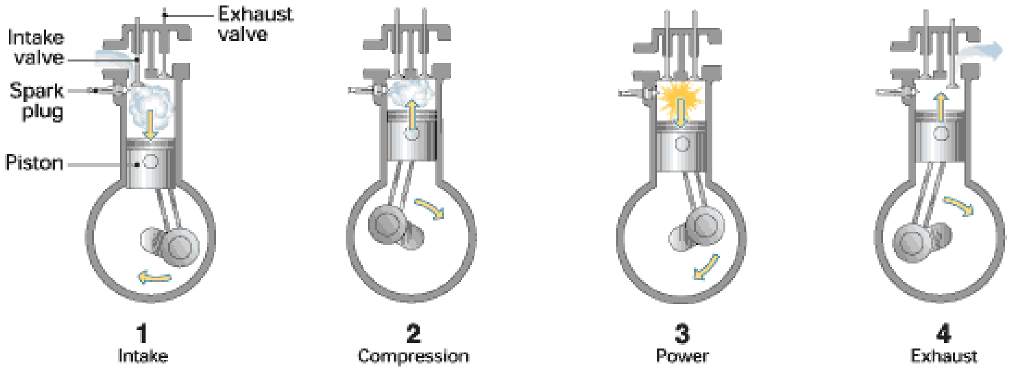


Figure 1.3 The four-stroke combustion cycle

1.2.2. Air System

Air is drawn into the engine through the intake system. It passes though an air filter to keep dust and contaminants out of the engine. A throttle (a disk attached to a rotatable shaft) is mounted in the air intake to control airflow. When the pilot opens the throttle, the disk tilts allowing more air to enter the engine. With more air, the engine can use more fuel and produce more power to take off or climb. An engine that uses intake air at atmospheric pressure is said to be *naturally aspirated*. The amount of air a naturally aspirated engine can use is limited by the local air density (barometric pressure) and pressure losses in the intake system. To get more air into an engine (boost the air pressure), small compressors are sometimes used to pressurize the intake air. If the compressor is driven off the engine crankshaft, the process is called *supercharging*.

Another way to power the compressor is to put it on a common shaft with a turbine driven by the engine's exhaust gas. This process is called *turbocharging*. To maintain boost pressure at a relatively constant amount over a wide range of engine speeds, some sort of pressure regulation is needed. Turbocharging is preferred since it extracts energy from exhaust gases that would otherwise be wasted, so it is more efficient than supercharging, which takes energy from the crankshaft. Since air density decreases along with atmospheric pressure as altitude increases, less and less air is drawn into a naturally aspirated engine as an aircraft climbs. This limits the maximum speed and altitude that can be achieved. This limitation was recognized even before World War I, but turbochargers were not developed until the mid-1920s. They were so successful that naturally aspirated engines were virtually obsolete in high-performance aircraft by the early 1930s.

1.2.3. Carburetion

In the intake system of an engine, air mixes with a small amount of vaporized fuel to produce a homogeneous fuel-air mixture. The carburetor is the most successful of the many devices developed to discharge the correct amount of fuel into the intake air stream. The heart of a carburetor is a *ventury* – a converging-diverging nozzle. The diameter of the nozzle decreases to a minimum at the throat and then increases to the discharge end. As air passes through the ventury, its velocity increases up to the narrowest portion (throat) because the cross-sectional flow area decreases. As the air velocity increases, its pressure decreases, creating a vacuum that draws fuel out of the carburetor's fuel bowl through a tiny orifice called a *jet*. Additional jets are used to enrich the mixture during acceleration and to supply sufficient fuel at idle. A hand-operated primer is used on many engines to enrich the mixture for cold starts.

Carburetors do not control fuel flow precisely enough for critical or high performance applications. In part this is because they are volume-flow based and difficult to calibrate for all operating conditions.

1.2.4. Fuel Injection

The second major type of fuel system design is the *fuel injection* system. Fuel injectors are mounted at the intake port of each cylinder, where they spray fuel onto the intake valves. To enrich the mixture during cold starts, an additional cold-start injector may be used. This injector adds additional fuel to the intake air for a short period of time while the engine warms up.

The primary advantage of fuel injection is more uniform fuel distribution to each cylinder compared to carburetion. Fuel-injected engines also respond more rapidly than carbureted engines when the pilot changes control settings.

1.2.5. Engine Configurations

Aircraft piston engines have been built in several different configurations. The in-line and "V" engines are very similar to those used in automobiles. Some early designs had separate cylinders to minimize weight; most later designs used the familiar engine block. As a rule, these usually were water cooled because the integral cylinder blocks are ideally suited to liquid cooling.

The radial engine configuration is unique to aviation. Here the crankshaft is in the circular centerpiece of the engine and the cylinders radiate out from it in a plane perpendicular to the crankshaft. In this design, each cylinder gets equal airflow, so most radials are air cooled. An interesting early design is the rotary engine, in which the engine block rotates about a fixed crankshaft.

Horizontally opposed engines are the third major configuration. These can be considered an extreme example of a "V" engine, in which the angle between the pistons is 180 degrees, as illustrated in Figure 1.4 the cylinders lie in a plane roughly parallel to the wings. Most horizontally opposed engines are air cooled. Horizontally opposed engines have been used in almost all small aircraft built since World War II.

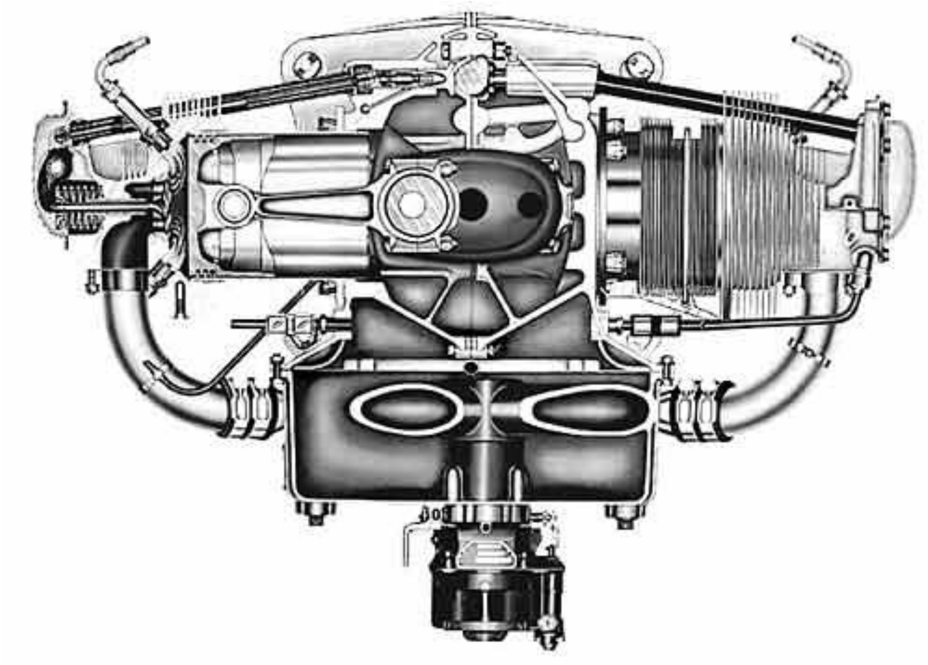


Figure 1.4: Horizontally opposed engine

<u>Exercise</u>: Interpretation of words and phrases: Circle the letter next to the best answer.

1. Finally, the compressed fuel-air mixture is ***ignited*** with a spark provided by a spark plug.
   A) Sounds loudly.
   B) Compresses very tightly.
   C) Begins to burn.

2. The explosive power is used to move the piston back, and remove the ***exhaust*** gases from the compression chamber.
   A) Used and drained off completely.
   B) Collected completely.
   C) Got wet completely.

3. Hence, piston engines are mostly ***restricted*** to training flights and slow flights.
   A) Limited
   B) Extended
   C) Standardized

4. The engine's power is generated by the force exerted on the piston by the rapid ***expansion*** of gases resulting from the combustion of a compressed fuel-air mixture.
   A) Melting
   B) Vaporizing
   C) Enlargement

5. One complete movement of the piston in either direction is called a ***stroke***.
   A) Piston
   B) Period of time
   C) Cylinder

6. To maintain boost pressure at a relatively constant amount over a wide range of engine speeds, some sort of pressure ***regulation*** is needed.
   A) Increasing
   B) Control by using laws
   C) Break down

7. Additional jets are used to ***enrich*** the mixture during acceleration and to supply sufficient fuel at idle.
   A) To make better
   B) To compress
   C) To fluidize

8. As a rule, these usually were water cooled because the integral cylinder blocks are ideally ***suited*** to liquid cooling.
   A) To become extinct
   B) To be present
   C) To be fit

<u>Exercise:</u> Vocabulary

Use each word or phrase in a sentence.

1. To rotate
2. Provide
3. Compression
4. Exhaust
5. Aspirate
6. To calibrate
7. Unique

1.3. Jet Engines

Figure 1.5: A jet engine

Most of the modern aircraft engines are powered by the Jet engines. They are called Jet engines because they take in a lot of air, compress it and push it behind through a nozzle at high pressure, which gives the aircraft the necessary thrust to move forward.

In a typical Jet engine, the inlet sucks in air from the surrounding atmosphere. The air from the atmosphere passes into the compression chamber, where it is compressed to very high pressures. The compressed air is mixed with highly inflammable fuels like aviation fuel. The mixture is the pushed into a combustion chamber where the air-fuel mixture is ignited. The ignited fuel releases explosive power that is allowed to pass through a set of rotating fans called turbines. The turbines are similar to the turbines that are used in hydroelectric plants and rotate at a fast rate because of the flow of the highly pressurized heated air that passes through it. The turbines provide the mechanical power to the aircraft. The turbines convey the rotary energy to other parts of the engines with the help of shafts that moves other components in the engine. Part of the power is used to turn the compressor, which sucks in a steady current of air into the compression chamber. The remaining hot gases are released from the combustion chamber at high pressure, which gives the thrust to the engine. The release of hit compressed gases, provide huge explosive power for the plane to get enough power at takeoff and also to cruise at high speeds.

The first jet aircraft flew in the Luftwaffe of Nazi Germany during World War II, but were still very experimental. Following the war, piston aircraft began to fall out of favor as designers embraced the speed and efficiency of jet-powered aircraft.

In its simplest form a jet engine has three major components, called the core:

Compressor: A series of blades or airfoils, some rotating (rotors) some stationary (stators), that draws air in and compresses it. More complex engines will have many rows of blades. As the air moves through these rows, its pressure will increase by as much as 40 times and the temperature will rise dramatically.

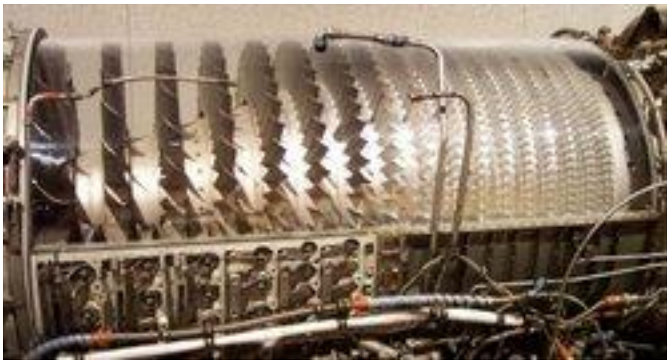


Figure 1.6 The compressor stage

Combustion chamber: The compressed air is then pushed rearward into the combustion chamber. In the combustor, fuel injectors mix jet fuel with the air and it is ignited. The flow and burn of the air/fuel mixture is controlled to ensure that the engine sustains a continuous flame. The expanding exhaust gases flow quickly toward the rear of the engine.

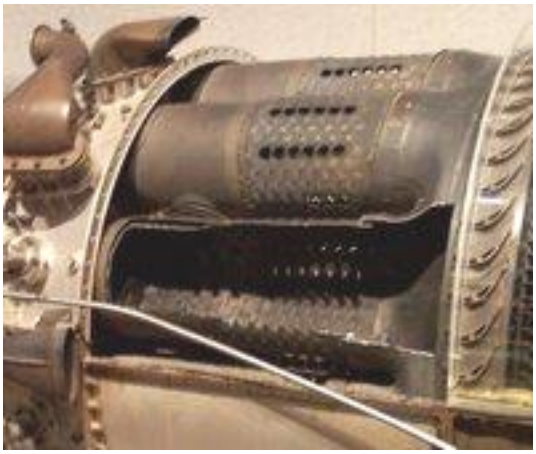


Figure 1.7 Combustion chamber

Turbines: The speeding gases that exit the combustor exert force against the turbine blades (airfoils), similar to the way a gust of wind spins a windmill. The turbine is connected to the compressor by a shaft. The force - or energy – created by the turbine spins the compressor, which pulls in more air, beginning the whole cycle again. The compressor is actually powered by the air it has already fed through!

Figure 1.8 The turbine stage

All of these components are housed in a durable metal casing that is the installed into the nacelle, a megaphone-shaped engine enclosure that is mounted to the airplane's wing or fuselage.

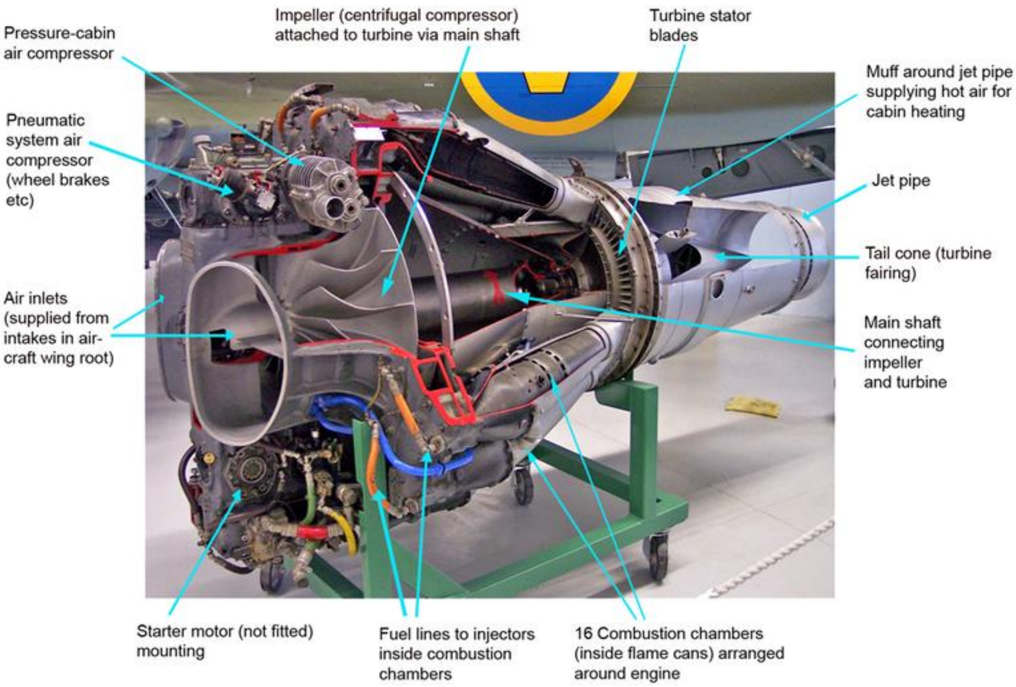


Figure 1.9: Sectioned picture of a jet engine to show its internal components

While every type of turbojet engine shares a basic core - compressor, combustor, and turbine - there are variations for different applications. Jet engines are further classified

Turbofans, TurboShaft and TurboProp Engines. All these engines use the same principle of Jet engines but they are put to different uses. The Turboprop engine uses energy from the engine to run fans mounted on the outside of the plane. TurboShaft engines are similar to Turboprop engines except that the shaft is used to power a variety of additional gadgets. The Turbofan engine has additional fans located on the front of the aircraft that draws additional air into the engine.

1.3.1. Turbo Prop Engines

The turboprop is the logical extension of the turbofan, and uses a low-powered jet engine to drive a full-sized propeller. Most propeller airliners today use turboprop engines. While they can fly faster and more efficiently than pistons, they are still slower than turbojets and turbofans.

Turbo prop engines can be found on small commuter aircraft. While they may look like the standard piston-driven propeller engines found on recreational planes, turbo props are much more powerful.

Energy from the turbine is used to spin the large front-mounted propeller. The shaft that connects the propeller to the turbine is also linked to a gearbox that controls the propeller's speed. The propeller is most efficient and quiet, when the tips are spinning at just under supersonic speed. (The speed of sound)

1.3.2. Turbo Shaft Engines

Turbo shaft engines are extremely versatile and are used in helicopters, electric power plants, offshore oil drilling, even the mighty M1 tank! In theory, it works just like the turbo prop. But instead of the turbine's force driving a propeller or creating thrust directly behind the engine, power can be routed via the shaft to a variety of devices; pumps, generators, wheels, helicopter blades, a ship's propeller – just about anything that spins.

1.3.3. Turbofan (High Bypass) Engines

Turbofan engines are turbojet engines with large fans at the front that turn along with the engine's compressor and generate extra thrust. The added fan makes the engine more powerful without demanding extra fuel. Most commercial jet engines nowadays are turbofans.

Figure 1.10 Turbofan engine

Large commercial airliners use a turbofan jet engine. Turbofans use the same compressor, combustor and turbine common to all turbojet engines. The difference is the addition of a large fan mounted to the front of the engine. These fans, some as large as 10' in diameter, draw air into the engine. Some of the air is sent to the compressor and the combustor, while the rest bypasses these components through ducts on the outside of the engine.

Most turbofans in use today are designated as high-bypass turbofans, where the ratio of bypass air to the air directed into the compressor is 5:1 or greater. At subsonic speed, high-bypass turbofans are more fuel efficient and quieter than other types of jet engines, making them ideally suited for commercial aircraft.

Accelerating a vehicle heavier than a locomotive from 0 to 200 mph in less than 60 seconds requires a lot of thrust. It is the fan, and the high volume of air it pulls in which creates most of the engine's thrust at takeoff!

Another type of jet engine is the **ramjet**, which was first played with in the 1960's. The ramjet has very few moving parts: it is designed to be used at high speeds, where air entering the engine can compress itself without the need for a separate compressor. While ramjets are incredibly efficient and powerful, they can only be used above 350 MPH or so, which makes them impractical to use on most modern aircraft.

Jet Engines and the Environment:

All engines those burn fossil fuels emit pollutants that are harmful to the environment, and turbojets are no exception. At ground level, they produce nitrogen oxides (NOx) and volatile organic compounds (VOCs) that combine with oxygen on warm, sunny days to create ozone also known as smog. Ozone exists naturally in the stratosphere in small amounts where it helps to shield the planet from harmful ultraviolet rays. But closer to the earth's surface, ozone is corrosive and harmful to humans and plants.

Jet engines add unwanted noise to airport environments. While sound levels are decreasing through new insulation materials and improved component design, the increasing popularity of air travel means that there will be more occasional blasts of noise as aircraft take off and land.

<u>Exercise:</u> Interpretation of words and phrases: Circle the letter next to the best answer.

1. Most of the modern aircraft engines are ***powered*** by the Jet engines.
   A) Made
   B) Strengthened
   C) Used

2. In a typical Jet engine, the inlet ***sucks*** in air from the surrounding atmosphere.
   A) Blows
   B) Pushes
   C) Takes in

3. The turbines ***convey*** the rotary energy *to* other parts of the engines with the help of shafts that moves other components in the engine.
   A) Transport to
   B) Transform to
   C) Leave to

4. The remaining hot gases are ***released*** from the combustion chamber at high pressure
   A) Left
   B) Taken
   C) Pulled

5. In its simplest form a jet engine has three ***major*** components, called the core
   A) Huge
   B) Nice
   C) Main

6. As the air moves through these rows, its pressure will increase by as much as 40 times and the temperature will rise ***dramatically***.

   A) Tragically
   B) Suddenly
   C) Slowly

7. All of these components are housed in a durable metal casing that is the installed into the nacelle, a megaphone-shaped engine enclosure that is mounted to the airplane's wing or ***fuselage***.
   A) Rear of wing
   B) Airplane's body
   C) Front of wing

8. TurboShaft engines are similar to Turboprop engines except that the shaft is used to power a variety of additional ***gadgets***.
   A) Accessories
   B) Fans
   C) Motors

9. Turbo shaft engines are extremely ***versatile*** and are used in helicopters.
   A) Strong
   B) Different
   C) Efficient

10. The added fan makes the engine more powerful without ***demanding*** extra fuel.
   A) Spraying
   B) Burning
   C) Necessity

<u>Exercise:</u> Vocabulary

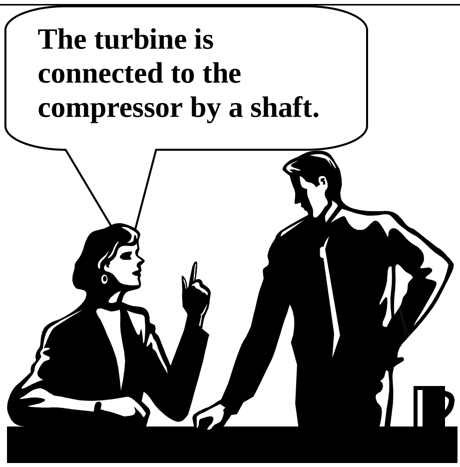
Use each word or phrase in a sentence.

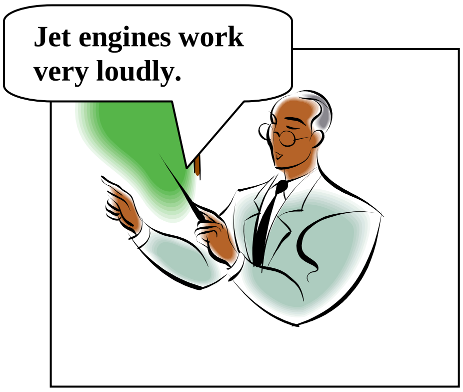
1. To suck
2. Propeller
3. Commercial
4. Efficient
5. Incredible
6. Mount
7. Except

APPLICATION ACTIVITY

Make conversations with each other in classroom, laboratory, workshop or wherever you are using terms and sentences involved technical English you have learned by this learning activity:

Examples:

<table>
<tr><th>Steps of proccess</th><th>Suggests</th></tr>
<tr><td>




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- Take advantage from activity 1.

</td></tr>
</table>

CHECKLIST

If you have behaviors listed below, put (X) in “Yes” box for earned your the skills within the scope of this activity otherwise put (X) in “No” box.

Evaluation criteria	Yes	No
1. Did you learn types of aircraft engines?		
2. Did you learn the features of aircraft engines?		
3. Did you learn the parts of aircraft engines?		
4. Did you learn the system of aircraft engines?		

EVALUATION

Please review a further in the "No" answers in the form at the end of evaluation. If you do not see enough yourself, be repeat learning activity. If you give all your answers "Yes" to all questions, pass to the " Measuring and Evaluation ".

MEASURING AND EVALUATION

Evaluate the given knowledge, If the knowledge is TRUE, write “T” , if it is FALSE, write “F” to end of the empty parenthesis.

1. ( ) An aircraft engine doesn’t have to be reliable.
2. ( ) If an engine is repaired, that would be cheap solution.
3. ( ) The engine, as well as the aircraft, needs to be lifted into the air, meaning it has to overcome lots of weight.
4. ( ) Magneto is a kind of power supply that relies on a battery.
5. ( ) Thrust is a force that pulls the aircraft backward.
6. ( ) Piston engines principle differs from car engines principle very much.
7. ( ) B-29 Super fortress used piston engine.
8. ( ) Using piston engines costs much expensive.
9. ( ) The mixture burns and expands in the fourth stroke.
10. ( ) To get more air into an engine, small compressors are sometimes used to pressurize the intake air.
11. ( ) Carburetors control fuel flow precisely enough for critical or high performance applications.
12. ( ) Piston engines are still very popular and they are mostly used in aircraft.
13. ( ) The air taken into the engine is compressed to very high pressures in the combustion chamber.
14. ( ) The jet aircrafts used during World War II. were developed.
15. ( ) The turbine is connected to the compressor by a shaft.
16. ( ) Turboprop engines are faster than turbojets and turbofans.
17. ( ) Turbofan engines need extra fuel to let the engine’s compressor generate extra thrust.
18. ( ) Large commercial airliners use a turboprop jet engine.
19. ( ) Jet engines work so loudly.
20. ( ) Jet engines do not pollute the environment as much as piston engines.

EVALUATION

Please check your answers from the answer key table which is at the end of this module. If you have more than 1 mistakes you need to review the learning activity – 1.

If you give right answers to all questions, pass to learning activity-2.

LEARNING ACTIVITY-2

AIM

According to information in this module and in suitable conditions, you can read the flight control surfaces with English language.

SEARCH

Try to remember that you learn before about flight control surfaces. Refresh the information on this subject.

2. FLIGHT CONTROL SURFACES

Figure 2.1: Having a look at flight control surfaces

2.1. Aircraft Axes

An airplane may turn about three axes. Whenever the attitude of the airplane changes in flight (with respect to the ground or other fixed object), it will rotate about one or more of these axes as illustrated below in figure 2.2. Think of these axes as imaginary axes around which the airplane turns like a wheel. The three axes intersect at the center of gravity and each one is perpendicular to the other two.

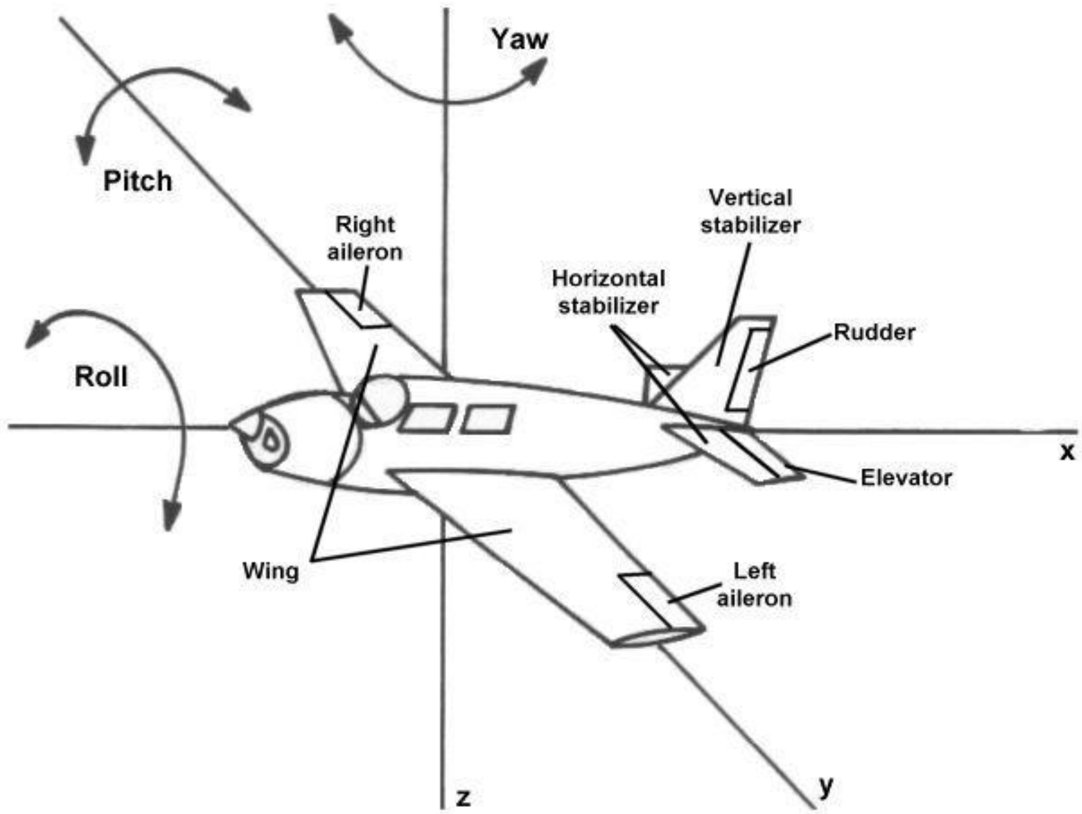


Figure 2.2 Aircraft axes of motion

First, the aircraft nose can rotate up and down about the y-axis, a motion known as pitch. Pitch control is typically accomplished using an elevator on the horizontal tail. Second, the wingtips can rotate up and down about the x-axis, a motion known as roll. Roll control is usually provided using ailerons located at each wingtip. Finally, the nose can rotate left and right about the z-axis, a motion known as yaw. Yaw control is most often accomplished using a rudder located on the vertical tail.

There is apparently no real rationale for these names; you simply have to memorize them as; longitudinal axis-roll, lateral axis-pitch, and vertical axis-yaw.

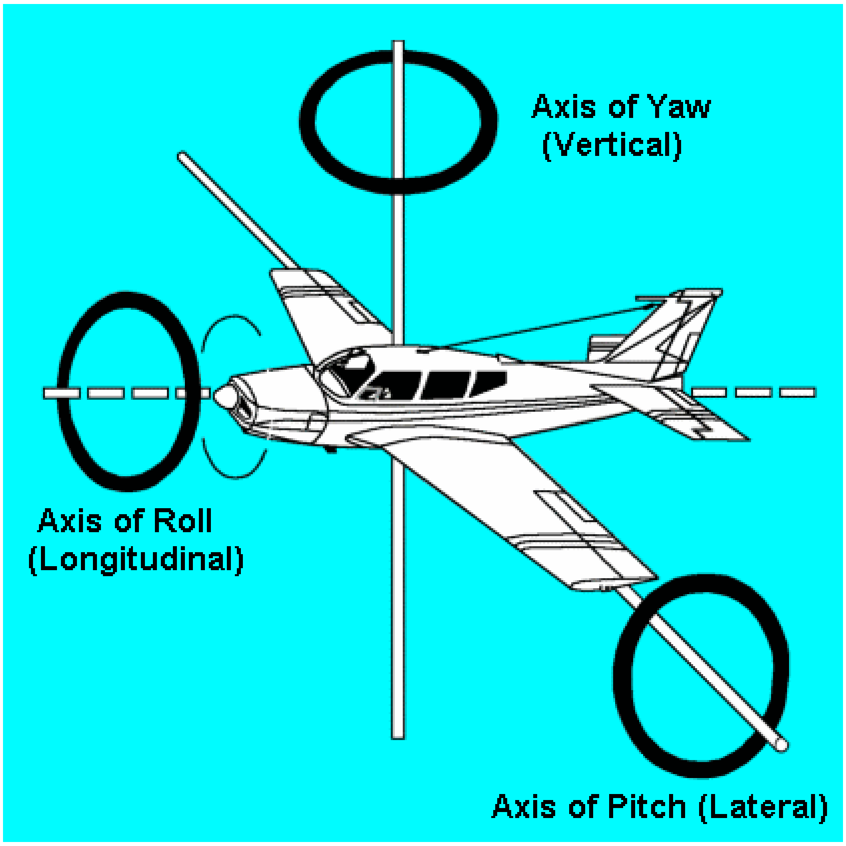


Figure 2.3 Axes of an Airplane in Flight

2.1.1. The Longitudinal Axis

Running from the nose to the tail of an aircraft is the longitudinal axis (see figure 2-3). This axis can be thought of as a skewer which runs the length of the fuselage, and movement around the longitudinal axis is called roll.

The cause of movement or roll about the axis is the action of the ailerons. Ailerons are attached to the wing and to the control column in a manner that ensures one aileron will deflect downward when the other is deflected upward. How is it that deflecting an aileron causes the wing to move? Very simply, when an aileron is not in perfect alignment with the total wing, it changes the wing's lift characteristics. To make a wing move upward, the aileron on that wing must move downward. When this happens, the total lift being produced by that wing is increased. At the same time, the lift on the other wing is reduced. This causes the aircraft to roll.

The ailerons are attached to the cockpit control column by mechanical linkage. When the control wheel is turned to the right (or the stick is moved to the right), the aileron on the right wing is raised and the aileron on the left wing is lowered. This action increases the lift on the left wing and decreases the lift on the right wing, thus causing the aircraft to roll to the right. Moving the control wheel or stick to the left reverses this and causes the aircraft to roll to the left.

2.1.2. The Lateral Axis

Another name for the lateral axis is the pitch axis. This name makes sense because the airplane is actually caused to pitch its nose upward or downward around the lateral axis which runs from wingtip to wingtip. What causes this pitching movement? It is the elevator which is attached to the horizontal stabilizer. The elevator can be deflected up or down as the pilot moves the control column (or stick) backward or forward. Movement backward on the control column moves the elevator upward. Since this motion is around the lateral axis, as the tail moves (pitches) downward, the nose moves (pitches) upward and the aircraft climbs. Deflection of the elevator downward creates the opposite effect and the relative wind striking the lower surface of the elevator causes the tail to pitch up. This pitches the nose of the aircraft downward and the airplane dives. Before leaving the horizontal stabilizer, we should introduce the term stabilizer. Most aircraft designs no longer use a stabilizer with elevator arrangement. Instead the entire horizontal tail surface is hinged so that the surface's angle of attack is changed as the pilot pulls or pushes on the control column. This type of design is doing the job of both a stabilizer and elevator so it is called a stabilator.

2.1.3. The Vertical Axis

The third axis which passes through the meeting point of the longitudinal and lateral axes from the top of the aircraft to the bottom is called the vertical or yaw axis. The aircraft's nose moves about this axis in a side-to-side direction. In other words, the airplane's nose is made to point in a different direction when the airplane turns about this particular axis.

The airplane's rudder, which is moved by pressing on the rudder pedals, is responsible for movement about this axis. The rudder is a movable control surface attached to the vertical fin of the tail assembly. By pressing the proper rudder pedal, the pilot moves the rudder of the aircraft in the direction of the pedal he or she presses (right pedal moves the rudder to the right, and left pedal moves the rudder to the left). What happens then? When the pilot pushes the left rudder pedal, he or she then sets the rudder so that it deflects the relative air to the left. This then creates a force on the tail, causing it to move to the right and the nose of the aircraft to yaw to the left.

At this point, it is probably well to point out that the rudder does not steer the aircraft in normal flight. The rudder does not turn the aircraft; rather, its primary purpose is to offset the drag produced by the lowered aileron.

<u>Exercise:</u> Interpretation of words and phrases: Circle the letter next to the best answer.

1. Whenever the ***attitude*** of the airplane changes in flight, it rotates about one or more of axes.
   A) Weight
   B) Behavior
   C) Balance

2. The three axes intersect at the center of gravity and each one is ***perpendicular*** to the other two.
   A) Connected
   B) Bended
   C) At angle of 90

3. Ailerons are attached to the wing and to the control column in a manner that ensures one aileron will ***deflect*** downward when the other is deflected upward.
   A) Loosing control
   B) Change of direction
   C) Doing wrong

4. Moving the control wheel or stick to the left ***reverses*** this and causes the aircraft to roll to the left.
   A) Makes it go to opposite direction.
   B) Breaks it down.
   C) Supports it.

5. By pressing the ***proper*** rudder pedal, the pilot moves the rudder of the aircraft in the direction of the pedal he or she presses.
   A) Long
   B) Right
   C) Wrong

6. At this point, it is probably well to point out that the rudder does not steer the aircraft in normal flight.
   A) Landing right
   B) Controlling
   C) Directing right

7. The rudder does not turn the aircraft; rather, its primary ***purpose*** is to offset the drag produced by the lowered aileron.
   A) Aim
   B) Act
   C) Motion

<u>Exercise:</u> Vocabulary

Use each word or phrase in a sentence.

1. Gravity
2. Apparent
3. Perfect
4. Reduce
5. Responsible

2.2. Primary Flight Control Surfaces

An airplane in flight moves around three axes of rotation: longitudinal axis, lateral axis, and vertical axis. These axes are imaginary lines that run perpendicularly to each other through the center of gravity of the airplane. Rotation around the longitudinal axis (the line from the nose of the plane to the tail) is called roll. Rotation around the lateral axis (the line from wingtip to wingtip) is called pitch. Rotation around the vertical axis (the line from beneath to above the plane) is called yaw. The pilot guides and controls the aircraft by controlling its pitch, roll, and yaw via the control surfaces. These include the ailerons, elevators, and rudder.

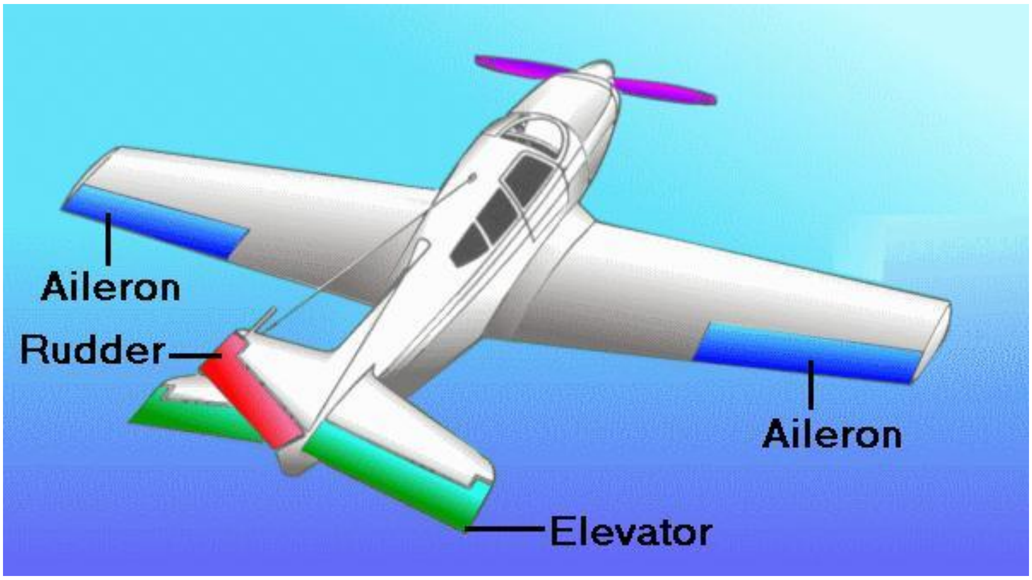


Figure 2.4 The three primary flight controls are the ailerons, elevator and rudder.

2.2.1. Ailerons

The two ailerons, one at the outer trailing edge of each wing, are movable surfaces that control movement about the longitudinal axis. The movement is roll. Lowering the aileron on one wing raises the aileron on the other. The wing with the lowered aileron goes up because of its increased lift, and the wing with the raised aileron goes down because of its decreased lift. Thus, the effect of moving either aileron is aided by the simultaneous and opposite movement of the aileron on the other wing.

Rods or cables connect the ailerons to each other and to the control wheel (or stick) in the cockpit. When pressure is applied to the right on the control wheel, the left aileron goes down and the right aileron goes up, rolling the airplane to the right. This happens because the down movement of the left aileron increases the wing camber (curvature) and thus increases the angle of attack. The right aileron moves upward and decreases the camber, resulting in a decreased angle of attack. Thus, decreased lift on the right wing and increased lift on the left wing cause a roll and bank to the right.

2.2.2. Elevators

The elevators control the movement of the airplane about its lateral axis. This motion is pitch. The elevators form the rear part of the horizontal tail assembly and are free to swing up and down. They are hinged to a fixed surface--the horizontal stabilizer. Together, the horizontal stabilizer and the elevators form a single airfoil. A change in position of the elevators modifies the camber of the airfoil, which increases or decreases lift.

Like the ailerons, the elevators are connected to the control wheel (or stick) by control cables. When forward pressure is applied on the wheel, the elevators move downward. This increases the lift produced by the horizontal tail surfaces. The increased lift forces the tail upward, causing the nose to drop. Conversely, when back pressure is applied on the wheel, the elevators move upward, decreasing the lift produced by the horizontal tail surfaces, or maybe even producing a downward force. The tail is forced downward and the nose up.

The elevators control the angle of attack of the wings. When back pressure is applied on the control wheel, the tail lowers and the nose raises, increasing the angle of attack. Conversely, when forward pressure is applied, the tail raises and the nose lowers, decreasing the angle of attack.

2.2.3. Rudder

The rudder controls movement of the airplane about its vertical axis. This motion is yaw. Like the other primary control surfaces, the rudder is a movable surface hinged to a fixed surface which, in this case, is the vertical stabilizer, or fin. Its action is very much like that of the elevators, except that it swings in a different plane--from side to side instead of up and down. Control cables connect the rudder to the rudder pedals.

<u>Exercise:</u> Interpretation of words and phrases: Circle the letter next to the best answer.

1. These axes are ***imaginary lines*** that run perpendicularly to each other through the center of gravity of the airplane.
   A) Not real lines, existing only in the mind.
   B) Straight lines.
   C) Curved lines.
2. The two ailerons, one at the outer ***trailing edge*** of each wing, are movable surfaces that control movement about the longitudinal axis.
   A) Back edge
   B) Side edge
   C) Front cutting edge

3. The effect of moving either aileron is ***aided*** by the simultaneous and opposite movement of the aileron on the other wing.
   A) Done
   B) Supported
   C) Prevented

4. This ***happens*** because the down movement of the left aileron increases the wing camber.
   A) Is observed
   B) Occurs
   C) Begins

5. This happens because the down movement of the left aileron increases the wing ***camber***.
   A) With curved angle
   B) Side of it
   C) Bottom of it

6. The three ***primary*** flight controls are the ailerons, elevator and rudder.
   A) Important
   B) Basic
   C) Main

<u>Exercise:</u> Vocabulary

Use each word or phrase in a sentence.

1. Imaginary
2. Perpendicular
3. Swing
4. Converse
5. Fixed

2.3. Secondary Flight Control Surfaces

Figure 2.5: Secondary flight control surfaces

In addition to the primary flight controls, there is, on most modern airplanes, a group termed "secondary controls." These include trim devices of various types, spoilers, and wing flaps.

2.3.1. Trimming

Trimming controls allow a pilot to balance the lift and drag being produced by the wings and control surfaces over a wide range of load and airspeed. This reduces the effort required to adjust or maintain a desired flight attitude.

2.3.1.1. Trim Tabs

Trim tabs are used to adjust the position of an associated main control surface. They are often hinged to the back edge of the control surface with a control in the cockpit. Some trim tabs on light aircraft are fixed sheets of metal that can be bent while the aircraft is on the ground but cannot be controlled in flight. Both types function by redirecting the air stream to generate a force which holds the main control surface in the desired position. Because they are furthest from the pivot point of the main control surface, their small aerodynamic effects are magnified by leverage to achieve the deflection of the main surface.

2.3.1.2. Trimming Tail Plane

Except for very light aircraft; trim tabs on elevators are unable to provide the force and range of motion desired. To provide the appropriate trim force the entire horizontal tail plane is made adjustable in pitch. This allows the pilot to select exactly the right amount of positive or negative lift from the tail plane while reducing drag from the elevators.

2.3.1.3. Control Horn

A control horn is a section of control surface which projects ahead of the pivot point. It generates a force which tends to increase the surface's deflection thus reducing the control pressure experienced by the pilot. Control horns may also incorporate a counterweight which helps to balance the control and prevent it from "fluttering" in the airstream. Some designs feature separate anti-flutter weights.

In the simplest cases trimming is done by a mechanical spring which adds appropriate force to the pilot's control.

2.3.2. Spoilers

On very high lift/low drag aircraft like sailplanes, spoilers are used to disrupt airflow over the wing and greatly reduce the amount of lift. This allows a glider pilot to lose altitude without gaining excessive airspeed. Spoilers are sometimes called "lift dumpers". Spoilers, that can be used asymmetrically are called spoilerons and are able to affect an aircraft's roll.

Figure 2.6 Spoilers

2.3.3. Flaps

Flaps are mounted on the back edge of each wing near the wing roots. They are deflected down to increase the effective curvature of the wing and produce additional lift, and also reduce the stalling speed of the wing. They are used during low speed, high angle of attack flight like descent for landing. Some aircraft use flaperons instead, which can also be used for roll control.

Slats are extensions to the front of a wing for lift augmentation, and are intended to reduce the stalling speed by altering the airflow over the wing. Slats may be fixed or retractable - fixed slats give excellent slow speed and STOL (Short Take-Off and Landing) capabilities, but compromise higher speed performance. Retractable slats, as on most airliners, allow higher lift on take off, but retract for cruising.

2.3.4. Air Brakes

These are used on high speed aircraft and are intended to increase the drag of an aircraft without altering the amount of lift. Airbrakes and spoilers are sometimes the same device - on most airliners for example, the combined spoiler/airbrakes act to simultaneously remove lift and to slow the aircraft's forward motion. Ground spoilers, which are a combination of airbrakes/flight spoilers along with additional panels, are deployed upon touchdown to assist braking the aircraft by applying positive downward forces which also ensures that the aircraft remains planted firmly on the ground.

Mechanical braking of the wheels is assisted by both functions - the weight of the aircraft carried by its wings is transferred to the undercarriage when the lift is dumped, so there is less chance of a skid, and the airbrake effect increases the form drag of the aircraft.

Figure 2.7 showing position of flap and airbrake/spoiler flight controls

<u>**Exercise:**</u> **Interpretation of words and phrases: Circle the letter next to the best answer.**

1. In addition to the primary flight controls, there is, on most modern airplanes, a group ***termed*** "secondary controls."

   A) Maintained
   B) Called
   C) Derived

2. This reduces the effort required to adjust or maintain a ***desired*** flight attitude.

   A) Liked
   B) Hated
   C) Wished

3. Trim tabs are used to adjust the position of an ***associated*** main control surface.

A) Combined
B) Separated
C) Deflected

4. Some trim tabs on light aircraft are fixed sheets of metal that can be ***bent*** while the aircraft is on the ground but cannot be controlled in flight.

A) Connected
B) Wrenched
C) Positioned

5. To provide the appropriate trim force the entire horizontal tail plane is made adjustable in pitch.

A) High
B) Dynamic
C) Suitable

6. A control horn is a section of control surface which projects ahead of the ***pivot point.***

A) Moving point
B) Turning point
C) Stable point

7. They are used during low speed, high angle of attack flight like ***descent*** for landing.

A) To get down
B) To prepare
C) To be ready

8. They are intended to reduce the ***stalling speed*** by altering the airflow over the wing.

A) Slowing down speed
B) Accelerating speed
C) Stabling speed

9. They are intended to reduce the stalling speed by ***altering*** the airflow over the wing.

A) Decreasing
B) Increasing
C) Changing

10. They are deployed upon touchdown to ***assist*** braking the aircraft by applying positive downward forces.

A) Start
B) Help
C) Prevent

<u>Exercise:</u> Vocabulary

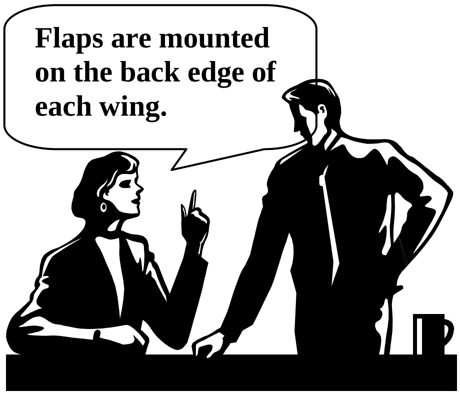
Use each word or phrase in a sentence.

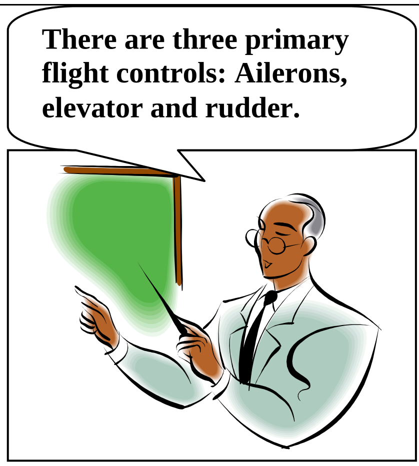
1. Various
2. Effort
3. Separate
4. Intend to
5. Amount

APPLICATION ACTIVITY

Make conversations with each other in classroom, laboratuary, workshop or wherever you are using terms and sentences involved technical english you have learned by this learning activity:

Examples:





CHECKLIST

If you have behaviors listed below, evaluate yourself putting (X) in “Yes” box for your earned skills within the scope of this activity otherwise put (X) in “No” box.

	Evaluation criteria	Yes	No
1.	Did you learn the aircraft axes?		
2.	Did you learn the primary flight control surfaces?		
3.	Did you learn the secondary flight control surfaces?		

EVALUATION

Please review your “No" answers in the form at the end of the evaluation. If you do not find yourself enough, repeat learning activity. If you give all your answers "Yes" to all questions, pass to the "Measuring and Evaluation".

MEASURING AND EVALUATION

Evaluate the given knowledge, If the knowledge is TRUE, write “T” , if it is FALSE, write “F” to end of the empty parenthesis. .

1. ( ) There is a 90^0 degrees angle between an axis and other axes.
2. ( ) The wingtips can rotate up and down about the x-axis, is a motion called pitch.
3. ( ) Elevator causes the pitching movement.
4. ( ) Yaw axis means horizontal axis.
5. ( ) The elevator can be deflected up or down as the pilot moves the control column (or stick) backward or forward and nothing is needed to help it.
6. ( ) The two ailerons, one at the outer trailing edge of each wing, are not stable surfaces.
7. ( ) Lowering the aileron on one wing raises the aileron on the other.
8. ( ) When the pilot moves the stick left, or turns the wheel counter-clockwise, the left aileron goes up and the right aileron goes down.
9. ( ) An elevator is mounted on the front edge of the horizontal stabilizer on each side of the tail.
10. ( ) If the pilot pushes the left pedal, the rudder deflects right.
11. ( ) Trimming controls help the pilot to balance the lift and drag being produced by the wings and control surfaces.
12. ( ) Trim tabs on elevators can provide excellent force and range of motion.
13. ( ) “This allows a glider pilot to lose altitude without gaining excessive airspeed.” In this sentence “altitude” means height.
14. ( ) Spoilerons are spoilers, that available to be used asymmetrically.
15. ( ) Flaps are used during high speed and high angle of attack flight.
16. ( ) Airbrakes and spoilers are always similar devices.

EVALUATION

Please check your answers from the answer key table which is at the end of this module. If you have more than 1 mistakes you need to review the learning activity – 1.

If you give right answers to all questions, pass to learning activity-3.

LEARNING ACTIVITY-3

AIM

You can get the necessary skills that to read English the aircraft systems.

SEARCH

- Try to remember that you learn before about aircraft systems. Refresh the information on this subject.

3. AIRCRAFT SYSTEMS

3.1. Pneumatic

In many cases energy from compressed air has different advantages on board, especially when the aircraft is powered by turbine engines because air can be easily bled from the compressors. Air is present at high pressures and temperatures and then, after regulation, can be used for heating and pressurization. Main uses are as follows:

- Environmental control;
- Ice protection;
- Windscreen demisting and rain dispersal;
- Pressurization for hydraulic oil reservoir, fuel tanks, water tanks;
- Turbine engine start;
- Turbines;
- Actuators (under very restricted conditions).

Pneumatic power generation and control: The turbine engine is a generator of high-speed gas aimed to provide thrust for the aircraft. Before entering the combustion chamber and being mixed with atomized fuel, the external air is processed by a multi-stage axial compressor, driven by the turbine. From one or more stages of the compressor, a limited volume of air can be bled without significant degradation of the engine performances. Then the engine compressor is responsible for the pneumatic power generation on board. Two remarks are relevant for this kind of compressed air generation:

1. The system needs a regulation, because bled air conditions depend on engine functioning conditions and these vary from idle (low pressure and temperature) to max thrust (high pressure and temperature);

2. In some flight conditions a reduced amount of air can be bled from the compressor to avoid significant breakdown in engine performance, especially when max thrust is requested.

The sketch in figure 3.1 summarizes the components of pneumatic system generation for a turbofan engine. Air is commonly bled at two different stages of the compressor: a low pressure port at an intermediate stage and a high pressure port at a final stage. A check valve is necessary to prevent air flowing from high to low pressure bleeding ports. The low pressure bleeding port is normally open, but can be excluded with the shut-off valve if the engine is in critical conditions; the high pressure port is open when the pressure coming from the intermediate stage is not adequate, or a considerable amount of air is necessary, and anyway the engine must be in operating conditions that cannot be deteriorated by intensive air bleeding.

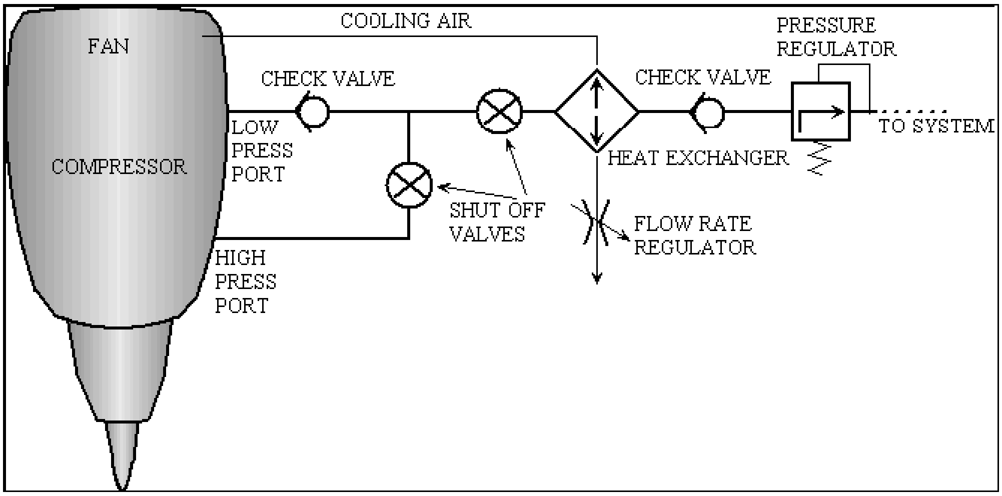


Figure 3.1 Compressed air generation

<u>Exercise:</u> Interpretation of words and phrases: Circle the letter next to the best answer.

1. Air is ***present*** at high pressures and temperatures and then, after regulation, can be used for heating and pressurization.
   A) To heat
   B) To exist
   C) To blow

2. Windscreen ***demisting*** and rain dispersal.
   A) Clearing
   B) Breaking
   C) Opening

3. From one or more stages of the compressor, a limited volume of air can be bled without ***significant*** degradation of the engine performances.
   A) Changeable
   B) Important
   C) Low

4. Two remarks are ***relevant*** for this kind of compressed air generation.
   A) Useable
   B) Important
   C) Appropriate

5. These vary from ***idle*** to max thrust.
   A) Not active
   B) Little
   C) Medium

6. The low pressure bleeding port is normally open, but can be ***excluded*** with the shut-off valve if the engine is in critical conditions
   A) Shut out
   B) Finished
   C) Sucked

7. The high pressure port is open when the pressure coming from the intermediate stage is not ***adequate.***

A) Well
B) Enough
C) Fresh

<u>Exercise:</u> Vocabulary

Use each word or phrase in a sentence.

1. Especially
2. Depend on
3. Condition
4. Considerable
5. Deteriorate

3.2. Air Conditioning And Pressurization

Air conditioning includes heating, cooling, ventilation, moisture/contaminant control, temperature control, distribution, and cabin pressure control. Common systems are the air conditioning system (ACS) and the cabin pressure control system (CPCS).

Air cycle refrigeration is the predominant means of air conditioning for commercial and military aircraft of all types. The aircraft air cycle air conditioning system utilizes the high-pressure air extracted from the gas turbine engine compressor to satisfy the aircraft ventilation, heating, cooling and pressurization requirements. A water separator removes moisture condensed during the refrigeration process. The refrigerated air is then delivered to the aircraft compartments to cool, pressurize and ventilate these areas with fresh air.

The cabin pressure control system includes the outflow valves, controller, selector panel and redundant positive pressure relief valves. This system controls cabin pressure by modulating the airflow discharged from the pressurized cabin through one or more cabin outflow valves.

It is necessary to become familiar with some terms and definitions to understand the operating principles of pressurization and air conditioning systems. These are:

1. Aircraft altitude: The actual height above sea level at which the airplane is flying.
2. Ambient temperature: The temperature in the area immediately surrounding the airplane.
3. Ambient pressure: The pressure in the area immediately surrounding the airplane.
4. Cabin altitude: Used to express cabin pressure in terms of equivalent altitude above sea level.

5. Differential pressure: The difference in pressure between the pressure acting on one side of a wall and the pressure acting on the other side of the wall. In aircraft air conditioning and pressurizing systems, it is the difference between cabin pressure and atmospheric pressure.

The cabin pressure control system provides cabin pressure regulation, pressure relief, vacuum relief, and the means for selecting the desired cabin altitude in the isobaric and differential range. In addition, dumping of the cabin pressure is a function of the pressure control system. A cabin pressure regulator, an outflow valve, and a safety valve are used to accomplish these functions.

The cabin air pressure safety valve is a combination pressure relief, vacuum relief, and dump valve. The pressure relief valve prevents cabin pressure from exceeding a predetermined differential pressure above ambient pressure. The vacuum relief prevents ambient pressure from exceeding cabin pressure by allowing external air to enter the cabin when ambient pressure exceeds cabin pressure. The dump valve is actuated by the cockpit control switch. When this switch is positioned to "ram," a solenoid valve opens, causing the valve to dump cabin air to atmosphere.

The degree of pressurization and, therefore, the operating altitude of the aircraft are limited by several critical design factors. Primarily the fuselage is designed to withstand a particular maximum cabin differential pressure.

<u>Exercise:</u> Interpretation of words and phrases: Circle the letter next to the best answer.

1. It utilizes the high-pressure air extracted from the gas turbine engine compressor to ***satisfy*** the aircraft ventilation, heating, cooling and pressurization requirements.
   A) To unbind something
   B) To fulfill requirements
   C) To loosen something

2. A water separator removes moisture condensed during the ***refrigeration*** process.
   A) Taking care
   B) Preserving
   C) Cooling

3. The refrigerated air is then ***delivered*** to the aircraft compartments to cool, pressurize and ventilate these areas with fresh air.
   A) Sent
   B) Cleared
   C) Blown

4. The cabin pressure control system includes ***redundant*** positive pressure relief valves.
   A) Less than is needed
   B) More than is needed
   C) Amount almost is needed

5. It is necessary to become ***familiar*** with some terms and definitions.
   A) Together
   B) Well known
   C) Foreigner

6. The pressure in the area ***immediately*** surrounding the airplane.
   A) Urgently
   B) Slowly
   C) Definitely

7. A cabin pressure regulator, an outflow valve, and a safety valve are used to ***accomplish*** these functions.
   A) Order
   B) Have
   C) Realize

8. Primarily the fuselage is designed to withstand a particular maximum cabin differential pressure.
   A) Go straight
   B) Endure
   C) Go beyond

<u>Exercise:</u> Vocabulary

Use each word or phrase in a sentence.

1. Commercial
2. Include
3. Desire
4. Safety
5. several

3.3. Safety And Warning Devices, Smoke Detection And Fire Protection Systems

Figure 3.2: Safety is very important for an aircraft

Aircrafts contain redundant systems for navigating and communicating. For navigation, there are electronic gyro compasses as well as old-fashioned mechanical compasses as backups. Dual flight management computers make the pilots aware of all aspects of the flight path - where the airplane is at all times and where it is going. Global Positioning Systems today enable aircrafts to navigate via satellite for extremely safe and efficient travel. For communication, there are several kinds of radios, with backups.

3.3.1. Controlling Attitude And Direction

Flight controls facilitate communication between pilot and co-pilot. The pilot cannot move the control stick without the co-pilot knowing it because their controls are linked together.

In addition, there are redundant controls from the pilot to the airplane. The sensors on the airplane that transmit speed, attitude and stability information back to the pilot also are redundant. (Attitude is the airplane's spatial orientation - its variations in yaw, pitch and roll.)

There are also many warning systems on aircrafts that alert pilots for changing situations - with voice commands, horns, buzzers, lights and vibrations.

3.3.2. Descending

For many years, aircrafts' fleets have relied on the ground-proximity warning system (GPWS) to help keep pilots from inadvertently hitting the ground at night or in bad weather. Since its introduction, GPWS has reduced the incidence of controlled flight into terrain accidents, a leading cause of aircraft losses.

Today, a newer version of GPWS is being phased in. The terrain avoidance warning system combines precise GPS navigation and digital three-dimensional terrain data to create a better warning device.

3.3.3. Warning Systems

In addition to ground-proximity warning systems, aircrafts have systems and procedures to help them avoid collisions and wind shear.

The **traffic alert and collision avoidance system** (TCAS) is an excellent example of how technology can make aviation safer.

TCAS takes advantage of the fact that all commercial aircrafts are equipped with radar transponders. When scanned by ground-based air traffic control radar, these units send altitude, heading, speed and other flight information that controllers see on their screens. TCAS interrogates the transponders of nearby aircraft and uses their responses to look for potential collisions. If TCAS detects a potential problem, it issues warnings to the airplanes and provides directions to help the flight crews steer away from the other airplane.

Wind shear is a sudden change in the wind's speed or direction. Wind shear often involves strong side-by-side updrafts and downdrafts and may occur in conjunction with a thunderstorm or other bad weather. It can have potentially disastrous consequences for an airplane if encountered near the ground. Appearing with little or no warning, low-level wind shear can overwhelm an airplane's ability to safely descend or climb.

The aviation industry has had great success dealing with wind shear. The rate of wind shear accidents has dropped dramatically in recent decades because of

- Specialized training and procedures -- flight crews today know how to fly safely out of wind shear, and they practice these skills in simulators.
- Reactive alerting -- this onboard function warns flight crews when an aircraft is entering possible wind shear conditions.
- Predictive alerting -- this new system looks ahead with special radar to warn of possible wind shear before it's encountered, so pilots can steer around it.
- Ground-based Doppler radar -- more and more airports are getting this special radar, which detects some forms of wind shear.

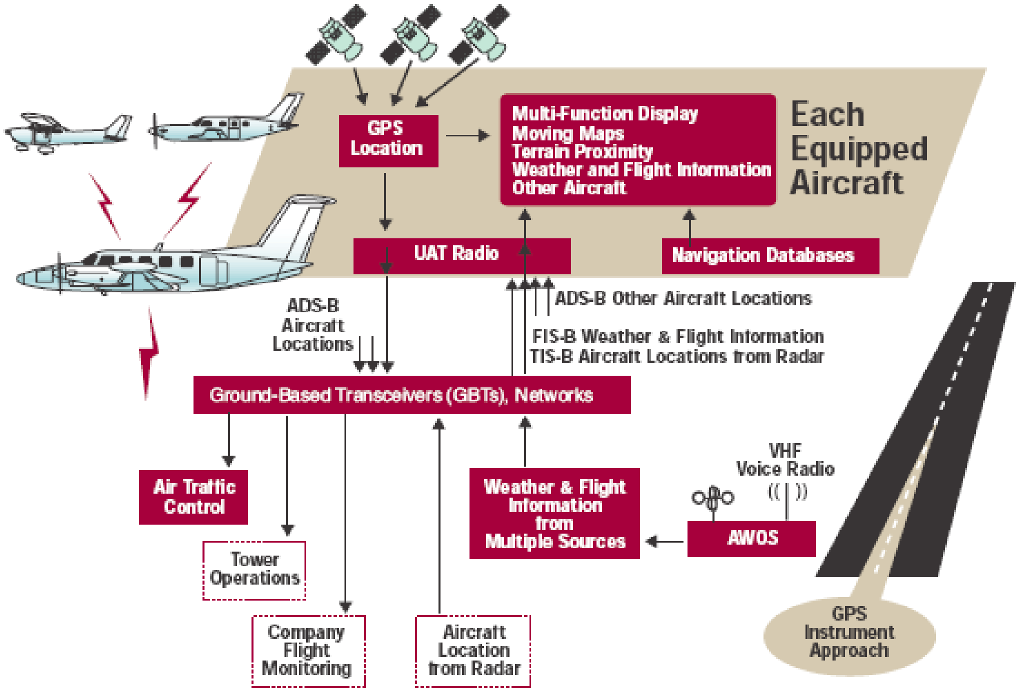


Figure 3.3: Air safety systems

Other aircraft components equipped by manufacturers for general aviation to make flying safer.

3.3.4. Landing Gear Warning Systems

An aircraft's gear alert system is an electronic gear warning device that senses the presence of the ground when landing. If the system determines that the aircraft is close to the ground, and the wheels are still retracted, it provides an instantly recognizable voice warning directly in the pilot's headset and through its built in speaker alerting of the problem .The unit also connects to the existing aircraft stall warning system. Anytime the existing stall horn sounds, the pilot will hear a separate voice message in his headset.

The system consists of 3 components, a ground sensing transducer (approximately 3 inch by 4 ½ inch by 1inch) that mounts on the belly of the aircraft, a small electronic unit that mounts anywhere in the aircraft, and a small switch that mounts in the instrument panel.

3.3.5. Low Voltage, & Low Vacuum or Pressure Warning System

An aircraft's Volt & Vac. Alert consists of a small electronic unit that can be mounted anywhere in the aircraft. It connects to aircraft voltage, instrument power (vacuum or pressure), and the aircraft audio system. A small red light is also mounted on the instrument panel within the pilots normal gyro scan. Should the gyro power fail, the pilot will hear the voice message "CHECK GYROS, CHECK GYROS" directly in his headset. The voice message will sound once, and then the red warning light will illuminate until the problem is fixed.

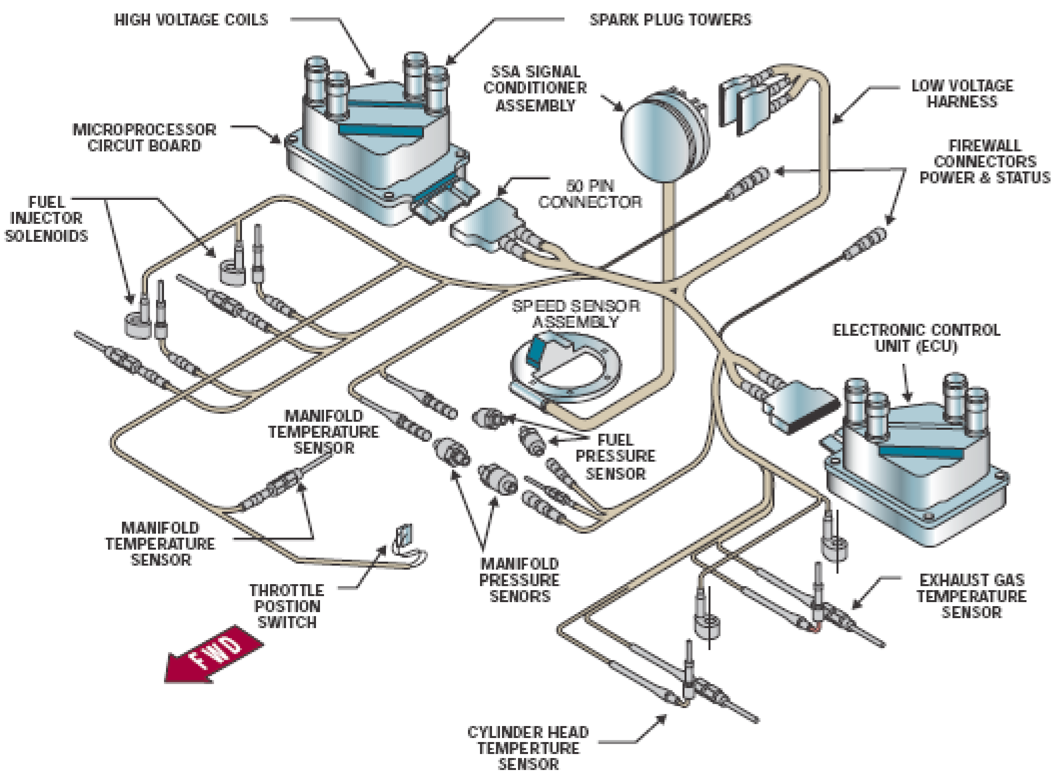


Figure 3.4: Aviation sensoring systems

3.3.6. Voice for Stall and Gear Warning

Voice Alert provides instantly recognizable voice warnings directly in pilot’s headset. Whenever the existing stall horn sounds, the pilot will hear the instantly recognizable voice message "STALL, STALL" from the speaker, if the gear warning horn sounds, the pilot will hear the voice message "CHECK LANDING GEAR, CHECK LANDING GEAR" alerting of the problem or gear horn sounds.

3.3.7. Engine Saving Systems & Accessories

Aircraft owners know that an aircraft not flown regularly is subject to rusting of the internal engine parts. This rust causes engine wear and shortens engine life. Water collects in the engine from two sources. First, moisture is a byproduct of combustion. When you shut your engine down, the crankcase is filled with hot gasses containing a high percentage of moisture. As the engine cools, this moisture condenses and water forms. (This is why you see water droplets on the dipstick cap when checking the oil level.) Secondly, daily changes in temperature, humidity, and barometric pressure force moist air into the engine. Cool evening temperatures then cause this moist air in the engine to condense forming droplets on the precision engine parts. Over time this moisture leads to rust. Cool air temperatures that occur in the early morning cool the metal engine parts. Whenever the temperature of the metal parts falls below the dew point temperature of the moist air inside the engine, water droplets form. If you can reduce the humidity level of the air inside the engine, (lower its dew point temperature below the outside air temperature,) you can prevent water from ever forming on the engine parts. This is what the Engine Saver does. Oil companies spend millions on developing additives to protect the engine parts from the water droplets and prevent rust formation. However, the best way to protect your engine from internal rust is to prevent moisture from forming in the first place. - No water, No rust!

The Engine Saver is an electrically powered device that produces a constant supply of very low humidity, low pressure air. The system builds up a slight pressure in the crankcase. this fills the crankcase with dry air, and the pressure forces the dry air past the piston ring end gap, into the top cylinder area, and finally out an open intake or exhaust valve. The system bathes the entire internal surfaces of the engine with low humidity air preventing the formation of water.

3.3.8. Altitude Alert

An aircraft's altitude alert is a pocket sized, portable, battery powered device that provides a pilot with a visual and a voice warning as the aircraft approaches a pre-selected altitude, or drifts from an assigned altitude. The unit incorporates a digital LCD display for readout of altitude and instructions. Simple switch operations allow setting the current barometric pressure, as well as the assigned altitude for climb or descent. The unit incorporates a speaker to play the voice messages. A cable assembly is also included allowing the voice messages to also play through the pilots headset.

3.3.9. Wireless Smoke Detection and Fire Protection System

The fire protection of aircraft lavatories is realized by a scattering light smoke detector near the air extraction and an automatic fire extinguisher in the receptacle.

System features wireless sensors, for quicker installation and easier maintenance than traditional wired systems. The sensors communicate with the central control unit of the system using Spread Spectrum RF, which is extremely resistant to signal interference, and which will not interfere with other onboard systems.

Requirements for Fire Protection Systems: Fire warning system must provide an immediate warning of fire or overheat by means of a red light and an audible signal in the flight deck. The system must accurately indicate that a fire had been extinguished and indicate if the fire re-ignites. The system must be durable and resistant to damage from all the environmental factors that may exist in the location where it is installed.

The system must include an accurate and effective method for testing to assure system integrity and it must be easily inspected, removed and installed.

3.3.9.1. Thermo-Switch System:

A circuit in which one or more thermal switches are connected to an electrical circuit with a warning horn and an aural alarm to alert the flight crew that an over-heat condition is present. If more than one thermal switch is used they are connected in parallel, so closing of any one switch will provide warning.

The thermal switch, sometimes called a spot detector, works by expansion of the outer casing in the unit. When exposed to heat the casing becomes longer, causing the two contacts inside to meet, thus closing the circuit. Closing the circuit activates the warning system on the flight deck.

3.3.9.2. Thermocouple System

It is also called a “rate of rise” detection system. A circuit where one or more thermocouples are connected in series to activate an alarm when there is a sufficient temperature increase at the sensor. Thermocouples are made of two dissimilar metals which are twisted together inside an open frame. The frame allows air to flow over the wires without exposing the wires to damage. The exposed wires make a hot junction. The cold junction is located under the insulating material in the sensor unit. When there is a difference in temperature a current about 4 mA is created. The current created sets off a sensitive relay activating the alarm. If the temperature rise is slow so that the cold junction heats up along with the hot junction then the relay will not be activated.

3.3.9.3. Fenwal System

This is continuous loop system and it consists of small, lightweight, flexible Inconel tube with a pure nickel conductor wire-center conductors. The space between the nickel conductor and tubing wall is filled with porous aluminum-oxide, ceramic insulating material.

Any voids or clearances are saturated with a eutectic salt mixture which has a low melting point. The tube is hermetically sealed at both ends with insulating material and threading fittings. When heated sufficiently, current can flow between the center wire and the tube wall because the eutectic salt melts, and the resistance drops rapidly. The increased current flow provides a signal which is used in the control unit to sound the alarm system. Once the fire is extinguished or the over-heat condition is corrected the eutectic salt increases its resistance and the system will return to a stand-by mode.

3.3.9.4. Kidde System

This also is continuous loop system and utilizes an Inconel tube with transmistor material embedded with two electrical conductors. One conductor is grounded to the outer shell at the end of the tube. When heated the transmistor material drops in resistance. The change in resistance is sensed by the electronic control circuit monitoring the system and sends a warning signal to illuminate the fire warning light and activate the aural warning device. When the condition is corrected the system returns to stand-by mode.

The sensing element in the Kidde system is unique because it consists of two wire conductors. The wire conductors are on two different circuits and allow for complete system redundancy. The control unit is a transistorized electronic device.

3.3.9.5. Pneumatic System

This is continuous-length system. The sensing element consists of a stainless steel tube containing two separate gases plus a gas absorption material in the form of wire inside the tube. Normally the tube is filled with helium gas under pressure. The titanium center wire, which is the gas absorption material, contains hydrogen gas.

The wire is wrapped in a helical fashion with an inert metal tape for stabilization and protection. Gaps between the turns of tape allow for rapid release of the hydrogen gas from the wire when the temperature reaches the required level.

The sensor acts in accordance with the law of gases. If the volume is held constant, its pressure will increase as temperature increases. The helium gas in the tube exerts a pressure which closes the pneumatic switch and operates the warning system. After the situation is corrected the titanium reabsorbs the hydrogen and the system returns to a stand-by mode.

3.3.10. Camera System

A kind of camera system is used for applications in flight safety, security, ground maneuvering, and in-flight entertainment. A typical system consists of a total of six camera inputs. It connects the system to the aircraft power and the video distribution system.

Control of the system can be accomplished via RS-485 data bus from the cabin video control system or by keyline control from switch closure to ground.

<u>Exercise:</u> Interpretation of words and phrases: Circle the letter next to the best answer.

1. For communication, there are ***several*** kinds of radios, with backups.
   A) Useful
   B) Important
   C) Many

2. There are also many warning systems on aircrafts that ***alert*** pilots for changing situations.
   A) Warn
   B) Sound
   C) Force

3. The terrain avoidance warning system combines ***precise*** GPS navigation and digital three-dimensional terrain data to create a better warning device.
   A) Modern
   B) Huge
   C) Sensitive

4. It can have potentially ***disastrous*** consequences for an airplane if encountered near the ground.
   A) Awful
   B) Unlucky
   C) Have ill

5. Appearing with little or no warning, low-level wind shear can ***overwhelm*** an airplane's ability to safely descend or climb.
   A) Arrange
   B) Get better
   C) Affect

6. The aviation industry has had great success ***dealing with*** wind shear.
   A) Prevent
   B) Struggle
   C) Handle

7. An aircraft's gear alert system is an electronic gear warning device that senses the ***presence*** of the ground when landing.
   A) Existence
   B) Approach
   C) Touch

8. When you shut your engine down, the crankcase is filled with hot gasses containing a high percentage of moisture.
   A) Flying
   B) Including
   C) Dropping

9. If you can reduce the ***humidity*** level of the air inside the engine, you can prevent water from ever forming on the engine parts.
   A) Moisture
   B) Freeze
   C) Drying

10. The system builds up a ***slight*** pressure in the crankcase.
   A) Hard
   B) Soft
   C) Not heavy

11. It must be easily ***inspected***, removed and installed.
   A) Controlled
   B) Explored
   C) Used

12. The tube is ***hermetically*** sealed at both ends with insulating material and threading fittings.
   A) Compressed
   B) Doesn't let air to pass.
   C) Closed hardly

13. Gaps between the turns of tape allow for rapid release of the hydrogen gas from the wire when the temperature ***reaches*** the required level.
   A) Arrives
   B) Heats
   C) Increases

<u>Exercise:</u> Vocabulary

Use each word or phrase in a sentence.

1. Rely on
2. Aware
3. Stable
4. Disastrous
5. Illuminate
6. Interference
7. Sensitive
8. Consist of

3.4. Flight Instruments

Figure 3.5: A part of instrument panel

Most aircrafts are equipped with a standard set of flight instruments which give the pilot information about the aircraft's attitude, airspeed, and altitude.

Most aircrafts have these seven basic flight instruments:

3.4.1. Altimeter

The altimeter gives the aircraft's height (usually in feet or meters) above some reference level (usually sea-level) by measuring the local air pressure. It is adjustable for local barometric pressure (referenced to sea level) which must be set correctly to obtain accurate altitude readings.

Figure 3.6: Barometric aircraft altimeter

3.4.2. Attitude indicator (also known as artificial horizon)

It shows the aircraft's attitude relative to the horizon. From this the pilot can tell whether the wings are level and if the aircraft nose is pointing above or below the horizon. This is a primary instrument for flight and is also useful in conditions of poor visibility. Pilots are trained to use other instruments in combination should this instrument or its power fail.

Figure 3.7: Attitude indicator

3.4.3. Airspeed Indicator

It shows the aircraft's speed (usually in knots) relative to the surrounding air. It works by measuring the ram-air pressure in the aircraft's pitot tube. A **Pitot tube** is a measuring instrument used to measure fluid flow, and more specifically, used to determine airspeed on aircraft.

The indicated airspeed must be corrected for air density (which varies with altitude, temperature and humidity) in order to obtain the true airspeed, and for wind conditions in order to obtain the speed over the ground.

Figure 3.8: Airspeed indicator

3.4.4. Magnetic Compass

It shows the aircraft's heading relative to magnetic north. While reliable in steady level flight, it can give confusing indications when turning, climbing, descending, or accelerating due to the inclination of the earth's magnetic field. For this reason, the heading indicator is also used for aircraft operation. For purposes of navigation it may be necessary to correct the direction indicated (which points to a magnetic pole) in order to obtain direction of true north or south (which points to the earth's axis of rotation).

Figure 3.9: A compass in a wooden box

3.4.5. Heading Indicator

Also it is known as the directional gyro, or DG. Sometimes it is also called the gyrocompass, though usually not in aviation applications. It displays the aircraft's heading with respect to magnetic north. Principle of operation is a spinning gyroscope, and is therefore subject to drift errors (called precession) which must be periodically corrected by calibrating the instrument to the magnetic compass. In many advanced aircraft, the heading indicator is replaced by a horizontal situation indicator which provides the same heading information, but also assists with navigation.

Figure 3.10: Heading indicator

3.4.6. Turn and Bank Indicator or Turn Coordinator

Turn and bank indicator is also called the turn and slip indicator. It displays direction of turn and rate of turn. Internally mounted inclinometer displays 'quality' of turn, i.e. whether the turn is correctly coordinated, as opposed to an uncoordinated turn, wherein the aircraft would be in either a slip or a skid. Replaced in the late sixties and early seventies by the newer turn coordinator, the turn and bank is typically only seen in aircraft manufactured prior to that time.

Turn coordinator Displays rate and direction of roll while the aircraft is rolling; displays rate and direction of turn while the aircraft is not rolling. Internally mounted inclinometer also displays quality of turn. It replaced the older turn and bank indicator.

3.4.7. Vertical Speed Indicator

It is also sometimes called a variometer. Senses changing air pressure and displays that information to the pilot as a rate of climb or descent, usually in feet per minute or meters per second.

Figure 3.11 Vertical speed indicator

3.4.8. Arrangement In Instrument Panel:

Most aircraft built since about 1953 have four of the flight instruments located in a standardized arrangement known as the "basic T". The attitude indicator is in top center, airspeed to the left, altitude to the right and heading indicator under the attitude indicator. The other two, turn-coordinator and vertical-speed are usually found under the airspeed and altitude. The magnetic compass will be above the instrument panel, often on the windscreen centerpost.

<u>Exercise:</u> Interpretation of words and phrases: Circle the letter next to the best answer.

1. It is adjustable for local barometric pressure which must be set correctly to obtain ***accurate*** altitude readings.
   A) Near
   B) Absolute
   C) Around

2. It shows the aircraft's attitude ***relative*** to the horizon.
   A) Pointed
   B) Near
   C) Acute

3. Pilots are ***trained*** to use other instruments in combination should this instrument or its power fail.
   A) Educated
   B) Failed
   C) Learned

4. It can give ***confusing*** indications when turning, climbing, descending, or accelerating due to the inclination of the earth's magnetic field.
   A) Simple
   B) Interesting
   C) Mind-bending

5. For this reason, the heading ***indicator*** is also used for aircraft operation.
   A) Section
   B) Pointer
   C) Location

6. For ***purposes*** of navigation it may be necessary to correct the direction indicated in order to obtain direction of true north or south
   A) Causes
   B) Results
   C) Necessities

7. It subjects to ***drift*** errors (called precession) which must be periodically corrected by calibrating the instrument.
   A) Connecting
   B) Measure
   C) Deviated

<u>Exercise:</u> Vocabulary

Use each word or phrase in a sentence.

1. Equip
2. Obtain
3. Specific
4. Climb
5. Principle
6. Assist

3.5. Electrical Power Unit

Figure 3.12: Electrical Power unit

As aircraft fly higher, faster and grow larger, the services that the power supply has to satisfy also grow more complex. In civil aircraft this means more power to the galley units, environmental control and passenger entertainment systems, while military aircraft require more power sensors and weapon systems. Both have increased power demands for actuators, lighting systems, avionics and heating.

There are several different power sources on aircraft to power the aircraft electrical systems. These power sources include: engine driven AC generators, auxiliary power units (APUs (Figure 3.13)), external power and ram air turbines.

The primary function of an aircraft electrical system is to generate, regulate and distribute electrical power throughout the aircraft. The aircraft electrical power system is used to operate

a) Aircraft flight instruments,
b) Essential systems such as anti-icing etc. and
c) Passenger services.

Essential power is power that the aircraft needs to be able to continue safe operation.

Passenger services power is the power that is used for cabin lighting, operation of entertainment systems and preparation of food.

Figure 3.13 Auxiliary Power Unit (APU)

Aircraft electrical components operate on many different voltages both AC and DC. However, most of the aircraft systems use 115 volts (V) AC at 400 hertz (Hz) or 28 volts DC. 26 volts AC is also used in some aircraft for lighting purposes. DC power is generally provided by "self-exciting" generators containing electromagnetics, where the power is generated by a commutator which regulates the output voltage of 28 volts DC. AC power, normally at a phase voltage of 115 V, is generated by an alternator, generally in a three-phase system and at a frequency of 400 Hz.

Higher than usual frequencies, such as 400 Hz, offer several advantages over 60 Hz – notably in allowing smaller, lighter power supplies to be used for military hardware, commercial aircraft operations and computer applications. As aircraft space is at a premium and weight is critical to aircraft engine thrust and fuel burn (and thus the aircraft range and engine horsepower per pound), 115 volts at 400 Hz offers a distinct advantage and is much better than the usual 60 Hz used in utility power generation.

However, higher frequencies are also more sensitive to voltage drop problems. There are two types of drops: resistive and reactive. Resistive losses are a function of current flowing through a conductor with respect to the length and size of the conductor. This is the most important factor in controlling resistive power loss and applies regardless of frequency. The short transmission range of higher frequencies is not a factor in most airborne applications.

Reactive drops, on the other hand, are caused by the inductive properties of the conductor. Reactive drops are a function of both cable length and the AC frequency flowing through the conductor. With high frequencies such as 400 Hz, reactive drops are up to seven times greater at 60 Hz.

This raises an interesting question: can you run a 400 Hz device at 60 Hz? If you try this, smoke and fire are certain to result. The lower winding inductance draws a much higher current at a set voltage, saturates the iron, and burns up. However, there is a simple workaround using fundamental principles of flux density. A 400 Hz device will usually run just fine on 60 Hz if you lower the voltage to 60/400ths or 0.15. The same current will produce the same magnetic flux, and the device will operate properly.

<u>Exercise:</u> Interpretation of words and phrases: Circle the letter next to the best answer.

1. In civil aircraft this means more power to the galley units, environmental control and passenger ***entertainment*** systems.
   A) Creation
   B) Struggle
   C) Fun

2. While military aircraft require more power sensors and ***weapon*** systems.
   A) Light
   B) Gun
   C) Electricity

3. The primary function of an aircraft electrical system is to generate, regulate and distribute electrical power ***throughout*** the aircraft.
   A) Some parts
   B) Ceiling
   C) All along

4. The aircraft electrical power system is used to operate ***essential*** systems.
   A) Very necessary
   B) Connected
   C) Useful
5. Higher than ***usual*** frequencies, such as 400 Hz, offer several advantages over 60 Hz
   A) High
   B) Low
   C) Common

6. 115 volts at 400 Hz offers a ***distinct*** advantage and is much better than the usual 60 Hz used in utility power generation.
   A) Sharp
   B) Obvious
   C) Definite

7. The same current will produce the same magnetic flux, and the device will operate ***properly***.
   A) Suddenly
   B) Well
   C) Rationally

8. However, there is a simple workaround using ***fundamental*** principles of flux density.
   A) Basic
   B) Usual
   C) Confusing

Exercise: Vocabulary

Use each word or phrase in a sentence.

1. Complex
2. Avionics
3. Distribute
4. Throughout
5. Premium

3.6. Aviation Fuel

Figure 3.14: A plane having filled fuel

Many parts of a successful aircraft are easily visible—the control surfaces, engines, wings, fuselage, and structure for instance. But the fuel that powers the engines is equally important, though not nearly as visible. Aircraft engines, from powerful piston engines to jet turbines, have always required a more sophisticated form of fuel than most ground vehicles, and the technological development of this fuel to power the engines is just as significant as other technological advances.

For the first few decades of flight, aircraft engines simply used the same kind of gasoline that powered automobiles. But simple gasoline was not necessarily the best fuel for the large, powerful engines used by piston-driven airplanes that were developed in the 1930s and 1940s.

Before World War II, Major Jimmie Doolittle realized that if the United States got involved in the war in Europe, it would require large amounts of aviation fuel with high octane. Doolittle was already famous in the aviation community as a racing pilot and for his support of advanced research and development in the 1930s; he headed the aviation fuels section of the Shell Oil Company.

Fuel is rated according to its level of octane. High amounts of octane allow a powerful piston engine to burn its fuel efficiently, a quality called "anti-knock" because the engine does not misfire, or "knock." At that time, high-octane aviation gas was only a small percentage of the overall petroleum refined in the United States. Most gas had no more than an 87 octane rating. When the United States entered the war in late 1941, it had plenty of high-quality fuel for its engines, and its aircraft engines performed better than similarly sized engines in the German Luftwaffe's airplanes. Engine designers were also encouraged by the existence of high-performance fuels to develop even higher-performance engines for aircraft.

A major problem with gasoline is that it has what is known as a low "flashpoint." This is the temperature at which it produces fumes that can be ignited by an open flame. Gasoline has a flashpoint of around 30 degrees Fahrenheit (-1 degree Celsius). This makes fires much more likely in the event of an accident. So engine designers sought to develop engines that used fuels with higher flashpoints.

The invention of jet engines created another challenge for engine designers. They did not require a fuel that vaporized (turned to a gaseous state) as easily as AvGas, but they did have other requirements. Instead of using gasoline, they chose kerosene or a kerosene-gasoline mix. The first jet fuel was known as JP-1 (for "Jet Propellant"), but the U.S. military soon sought fuels with better qualities. They wanted fuels that did not produce visible smoke and which were also less likely to produce contrails (the visible trail of condensed water vapor or ice crystals caused when water condenses in aircraft exhaust at certain altitudes). But a major requirement was for fuels that did not ignite at low temperatures in order to reduce the chance of fire.

Certain types of aircraft operations also demanded that specific types of fuel be available. For instance, the U.S. Navy had to carry large amounts of fuel for the planes and helicopters on its aircraft carriers. When most of the aircraft were piston-driven, they carried AvGas, which had a low flashpoint and was therefore dangerous to have on board because it could easily catch fire. The advent of jets led the Navy to seek jet propellant that had a higher flashpoint than JP-1. Whereas most Air Force aircraft soon used a kerosene-gasoline mix called JP-4, which already had a higher flashpoint than standard AvGas, the Navy developed a fuel known as JP-5 with an even higher flashpoint than JP-4. It also sought to retire aircraft that used AvGas. Fortunately, the introduction of turbine engines on helicopters and for propeller-driven airplanes also reduced the Navy's need for AvGas. Navy leaders are extremely safety-conscious about fuels. When a Navy jet is refueled in flight by an Air Force tanker with Air Force fuel, safety rules prohibit the plane from being stored below deck on the ship when it lands.

Commercial jet fuel, known as Jet-A, is pure kerosene and has a flashpoint of 120 degrees Fahrenheit (49 degrees Celsius). It is a high-quality fuel, however, and if it fails the purity and other quality tests for use on jet aircraft, it is sold to other ground-based users with less demanding requirements, like railroad engines. Commercial jet fuel as well as military jet fuel often includes anti-freeze to prevent ice buildup inside the fuel tanks.

The development of the A-12 OXCART spyplane in the late 1950s created another problem for aircraft and engine designers. The high speeds reached by the A-12 would cause the skin of the aircraft to get hot. Temperatures on the OXCART ranged from 462 to 1,050 degrees Fahrenheit (239 to 566 degrees C). The wings, where the fuel was stored, had external temperatures of more than 500 degrees Fahrenheit (260 degrees C). Even with the lower flashpoint, fuel stored in the wings could explode. As a result, the engine designers at Pratt & Whitney sought a fuel with an extremely high flashpoint. Working with the Ashland Shell and Monsanto companies, the engine designers added fluorocarbons to increase lubricity (or slipperiness), and other chemicals to raise the flashpoint. The resulting fuel was originally known as PF-1 but later renamed JP-7. It was used only by the A-12 OXCART (and its sister YF-12 interceptor) and later the SR-71 Blackbird. JP-7 has such a high flashpoint that a burning match dropped into a bucket of it will not cause it to ignite.

Engine designers and fuel chemists created JP-7 with a high flashpoint that would not explode in the aircraft's tanks, but this also made the fuel hard to ignite within the engines themselves. Because JP-7 is so hard to ignite, particularly at the low pressures encountered at high altitudes, these planes used a special chemical called tri-ethyl borane (TEB), which burns at a high temperature when it is oxidized (combined with air). Another problem that the A-12 encountered was that the engine exhaust (particularly shock waves created in the exhaust when the engines were at full afterburner) was easily seen by radar. The engine designers added an expensive chemical known as A-50, which contained cesium, to the fuel for operational flights that reduced its ability to be detected by radar.

<u>Exercise:</u> Interpretation of words and phrases: Circle the letter next to the best answer.

1. Many parts of a successful aircraft are easily ***visible***.
A) Can be moved
B) Can be used
C) Can be seen

2. The control surfaces, engines, wings, fuselage, and structure ***for instance***.
A) For example
B) Suddenly
C) Of parts

3. They have always required a more ***sophisticated*** form of fuel than most ground vehicles.
A) Different
B) Liquid
C) Complicated

4. For the first few ***decade***s of flight, aircraft engines simply used the same kind of gasoline that powered automobiles.
A) A long period
B) 10 Years
C) A couple of years

5. Before World War II, Major Jimmie Doolittle realized that if the United States got ***involved*** in the war in Europe, it would require large amounts of aviation fuel with high octane.
A) Included
B) Suffered
C) Damaged

6. This is the temperature at which it produces fumes that can be ignited by an open flame.
A) Heated
B) Burned
C) Neglected

7. So engine designers ***sought*** to develop engines that used fuels with higher flashpoints.
A) Searched
B) Started
C) Needed

8. Even with the lower flashpoint, fuel stored in the wings could ***explode.***
   A) Leak
   B) Fire
   C) Detonate

<u>Exercise:</u> Vocabulary

Use each word or phrase in a sentence.

1. Vehicle
2. Famous
3. Convince
4. Encourage
5. Prohibit

3.7. Hydraulic and Some Facts about Aviation Oil

3.7.1. Hydraulic

All modern naval aircraft contain hydraulic systems that operate various mechanisms. The number of hydraulically operated units depends upon the model of aircraft. The average operational aircraft has about a dozen hydraulically operated units. Aircraft hydraulic systems are designed to produce and maintain a given pressure over the entire range of required fluid flow rates. The pressure used in most Navy high-performance aircraft is 3,000 psi. The primary use of hydraulic fluids in aircraft hydraulic systems is to transmit power, but hydraulic systems perform other functions. Hydraulic fluid acts as a lubricant to reduce friction and wear. Hydraulic fluid serves as a coolant to maintain operating temperatures within limits of critical sealant materials, and it serves as a corrosion and rust inhibitor. Critical functions of hydraulic systems maybe impaired if the hydraulic system fluid is allowed to become contaminated beyond acceptable limits.

Hydraulic fluid contamination is defined as any foreign material or substance whose presence in the fluid is capable of adversely affecting the system performance or reliability. Control consists of requirements, techniques, and practices that minimize and control fluid contamination. Remember the proverb, "An ounce of prevention is worth a pound of cure."

Hydraulic contamination in an aircraft and related support equipment (SE) is a major cause of hydraulic system and component failure. Every technician who performs hydraulic maintenance should be aware of the causes and effects of hydraulic contamination. You should follow correct practices and procedures to prevent contamination. Supervisory and quality assurance personnel must know and ensure compliance with accepted standards.

The general contamination control procedures hydraulic systems, subsytems, and testing of components and fluids are requirements for each maintenance level. Hydraulic fluid contamination controls ensure the cleanliness and purity of fluid in the hydraulic system. Fluid sampling and analysis is performed periodically. Checks are made sufficiently before the scheduled aircraft induction date so that if fluid decontamination is required, it may be accomplished at that time. The condition of the fluid depends, to a large degree, on the condition of the components in the system. If a system requires frequent component replacement and servicing, the condition of the fluid deteriorates proportionately. Replacement of aircraft hydraulic system filter elements takes place on a scheduled or conditional basis, depending upon the requirements of the specific system. A differential pressure flow check and bubble point test are performed to properly evaluate the condition of a cleanable filter element. These two checks are done to verify that the element is good before it is installed in a system or component. Many filter elements look identical, but all of them are not compatible with flow requirements of the system.

If the hydraulic system fluid is lost to the point that the hydraulic pumps run dry or cavitate, you should change the defective pumps, check filter elements, and decontaminate the system as required. Check the applicable MIM for corrective action to be taken regarding decontamination of the system. If this action is not taken, the complete system could be contaminated.

3.7.2. Some Facts about Aviation Oil

Figure 3.15: The oil used for aviation must be special for aircrafts

3.7.2.1. Oil Additives Wear Out

Technically, oil does not wear out. However, extended use causes oil's additives to wear out or become depleted. For example, ashless dispersant aviation oil is designed to suspend dirt and metal particles picked up from an aircraft engine. Eventually the oil will become "over-suspended." The principal reason oil is changed at regular intervals is to rid the engine of these suspended impurities. Old oil, with a high degree of contaminants, can cause bearing corrosion and deposit buildup. It can also get to the point where it will not suspend the additional particles created during engine operation. This produces particle buildup or sludge. Overworked oil will also result in the depletion of its other additives. The result is that it will be unable to perform with the benefits the additives were designed to provide.

3.7.2.2. Oil Removed During An Oil Change Should Appear Dirty.

If oil is doing its job properly, it should suspend dirt, metallic wear materials, and unburned carbon. Therefore, when you change your oil it should look much dirtier than it did when first added to the engine. An excellent method for monitoring oil's condition is through oil analysis, which can be a key to any preventive maintenance program. Oil analysis must be conducted regularly to establish trends of operation. It provides information on wear metals, viscosity integrity, fuel dilution, and air intake system leaks, among other things. As a long-term preventive maintenance tool, it will build a history of the engine's performance and aid in the detection of possible problems before they become severe.

3.7.2.3. Aircraft Engine Oil Should Be Changed Every 25 Operating Hours When Not Using An Oil Filter.

It is recommended changing aviation oil every 25 hours if an oil filter is not being used. If an oil filter is being used, it should be changed every 50 hours.

3.7.2.4. Off-the-shelf oil additives do not improve aircraft engine performance

Except in extremely rare instances, original engine manufacturers (OEMs) do not recommend using additives with aviation oil. Changing oil regularly is much more beneficial. Little is to be expected from the inclusion of aftermarket additives to approved oil, and no OEM recommends their use. These include additives that claim to fortify or enhance the oil's lubrication properties.

3.7.2.5. Fuel-Injected Engines Can Benefit From Multiviscosity Oil

Proponents of fuel-injected engines claim they start better in cold weather than a carbureted engine. For this reason, multiviscosity oil can be of great benefit to a fuel-injected engine because it can provide instant lubrication at cold start-up. Single- grade oil may not flow quickly enough to provide adequate lubrication at those low temperatures because it is too sluggish, creating excessive viscous drag. Approximately 85 percent of harmful engine wear occurs during the start-up phase.

3.7.2.6. Automotive Oil Should Never Be Used In An Airplane Engine

The most important reason not to use automotive oil in an aircraft engine is the number of additives in it that are designed for use in water-cooled engines operating within a certain range of temperatures and pressures and at constantly changing levels of power. Aircraft engines are air-cooled and operate under an entirely different set of parameters.

3.7.2.7. Oil's Viscosity Is Key To Its Performance

Viscosity plays a key role in preventing aircraft engine wear and is also important at low temperatures for pumpability. Viscosity determines how easy it is for oil to pump and move through lines and passages. The oil must be thick enough to keep moving parts from contacting each other, and thin enough to permit adequate flow and minimize viscous drag.

3.7.2.8. Using Multiviscosity Oil Can Decrease Oil Consumption

Multiviscosity oils reduce oil consumption rates. The three ways oil leaves an engine are base oil evaporation at high temperatures, leaks, and blow-by past the piston rings during operation. Because base oils for aviation lubricants are not formed from light base stocks, the evaporation factor is negligible. Multiviscosity oils do not thin out as much at high temperatures, helping to prevent excessive blow-by and/or leakage.

3.7.2.9. Engines Using A Straight Mineral Oil Can Easily Be Switched To Ashless Dispersant (AD) Oil

If the changeover is completed properly, there are no negative effects to switching from a straight mineral to AD oil, regardless of the number of operating hours accumulated. All AD aviation oils use the same base stock and additives. Therefore, AD oils will not cause sludge to move, blocking oil galleys. When switching from mineral to AD oils, a darkening of the oil as the dispersant suspends surface deposits can be expected at the first two oil changes. This poses no danger to the engine and means the oil is properly suspending engine-wear particles.

3.7.2.10. Aviation Oil Brands Vary Widely In Performance

All aviation oils provide some form of lubrication, but that's where the similarities end. Each manufacturer blends proprietary additives to enhance the oil and provide predictable performance characteristics for the end-user. Each oil's viscosity grade is designed to satisfy specific engine requirements. Using the right aviation oil for a specific aircraft engine can help improve engine efficiency.

3.7.2.11. Multiviscosity Mineral AD Oils Can Be Used To Seat New Piston Rings In A Newly Replaced Cylinder

Just as it is true that a multiviscosity mineral AD oil, it can also be used to seat piston rings in a new cylinder. In fact, it is a good practice for the operator to continue using a multiviscosity AD oil after the cylinder has been replaced because the cylinder will run hotter until the piston rings have seated. Engines run hotter during a replacement cylinder's ring seating process just as they do during the initial engine break-in period. This is due to increased friction between the cylinder bore and the piston rings and less heat transfers to the cooling fins. The metal-to-metal contact necessary for ring seating causes temperatures to rise within the cylinders.

3.7.2.12. Synthetic Oils Do Not Show Superior Performance When Used In Piston-Powered Aircraft

The decision to use synthetic oils should be based on the expected use of the oil. Since synthetics cost at least twice as much as mineral oil-based products, there is a tendency on the part of the operator to expect them to outperform in all circumstances. In a piston engine aircraft environment, however, the favorable properties of synthetic oils are marginal. Supporters of synthetic oils have basically two main claims: one, they increase time between oil changes and second, they improve startability at extreme low temperatures.

<u>Exercise:</u> Interpretation of words and phrases: Circle the letter next to the best answer.

1. Aircraft hydraulic systems are designed to produce and ***maintain*** a given pressure over the entire range of required fluid flow rates.
   A) Supply
   B) Flood
   C) Handle

2. The primary use of hydraulic fluids in aircraft hydraulic systems is to transmit power, but hydraulic systems ***perform*** other functions.
   A) Prevent
   B) Do
   C) Cause

3. Hydraulic fluid serves as a coolant to maintain operating temperatures within limits of critical sealant materials, and it serves as a corrosion and rust ***inhibitor***.
   A) Required
   B) Maker
   C) Preventive

4. Critical functions of hydraulic systems maybe impaired if the hydraulic system fluid is allowed to become ***contaminated*** beyond acceptable limits.
   A) Rusty
   B) Corrupted
   C) Polished

5. If a system requires frequent component replacement and servicing, the condition of the fluid ***deteriorates*** proportionately.
   A) Becomes worse
   B) Dissolves
   C) Desiccates

6. However, ***extended*** use causes oil's additives to wear out or become depleted.
   A) Rude
   B) Long
   C) Abnormal

7. For example, ashless dispersant aviation oil is designed to ***suspend*** dirt and metal particles picked up from an aircraft engine.
   A) Avoid
   B) Cover
   C) Wash

8. Old oil, with a high degree of ***contaminants***, can cause bearing corrosion and deposit buildup.
A) Particles
B) Fuel
C) Waste

9. This produces particle buildup or ***sludge***.
A) Polluted oil
B) Dust
C) Rust

10. It provides information on wear metals, viscosity integrity, fuel ***dilution***, and air intake system leaks, among other things.
A) Drop
B) Leakage
C) Melt

11. Aircraft engines are air-cooled and operate under an ***entirely*** different set of parameters.
A) Surely
B) Completely
C) Partly

12. The oil must be thick enough to keep moving parts from contacting each other, and thin enough to permit adequate flow and minimize ***viscous*** drag.
A) Between solid and liquid
B) Fluids easily
C) Smoke as firing

13. Because base oils for aviation lubricants are not formed from light base stocks, the evaporation factor is ***negligible***.
A) Recognizable
B) Useable
C) Unessential

14. Since synthetics cost at least twice as much as mineral oil-based products, there is a tendency on the part of the operator to expect them to outperform in all ***circumstances***.
A) Places
B) Conditions
C) Positions

<u>Exercise:</u> Vocabulary

Use each word or phrase in a sentence.

1. Depend upon
2. Serve
3. Beyond
4. Proverb
5. Defective
6. Interval
7. Method
8. Wear out
9. Recommend
10. Except
11. Fortify
12. Approximately
13. Excessive

3.8. Ice And Rain Protection – Ice And Rain Panel

High humidity and low winter freezing levels provide likely conditions for icing at low levels. Hopefully it is unlikely that an ultralight or VFR (visual flight rules) general aviation pilot would venture into possible icing conditions but an enclosed cockpit ultralight may be tempted to fly through freezing rain or drizzle. Aircraft cruising in Visual Meteorological Conditions above the freezing level and then descending through a cloud layer may pick up ice.

The prerequisites for airframe icing are:

- The aircraft must be flying through visible supercooled liquid, i.e. cloud, rain or drizzle
- The airframe temperature, at the point where the liquid strikes the surface, must be sub-zero.

The severity of icing is dependent on the supercooled water content, the temperature and the size of the cloud droplets or raindrops.

Flying through snow crystals or snowflakes will not form ice but may form a line of heavy frosting on the wing leading edge at the point of stagnation, which could increase stalling speed on landing. Flying through wet mushy snow, which is a mixture of snow crystals and supercooled raindrops, will form pack snow on the aircraft.

Freezing rain creates the worst icing conditions, occurring when the aircraft flies through supercooled rain. The rain striking an airframe, at sub-zero temperature, freezes and glaze ice accumulates rapidly, as much as one cm per four miles.

Figure 3.16 Ice and rain panel

3.8.1. Window Heat

If window heat is switched ON but the ON light is extinguished, this means that heat is not being applied to the associated window. This could be because the heat controller has detected that the window is becoming overheated (normal on hot days in direct sunlight) and can be verified by touching the window. The heat will automatically be restored when the window has cooled down. To verify that window heat is still available a PWR TEST should illuminate all ON lights if the window heat switches are ON. The PWR TEST forces the temperature controller to full power but overheat protection is still available.

If an OVERHEAT light illuminates, either a window has overheated or electrical power to the window has been interrupted. The affected window heat must be switched OFF and allowed 2-5mins to cool before switching ON again. The OVHT TEST simulates an overheat condition.

3.8.2. Wing Anti Ice

Wing anti-ice (WAI) is very effective and is normally used as a de-icing system in-flight, in applications of 1 minute. On the ground it should be used continuously in icing conditions.

The WAI switch logic is interesting, on the ground, bleed air for WAI will cut-off if either thrust lever is above the take-off warning setting, but will be restored after the thrust is reduced. This allows you to perform engine run-ups etc without having to check that the WAI is still on afterwards. The switch is solenoid held and will trip off at lift-off, this is for performance considerations as the bleed air penalty is considerable.

3.8.3. Engine Anti Ice

Engine anti-ice (EAI) heats the engine cowl to prevent ice build-up, which could break off and enter the engine. Old aircrafts' spinner was originally conical to prevent ice buildup but was changed to an elliptical shape to deflect ice away from the engine core. EAI should be used continuously on the ground and in the air in icing conditions. COWL ANTI-ICE lights will illuminate if an overtemp (825F) or overpressure (65psig) condition exists in either duct. In this situation thrust on the associated engine should be reduced until the light extinguishes.

Wing and engine VALVE OPEN lights use the bright blue/dim blue - valve position in disagreement / agreement logic. The wing L and R VALVE OPEN lights in particular may remain bright blue after start and during taxy. This is because they are pneumatically operated, and they can be made to open with a modest amount of engine thrust.

3.8.4. Airframe Visual Icing Cues

An ice detection system is an option that is rarely taken up on the 737 so it is up to the crew to spot ice formation and take the necessary action. The following photo in figure 3.17 shows a kind of the place where ice accretion is visible from the flight deck. Note engine anti-ice should be used whenever the temperature and visible moisture criteria are met and not left until ice is seen, to avoid inlet ice build up which may shed into the engine.

For ice to form on a flat heated windscreen, conditions must be bad. You can see how the shape of the formation follows the airflow lines in figure 3.17. You can imagine how much ice is on the rest of the aircraft, especially when you consider that most of it is unheated, particularly on the fin and stabilizer.

Figure 3.17 forming ice on the central windscreen pillar

3.8.5. Non-Environmental Icing

Most of aircrafts have a problem with frost forming after landing on the wing above the tanks where fuel has been cold soaked. This is officially known as "Wing upper surface non-environmental icing". The reason is the increased surface area of the fuel that comes into contact with the upper surface of the wing. This is because the shape of the wing fuel tanks was changed (moved outboard) to accommodate the longer landing gear that was in turn required for the increased fuselage lengths of some aircrafts to reduce the risk of tail strikes! The only solution until recently has been to limit your arrival fuel to less than approx 4,000kg.

3.8.6. Wiper Controls

One of the most welcome features of most aircrafts is the improvement to the windscreen wipers. The wipers are now independent, have an intermittent position and best of all - are almost silent.

Figure 3.18 The wiper panel

3.8.7. Rain Repellent

As soon as the visibility through the windshield becomes affected due to rainy conditions, the pilot presses on the Rain Repellent switch as to activate the system: a calibrated quantity of fluid is sprayed on the windshield which will give perfect visibility within only 5 seconds. This fluid is compatible with the use of wipers.

<u>Exercise:</u> Interpretation of words and phrases: Circle the letter next to the best answer.

1. Hopefully it is unlikely that an ultralight or VFR (visual flight rules) general aviation pilot would ***venture*** into possible icing conditions but an enclosed cockpit ultralight may be tempted to fly through freezing rain or drizzle.
   A) Throw
   B) Doesn't help
   C) Put at risk

2. Aircraft ***cruising*** in Visual Meteorological Conditions above the freezing level and then descending through a cloud layer may pick up ice.
   A) Journey
   B) Maintaining
   C) Enduring

3. The aircraft must be flying through visible supercooled liquid, i.e. cloud, rain or ***drizzle***.
   A) Light rain
   B) Icy rain
   C) Fog

4. Flying through wet ***mushy*** snow, which is a mixture of snow crystals and supercooled raindrops, will form pack snow on the aircraft.
   A) Heavy
   B) Pulpy
   C) Too much wet

5. The rain striking an airframe, at sub-zero temperature, freezes and ***glaze*** ice accumulates rapidly, as much as one cm per four miles.
   A) Like stone
   B) Hard
   C) Shining

6. If window heat is switched ON but the ON light is ***extinguished***, this means that heat is not being applied to the associated window.
   A) Extinct
   B) Flashed
   C) Stopped

7. To ***verify*** that window heat is still available a PWR TEST should illuminate all ON lights if the window heat switches are ON.
   A) Control
   B) Confirm
   C) See

8. The following photo in figure 3.17 shows a kind of the place where ice ***accretion*** is visible from the flight deck.
   A) Freezing
   B) Enlargement
   C) Melting

<u>Exercise:</u> Vocabulary

Use each word or phrase in a sentence.

1. Stagnation
2. Cool down
3. Illuminate
4. Interrupt
5. Shed into
6. Accommodate

3.9. Aviation Lights

Figure 3.19: Lighting is very important for aviation

Aviation lights are analyzed in two main sections which are called exterior lightings and interior lightings. The exterior lights are also called navigation lights because they are used not only in aircrafts but also in other crafts too.

A Navigation Light is a colored source of specular illumination (a point source) on an aircraft, water-borne vessel, or land vehicle. Commonly, their placement is mandated by international conventions or civil authorities. They are used to signal a craft's position in low visibility, and to communicate basic information about the craft, primarily its position, heading, and status.

Some common navigation lighting systems include:

3.9.1. Right-of-Way lights

On aircrafts, ships, and manned spacecrafts, a red light is mounted on the left or port side of the craft and a green on the right or starboard side. These help two craft on a collision course determine who has right-of-way: if a pilot sees a craft on a path crossing his own, he will see either its red running light or green running light. If he sees green, he is to the impinging craft's starboard and has the right of way. If the pilot sees the red light, he knows that the approaching craft has the right-of-way, and he is required to deviate from his course to avoid the collision.

3.9.2. Strobe Lights

A strobe light commonly called a strobe, is a device used to produce regular flashes of light. On aircraft primarily, strobe lights flash a high-intensity burst of white light, to help other pilots recognize the aircraft's position in low-visibility conditions. Strobe lights are installed on each wingtip. They are used to designate the end of each wingtip.

Some other aircraft lighting systems and their purpose:

3.9.3. Position Lights

The forward position lights consist of a red light on the left (port) wingtip and a green light on the right (starboard) wingtip. They indicate the respective wingtips to other aircraft and ground proximity operations.

3.9.4. Nacelle Lights

The engine nacelle lights are installed on each side of the fuselage and are provided to visually check the engine nacelles and wing leading edges for icing conditions.

3.9.5. Wing Landing Lights

One retractable wing landing light is installed on the lower surface of each wingtip. They are used to aid in illuminating the landing surface or runway.

3.9.6. Nose Taxi Lights

Two, sealed-beam, fixed position lights are installed on the nose gear assembly. They are used to aid in illuminating the landing surface or runway.

3.9.7. Anti-Collision Lights

The anti-collision lights are installed on the upper and lower fuselage surfaces. They illuminate the aircraft at night and they are illuminated whenever the engines are running.

3.9.8. Ground Flood Lights

A fixed position ground floodlight is installed on each side of the fuselage to provide area lighting for ground servicing and to aid side visibility while taxiing.

3.9.9. Downlock Lights

These lights are located in the cockpit to indicate if the landing gear is in the down and locked position.

3.9.10. Interior/Emergency Evacuation Lights

The emergency evacuation lighting system consists of numerous lights and lighted exit signs located throughout the main cabin, flight compartment, and aft stairway compartment.

Usually, the lights are powered by 8 rechargeable battery packs that supply power for approximately 15 minutes. The lights are controlled by the emergency lights switch located on the overhead switch panel or the emergency lights switch located on the aft flight attendant panel.

NIGHT VISION GOGGLE COMPATIBLE LIGHTING

The purpose of Night Vision Goggles (NVG) is to allow aircrew to operate their aircraft visually at night. Piloting is enabled by the wide field of regard of NVG, and assisted by the covert nature of these devices. The NVG's are not effective alone, the cockpit and external lighting also need to be made compatible, as the light affects the NVG image by 'blooming out' the view through the goggles.

3.9.11. Cockpit Lighting

What could be more basic than cockpit illumination? Simple white light bulbs for map reading and other flightdeck chores. For years incandescents have dominated the cockpit, while cabins began to change. But now this last bastion of the older technology is beginning to give way to longer-lasting solid state, light-emitting diodes (LEDs).

Cockpit lighting is a niche market: it requires numerous illuminators in very small quantities. Still a customer can spend $5,000 to $15,000 or more to place light where it is needed, excluding displays, switches and annunciators. There are map and chart lights, table lights, utility, stowage and aisle lights. There are glareshield lights to floodlight the instrument panel, dome lights, floor lights, emergency lights and oxygen mask lights.

Figure 3.20 Some Interior cockpit lights

Cockpit lights come in a range of shapes and sizes. High-brightness halogen or conventional incandescent reading lights can be installed in the cockpit ceiling. LEDs can be embedded in a chart holder attached to the pilot's yoke. Small, glareshield-mounted LED or incandescent lights can illuminate the instrument panel.

3.9.12. Incandescent Lights

Incandescents represent about 90 percent of the cockpit lighting market across aviation sectors. A company provides incandescent designs, including a fixed-base, cylindrical utility lamp that is adjustable in every axis. Adjustable in intensity, the lamp is mounted on a flexible, gooseneck arm in the sidewall of the cockpit. It can be pulled out and moved to different positions.

3.9.13. Halogen

But incandescent lights don't last that long. Halogen lamps, using a specialized type of incandescent technology, are replacing conventional bulbs in certain applications. Halogen technology allows tungsten to be redeposited on the lamp's filament, extending its life.

Of course a light's life span depends on its circumstances and characteristics. Incandescent "microbulbs" used in cockpit panels theoretically could last 10,000 to 20,000 hours.

Fluorescent lights last longer than incandescents. Manufacturers mounted fluorescent light to illuminate instrument displays. This dimmable "thunderstorm" light helps the pilot to adjust his eyes to various conditions outside.

3.9.14. Light-Emitting Diodes

New aircraft and retrofits use LEDs in the cockpit to increase reliability and reduce life-cycle cost. These solid state parts consume less power and have no coiled filaments, which can weaken from vibration and temperature extremes. Their downside is obsolescence.

But long life isn't necessarily guaranteed. Proper heat management, among other things, is essential. Designers also need to compensate for variation in LED performance. LED makers sort parts into bins based on characteristics such as light intensity, forward voltage and color, but performance may vary up to 20 percent between the LEDs in a single bin.

Because these solid state, semiconductor devices are like a computer chip, they can be monitored via closed-loop systems more easily than analog light sources can. Users therefore can assess variations in output and color. If an operator needs to swap out a section of a LED light at some later time, he or she can compare the output of the new section with the output of the sections to the left and right of it. The replacement part can automatically compensate to make the lighting uniform.

A key factor in extending LED life is controlling the temperature of the LED junction, the area of the semiconductor device that emits light.

Use of fast-moving LED technology also risks product obsolescence. Engineers have to anticipate these changes as much as possible in their initial design. LEDs, for example, are getting brighter. Optics systems can be designed as modules to accommodate this trend and make upgrades easier as the technology progresses.

<u>Exercise:</u> Interpretation of words and phrases: Circle the letter next to the best answer.

1. A Navigation Light is a colored source of ***specular*** illumination (a point source) on an aircraft, water-borne vessel, or land vehicle.
   A) Powered
   B) Reflective
   C) Special

2. Commonly, their placement is ***mandated*** by international conventions or civil authorities.
   A) Directed
   B) Rejected
   C) Approved

3. If the pilot sees the red light, he knows that the approaching craft has the right-of-way, and he is required to deviate from his ***course*** to avoid the collision.
   A) Process
   B) Route
   C) Lesson

4. On aircraft primarily, strobe lights flash a high-intensity burst of white light, to help other pilots ***recognize*** the aircraft's position in low-visibility conditions.
   A) Show signs
   B) Change
   C) Become aware of

5. They indicate the respective wingtips to other aircraft and ground ***proximity*** operations.
   A) Surface
   B) Direction
   C) Closeness

6. One ***retractable*** wing landing light is installed on the lower surface of each wingtip.
   A) Important
   B) Not essential
   C) Movable

7. The lights are controlled by the emergency lights switch located on the overhead switch panel or the emergency lights switch located on the ***aft*** flight attendant panel.
   A) Situated at back
   B) Situated in front
   C) Situated at centre
8. Simple white light bulbs for map reading and other flightdeck ***chores***.
   A) Navigating
   B) Readings
   C) Routine businesses

9. For years ***incandescents*** have dominated the cockpit, while cabins began to change.
   A) Weak lights
   B) Brilliant lights
   C) Unmodern lights

10. New aircraft and ***retrofits*** use LEDs in the cockpit to increase reliability and reduce life-cycle cost.
    A) Added accessories
    B) Sea crafts
    C) Not so new

<u>Exercise:</u> Vocabulary

Use each word or phrase in a sentence.

1. Indicate
2. Approximately
3. Purpose
4. Compatible
5. Dominate
6. Represent
7. Reliable

3.10. Oxygen

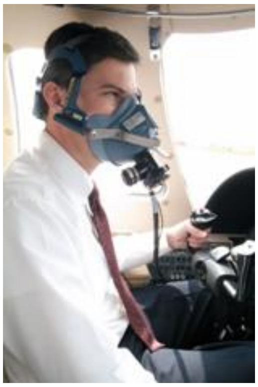


Figure 3.21: Oxygen tubes are vital while navigating on such high altitude

When the body is deprived of an adequate oxygen supply, even for a short period, various organs and processes in the body begin to suffer impairment from oxygen deficiency. This condition is known as "hypoxia". Hypoxia affects every cell in the body, but especially the brain and the body's nervous system. This makes hypoxia extremely insidious, difficult to recognize, and therefore, a serious hazard, especially to flight personnel.

Hypoxia causes impairment of vision (especially at night), lassitude, drowsiness, fatigue, headache, euphoria (a false sense of exhilaration), and temporary psychological disturbance. These effects do not necessarily occur in the same sequence or to the same extent to all individuals, but are typical in average persons when affected by hypoxia.

Supplementary oxygen must be used to enrich the air we breathe to compensate for either a deficiency on the part of the individual or a deficiency of the atmosphere which we are breathing.

When we ascend in altitude, a different condition is encountered, a condition in which the individual may be perfectly normal, but in which there is an oxygen deficiency in the atmosphere and supplementary oxygen must therefore be used.

The blanket of air, several hundred miles thick, which surrounds our planet is compressible and has weight. The air closest to the earth is supporting the weight of the air above it, and, therefore, is more dense; its molecules are packed closer together. As we ascend in altitude, for example, at 10,000 feet, the atmospheric pressure is only two-thirds that at ground level. Consequently, the air is less dense, and each lungful of air contains only two-thirds as many molecules of oxygen as it did at ground level. At 18,000 feet the atmospheric pressure is only one-half that at ground level. Although the percentage of oxygen is still the same as at ground level, the number of molecules of oxygen in each lungful is reduced by one-half. As we ascend, there is a progressive reduction in the amount of oxygen taken into the lungs with each breath, and, therefore, there is a decrease in the amount of oxygen available for the bloodstream to pick up and transport to every cell in the body. To compensate for this progressive oxygen deficiency, we must add pure oxygen to the air we breathe in order to maintain in the inspired air enough molecules to supply the metabolic needs of the body.

In general, it can be assumed that the normal, healthy individual is unlikely to need supplementary oxygen at altitudes below 8,000 feet. One exception is night flying; because the retina of the eye is affected by even extremely mild hypoxia, deterioration of night vision becomes significant above 5,000 feet. Between 8,000 and 12,000 feet, hypoxia may cause the first signs of fatigue, drowsiness, sluggishness, headache, and slower reaction time. At 15,000 feet, the hypoxic effect becomes increasingly apparent in terms of impaired efficiency, increased drowsiness, errors in judgment, difficulty with simple tasks requiring mental alertness or muscular coordination. These symptoms become more intensified with progressively higher ascent or with prolonged exposure. At 20,000 feet, a pilot may scarcely be able to see -- much less read -- the instruments. Hearing, perception, judgment, comprehension, and general mental and physical faculties are practically useless. The pilot may be on the verge of complete collapse. Therefore, the availability and use of oxygen from the ground up on night flights where altitudes above 5,000 feet are contemplated, and at altitudes above 8,000 feet on daytime flights, is recommended.

With oxygen equipment aboard, the pilot can choose the higher altitudes which give the smoothest flight, the most favorable winds, the best performance from the Omni and other radio navigation equipment, the highest speed, the longest range, and the best engine performance. The pilot can have these advantages safely with oxygen, because his or her own performance will not be affected by hypoxia; he or she will be just as efficient and capable as at lower altitudes or even on the ground. With oxygen equipment in use, pilot and passengers will arrive at their destination fresh and fit, without the headache, lassitude and fatigue which often result from prolonged exposure to even mild hypoxia.

There are several types of oxygen systems commonly found in general aviation aircraft: Constant flow, Altitude adjustable and Altitude compensating. Each type has advantages and disadvantages.

3.10.1. Constant Flow Systems

The most common and lowest cost system found in general aviation is the constant flow type. The basic system includes three parts: the cylinder(s), regulator, and manifold system.

The cylinder is common to all systems. It can be made from steel, aluminum, or composites. The tank pressure is usually less than 2,200 pounds per square inch (psi). The regulators which step down the pressure from 2200 psi to 20-75 psi can be attached separately from the cylinder(s) or directly screwed onto the cylinder. Most regulators are of the diaphragm type. They typically hold a constant output pressure between 20 and 75 pounds, depending on the manufacturer, from either a full cylinder to one that is almost empty. A manifold system is built into the regulator for portable systems. For built-in systems there is a manifold system installed in the aircraft. The manifold system operates at the 20-75 pound pressure.

Figure 3.22 Oxygen Regulator

The constant flow type provides the same output pressure or flow regardless of altitude. There is virtually no maintenance required. It is low in cost and well as low in weight. The regulator output is typically 2.5 to 3.0 liters per minute at a regulated line pressure of 25 to 75 pounds. The output is controlled by a small orifice in the regulator itself or most commonly done by the connector going into the manifold system. The connector orifice can be a hole as small as .012 inches in diameter. Most portable systems are of the constant flow type.

The disadvantage of the constant flow system is that there is a waste of oxygen at lower oxygen altitudes. The system typically provides the pilot a flow of 2.5 liters per minute. This is the correct amount of oxygen at 25,000 feet. However, if the aircraft were only at 15,000 feet, only 1.5 liters per minute are required. There is a waste of 1 liter per minute of oxygen. The excess oxygen used has no serious medical effect other than drying out your nose quickly. Obviously, however there is an economic disadvantage.

3.10.2. Altitude Adjustable Systems

An altitude adjustable oxygen system is similar to the constant flow system except there is an adjustable control to set the necessary flow. This adjustment is accomplished by turning a control knob so a reading on a gauge, calibrated in altitude, is the same as the aircraft's altimeter setting. There is a significant saving in oxygen, since you are not wasting the excess flow of oxygen. Not many built in systems use this type. However some portable systems have this feature. The military surplus A8A regulators of the altitude adjustable type are commonly used in many sailplanes.

One disadvantage to this type of system, other than it costs more, is that there is no positive indication of flow to the individual breathing devices. You cannot adjust individually the flow of oxygen to each of the breathing devices. Not all people require the same amount of oxygen (for example the smoker). The red/green indicator is commonly used to show flow. As previously mentioned, this doesn't tell you that the system is working properly. The flow meter can be set wide open, and the resulting flow from the altitude adjusting system can be observed in the flow meter. What is recommended is to have at least one flow meter installed so the pilot can monitor the resulting flow from the altitude adjustments made on the flow adjustment control on the regulator.

3.10.3. Altitude Compensating Systems

The altitude compensating system is similar to the altitude adjustable systems except that the adjustment is done automatically instead of manually setting the flow rate to an altitude gauge. Beechcraft and Mooney use this type of system. Also, some portable systems have this feature. The systems work quite well in the automatic mode. There are again disadvantages to this type of system. Some systems do not turn on or provide any oxygen until the system is at 8 to 10,000 feet. If you want oxygen at a lower altitude, you are out of luck. Like the altitude adjustable system, you cannot individually adjust the flow of oxygen since all of the outlets are controlled by the automatic system. If there is a person on board who requires extra oxygen, you cannot provide additional oxygen for that person. In addition, usually there is no actual flow meter available to indicate if the automatic flow control device is working properly.

<u>Exercise:</u> Interpretation of words and phrases: Circle the letter next to the best answer.

1. When the body is ***deprived*** of an adequate oxygen supply, even for a short period, various organs and processes in the body begin to suffer impairment from oxygen deficiency.
   A) To be without
   B) To be together
   C) To be Miserable

2. This makes hypoxia extremely ***insidious***, difficult to recognize, and, therefore, a serious hazard, especially to flight personnel.
   A) Recognizable
   B) Changeable
   C) Very harmful

3. Hypoxia causes impairment of vision (especially at night), ***lassitude***, drowsiness, ***fatigue***, headache, euphoria (a false sense of exhilaration), and temporary psychological disturbance.
   A) Much exhaustion
   B) Sleepiness
   C) Illness

4. To ***compensate*** for this progressive oxygen deficiency, we must add pure oxygen to the air we breathe in order to maintain in the inspired air enough molecules to supply the metabolic needs of the body.
   A) Decrease
   B) Replace
   C) Enclose

5. The pilot may be on the ***verge*** of complete collapse.
   A) Border
   B) Floor
   C) Degree

6. The constant flow type provides the same output pressure or flow ***regardless*** of altitude.
   A) According to
   B) By controlling
   C) Not matter

7. The ***excess*** oxygen used has no serious medical effect other than drying out your nose quickly.
   A) Dryer than normal
   B) More than is needed
   C) Less than used before

8. This adjustment is accomplished by turning a control knob so a reading on a ***gauge***, calibrated in altitude, is the same as the aircraft's altimeter setting.
   A) Instrument
   B) Measure
   C) Panel

9. However some portable systems have this ***feature***.
   A) Character
   B) System
   C) Advantage

10. Like the altitude adjustable system, you cannot individually adjust the flow of oxygen since all of the ***outlets*** are controlled by the automatic system.
   A) Output labels
   B) Output covers
   C) Output paths

<u>Exercise:</u> Vocabulary

Use each word or phrase in a sentence.

1. Suffer
2. Disturb
3. Assume
4. Drowsiness
5. Intensify
6. Accomplish

APPLICATION ACTIVITY

Make conversations with each other in classroom, laboratory, workshop or wherever you are using terms and sentences involved technical English you have learned by this learning activity:

Examples:

-Aircrafts should be maintained periodically for maximum safety.

- Aviation lights of an aircraft are very important for navigating and landing safely.

CHECKLIST

If you have behaviors listed below, evaluate yourself putting (X) in “Yes” box for your earned skills within the scope of this activity otherwise put (X) in “No” box.

Evaluation criteria	Yes	No
1. Did you learn the features of aircraft systems?		
2. Did you learn the flight instruments?		
3. Did you learn the aviation lights?		
4. Did you learn the electrical power unit?		
5. Did you learn the oil and fuel of aviation?		

EVALUATION

Please review your “No" answers in the form at the end of the evaluation. If you do not find yourself enough, repeat learning activity. If you give all your answers "Yes" to all questions, pass to the "Measuring and Evaluation".

MEASURING AND EVALUATION

Evaluate the given knowledge, If the knowledge is TRUE, write “T” , if it is FALSE, write “F” to end of the empty parenthesis. .

1. ( ) Turbine engine provides thrust for aircraft.

2. ( ) The engine compressor is not significant for the pneumatic power generation.

3. ( ) There are two remarks appropriate for compressed air generation, mentioned in the passage

4. ( ) A check valve cannot prevent air flowing from high to low pressure bleeding ports.

5. ( ) Aircraft altitude is the actual height above some land level.

6. ( ) Ambient means the area surrounding the airplane.

7. ( ) The cabin pressure control system arranges cabin pressure regulation.

8. ( ) The dump valve is actuated by the cabin pressure control system.

9. ( ) Body of an aircraft should be designed to resist much differential pressure.

10. ( ) Owing to Global Positioning Systems, aircrafts are extremely safer than before.

11. ( ) In fact, there are more than necessary instruments in an aircraft.

12. ( ) If the wind’s speed or direction remains constant, this is called “wind shear”.

13. ( ) There are three components in the landing gear warning system.

14. ( ) The Low Voltage & Low Vacuum or Pressure Warning System should only be mounted near the pilot in the cockpit.

15. ( ) Flying regularly prevents an aircraft’s engine from rust.

16. ( ) Low Voltage & Low Vacuum or Pressure Warning System alerts the pilot only by the ways using buzzer or light.

17. ( ) An aircraft’s altitude alert device must be analog displayed.

18. ( ) A typical camera system usually consists of four camera inputs.

19. **( )** Some of warning systems instruments are three-dimensional.

20. ( ) All aircrafts’ flight instrument arrangements are usually different from each other.

21. ( ) There could be alternatives if an attitude indicator fails in an aircraft.

22. ( ) A magnetic compass is a navigational instrument for finding directions.

23. ( ) A pilot always can trust in a magnetic compass while navigating.

24. ( ) The “Basic T” had had its name from arrangement shape of four instruments.

25. ( ) Power of food preparation is a kind of essential system power.

26. ( ) Most of aircraft electrical parts work under D.C. voltage.

27. ( ) 115 volts at 400 Hz is much better than 60 Hz used in utility power generation.

28. ( ) AC frequency flowing through a conductor doesn’t affect reactive drops.

29. ( ) If you run a 400 Hz device at 60 Hz, there would be smoke and fire.

30. ( ) Ground vehicles’ fuel systems are more complex than aircrafts’.

31. ( ) Automobile fuel is used for first flights and there were no problems

32. ( ) If there weren’t probability involving the World War II for US, fuel with high octane might not been developed in 1930s yet.

33. ( ) High amount of octane harms the engine, so it should be decreased.

34. ( ) German Luftwaffe's airplanes used more developed fuel than US’ in the World War II.

35. ( ) Jet fuel doesn’t freeze as easily as other types of fuels.

EVALUATION

Please check your answers from the answer key table which is at the end of this module. If you have more than 2 mistakes you need to review the learning activity – 3.

If you give right answers to all questions, pass to learning activity-4.

LEARNING ACTIVITY-4

AIM

You can make translation by reading booklets technically.

SEARCH

- Read and examine by getting English aircraft repairing booklets, the parts catalogues with pictures and English technical documents from airlines companies, universities and aircraft repairing companies etc.

4. USAGE OF MAINTENANCE MANUALS

4.1. Aircraft Maintenance Manual and Basic Aircraft Technician Hand Book

4.1.1. Application of Sample Translation

Note about the translation:

Practically while making translation from English documents to Turkish, the text which will be translated should be read twice and especially the main idea should be understood. Then the words which are new for you and they have the meaning in the technical dictionary should be learnt.

As a first, translation progress should be done paragraph by paragraph and then each paragraph should be translated sentence by sentence. It is important to protect the sentence integrity. Also to provide the meaning integrity is important. Do not forget: You shouldn't insist on the text which you have translated can be same with the original text word by word. Otherwise, you can create meaningless sentences and cannot fulfill your aims.

It will be given some operational steps of a paragraph translation as an example. But do not forget: To understand and translate the maintenance guides and booklets is relatively easier. Because in those books, common patterns, standard tense structures and command sentences are generally included.

A PROPERLY MAINTAINED AIRCRAFT IS A SAFE AIRCRAFT.

Figure 4.1: A technician maintaining the engine of an aircraft

Maintenance means the preservation, inspection, overhaul, and repair of aircraft, including the replacement of parts. The purpose of maintenance is to ensure that the aircraft remains airworthy throughout its operational life. Although maintenance requirements vary for different types of aircraft, experiences show that most aircraft need some type of preventive maintenance every 25 hours or less of flying time, and minor maintenance at least every 100 hours. This is influenced by the kind of operation, climatic conditions, storage facilities, age, and construction of the aircraft. Maintenance manuals are available from aircraft manufacturers or commercial vendors with revisions for maintaining your aircraft.

Aircraft maintenance has two main critical functional models, preventive maintenance and requirement-based maintenance. In Preventive maintenance, some extra steps are usually taken to protect the aircraft from snags that could possibly occur in future, like wing inspection after every flight to foresee and rectify problems that could possibly create problems while landing or in the air.

Requirement based maintenance involves rectifying the problem as and when it occurs. It usually involves critical activities, so instructions are usually prepared proactively for every foreseen problem to ensure minimum time wastage during its occurrence.

Aircraft testing is the most critical operational activity that maintenance technicians perform. Every part, like wings, fuselage, tail plane, pumps, valves and communication equipment is inspected and immediately replaced if found problematic.

Figure 4.2: It is very important to maintain aircrafts periodically

Testing procedures are usually repetitive, complex and meticulously designed. These procedures are divided into certain levels depending upon the kind of maintenance the aircraft needs. Under normal conditions, an aircraft is inspected after every flight (Level 1) and subsequently the level increases with increases in flying hours. The experts suggest getting the aircraft checked every six months at a maintenance yard for thorough inspection.

Taking passenger safety into account, aircraft maintenance has never been considered as an ordinary maintenance activity. International aircraft maintenance agencies like the Federal Aviation Administration (USA, Europe and Australia) have laid stringent rules and guidelines for aircraft maintenance to ensure maximum safety for passengers.

After reading the text one or two times the next step is learning the meaning of new words and structures. That's why you must use a technical dictionary.

Overhaul:	Gözden geçirme, tamir
Although:	Her ne kadar… ise de
Experience:	Deneyim, tecrübe
Influence:	Etki
Facility:	Tesis, servis alanı
Commercial:	Ticari
Vendor:	Satıcı
Step:	Tedbir, önlem
Snag:	Engel, tökezlemek
Foresee:	İleriyi görmek, tahmin etmek
Wastage:	İsraf
Meticulous:	Titiz
Depending upon:	-e , -a bağlı olarak
Suggest:	Önermek
Subsequently:	Sonra
Stringent:	Katı, sert
To get something done:	Bir şeyi yaptırtmak
(To get the aircraft checked:	Uçağı kontrol ettirtmek)

Be careful, a word may have more than one meaning. It is important to read the text carefully, so you can guess the meaning of the unknown word truely. For instance, the word "facility" means –fırsat, yetenek, vasıta, tesis, rahatlık and olanak- on its own, but in the text it was used as "tesis and servis alanı. When you look it up in the dictionary you can see that the word "step" means adım, önlem girişim, hareket, terfi.

Now it's time to translate. We will translate the text paragraph by paragraph. Examine the sentences carefully one by one.

A PROPERLY MAINTAINED AIRCRAFT IS A SAFE AIRCRAFT

Maintenance means the preservation, inspection, overhaul, and repair of aircraft, including the replacement of parts. The purpose of maintenance is to ensure that the aircraft remains airworthy throughout its operational life. Although maintenance requirements vary for different types of aircraft, experiences show that most aircraft need some type of preventive maintenance every 25 hours or less of flying time, and minor maintenance at least every 100 hours. This is influenced by the kind of operation, climatic conditions, storage facilities, age, and construction of the aircraft. Maintenance manuals are available from aircraft manufacturers or commercial vendors with revisions for maintaining your aircraft.

DÜZENLİ BAKIMI YAPILAN BİR UÇAK GÜVENLİ BİR UÇAKTIR

Bakım, uçağın parçalarının yerleştirilmesi dahil; korunması, denetlenmesi, gözden geçirilmesi ve tamiri demektir. Bakımın amcacı uçağın çalışma ömrü süresince sağlıklı uçuş yapmaya devam edeceğinden emin olmaktır. Her ne kadar bakım gereksinimleri farklı uçak tiplerine göre değişse de, deneyimler çoğu uçağın her 25 saat veya daha kısa uçuş zamanı için bazı koruyucu bakım çeşidine ve en azından her 100 saat için de hafif bakıma ihtiyaç duyduğunu göstermiştir. Bu, çalışmanın türünden, iklim koşullarından, bekleme yapılan tesislerden, yaştan ve uçağın yapısından etkilenir. Bakım kılavuzları uçağınızın bakımı için düzeltilmiş baskılarla uçak üreticilerinden veya ticari bayilerden temin edilebilir.

Aircraft maintenance has two main critical functional models, preventive maintenance and requirement-based maintenance. In Preventive maintenance, some extra steps are usually taken to protect the aircraft from snags that could possibly occur in future, like wing inspection after every flight to foresee and rectify problems that could possibly create problems while landing or in the air.

Uçak bakımının koruyucu bakım ve gereksinim tabanlı bakım diye iki ana işlevsel kalıbı vardır. Koruyucu bakımda genellikle, uçağı ileride meydana gelebilecek aksiliklerden korumak için, iniş sırasında ve havada iken problem yaratabilecek sorunları önceden tahmin edip düzeltmek için her bir uçuştan sonra kanat denetimi yapmak gibi bazı ek önlemler alınır.

Requirement based maintenance involves rectifying the problem as and when it occurs. It usually involves critical activities, so instructions are usually prepared proactively for every foreseen problem to ensure minimum time wastage during its occurrence.

Gereksinim tabanlı bakım problemi meydana geldiği anda düzeltmeyi gerektirir. Genellikle kritik faaliyetler içerir, böylece yönergeler genellikle problemin meydana gelişi sırasında zaman israfını minimuma düşürmek için olası her bir problem için hassasiyetle profesyonelce hazırlanır.

Aircraft testing is the most critical operational activity that maintenance technicians perform. Every part, like wings, fuselage, tail plane, pumps, valves and communication equipment is inspected and immediately replaced if found problematic.

Uçağın test edilmesi bakım teknisyenlerinin gerçekleştirdiği en kritik işlemsel aktivitedir. Kanatlar, uçağın gövdesi, kuyruk yüzeyi, pompalar, vanalar ve haberleşme cihazları gibi her parça denetlenir ve sorunlu bulunursa acilen değiştirilir.

Testing procedures are usually repetitive, complex and meticulously designed. These procedures are divided into certain levels depending upon the kind of maintenance the aircraft needs. Under normal conditions, an aircraft is inspected after every flight (Level 1) and subsequently the level increases with increases in flying hours. The experts suggest getting the aircraft checked every six months at a maintenance yard for thorough inspection.

Deneme işlem basamakları genellikle tekrarlı, karmaşık ve titizce tasarlanır. Bu işlem basamakları uçağın ihtiyaç duyduğu bakım türüne bağlı olarak belirli düzeylere bölünür. Normal koşullar altında, bir uçak her uçuş sonrası denetlenir (Seviye 1) ve sonra uçuş saatlerindeki artışla seviye artar. Uzmanlar uçağa her altı ayda bir, bir bakım alanında komple denetim için bakım yaptırtmayı önermektedir.

Taking passenger safety into account, aircraft maintenance has never been considered as an ordinary maintenance activity. International aircraft maintenance agencies like the Federal Aviation Administration (USA, Europe and Australia) have laid stringent rules and guidelines for aircraft maintenance to ensure maximum safety for passengers.

Yolcu güvenliğini hesaba kattığımızda, uçak bakımı asla sıradan bir bakım faaliyeti olarak düşünülmemiştir. Uluslar arası uçak bakım acenteleri Federal Havacılık İdaresi (ABD, Avrupa ve Avustralya) gibi, yolculara maksimum güvenliği sağlamak amacıyla uçak bakımı için katı kurallar ve talimatlar koymuştur.

The place of the words should have taken your attention. For instance let’s examine this sentence:

These procedures are divided into certain levels depending upon the kind of maintenance the aircraft needs.

Bu işlem basamakları uçağın ihtiyaç duyduğu bakım türüne bağlı olarak belirli düzeylere bölünür.

As it is seen in the phrases the most important difference between the two sentences is the place of main verb. Whereas the subject is in the beginning and the main verb is at the end of the sentence in Turkish, the main verb in target language is placed just after the subject.

In Turkish
Subject + Object + ……+……. + Main verb

In English
Subjects + (auxiliary verb) + Main verb + ……. +…….

If we are examining/scanning an English sentence to translate, we should determine the main verb after the subject search but first it would be better to scan the latest parts of the sentence then handle the translation.

As mentioned before to translate the maintenance manuals and booklets would be easier. In the next part there would be examples of quotations from aircraft maintenance-repairing booklets, manuals and parts catalogues.

4.1.2. A quotation from Aircraft Maintenance Manual

ENGINE OIL SERVICING

A340

AIRCRAFT MAINTENANCE MANUAL
ENGINE OIL - SERVICING

TASK 12-13-79-610-801
Check of the Oil Level and Gravity filling

1. Reason for the Job

Self Explanatory

2. Job Set-up Information

A. Fixtures, Tools, Test and Support Equipment

REFERENCE	QTY	DESIGNATION
No specific		circuit breaker(s) safety clip(s)
No specific		lint-free cloth
No specific		access platform 2.5 m (8 ft. 2 in.)
No specific		adjustable access platform 4.3 m (14 ft.1 in.)

B. Consumable Materials

REFERENCE	DESIGNATION
Material No. CP2442	USA MIL-L-23699 engine oil (Ref. 70-30-00)

C. Referenced Information

REFERENCE	DESIGNATION
12-13-79-610-805	Flushing of the Oil System
24-42-00-861-801	Energize the Ground Service Network
24-42-00-862-801	De-energize the Ground Service Network
79-11-10-000-802	Removal of the 0-ring from the Oil Tank Filler Cap (5000EN)
79-11-10-400-802	Installation of the 0-ring from the Oil Tank Filler Cap (5000EN)
79-21-20-000-801	Removal of the Rain Oil/Fuel Heat Exchanger (5002EN)
79-21-20-400-801	Installation of the Main oil/fuel Heat Exchanger (5002EN)
12-13-79-991-001	Fig. 301
12-13-79-991-002	Fig. 302

3. Job Set-up

Subtask 12-13-79-861-050
A. Energize the ground service network
(Ref. TASK 24-42-00-861-801).

Subtask 12-13-79-941-050

B. Safety Precautions

(1) Make sure that the engine 1, (2), (3), (4) shut down occurred not less Than 5 minutes before you do this procedure.

Subtask 12-13-79-010-057

C. Get Access to the Avionics Compartment

(1) Put the access platform in position at the access door 811.
(2) Open the access door 811.

(3) Open the protective door of the AC/DC emergency power-center 740vu.

Subtask 12-13-79-865-050

D. Open, Safety and tag this (These) circuit breaker(s):

PANEL DESIGNATION	FIN	LOCATION
FOR 4000EM1		
722VU FADEC B ENG 1	13KS1	K46
742VU FADEC A ENG 1	12KS1	N74
FOR 4000EM2		
722VU FADEC B ENG 2	13KS2	D43
742VU FADEC A ENG 2	12KS2	Q73
FOR 4000EM3		
722VU FADEC B ENG 3	13KS3	K47
742VU FADEC A ENG 3	12KS3	Q74
FOR 4000EM4		
722VU FADEC B ENG 4	13KS4	D44
742VU FADEC A ENG 4	12KS4	N75

Subtask 12-13-79-010-050

E. Get Access

(1) Put the adjustable access platform in position on the left side of the engine.

(2) Open the oil tank access door:
- FOR 4000EM1
415BL
- FOR 4000EM2
425BL
- FOR 4000EM3
435BL
- FOR 4000EM4
445BL.

4. Procedure

(Ref. Fig.301/TASK 12-13-79-991-001, 302/TASK 12-13-79-991-002)

Subtask 12-13-79-210-050

A. Check of the Oil Level

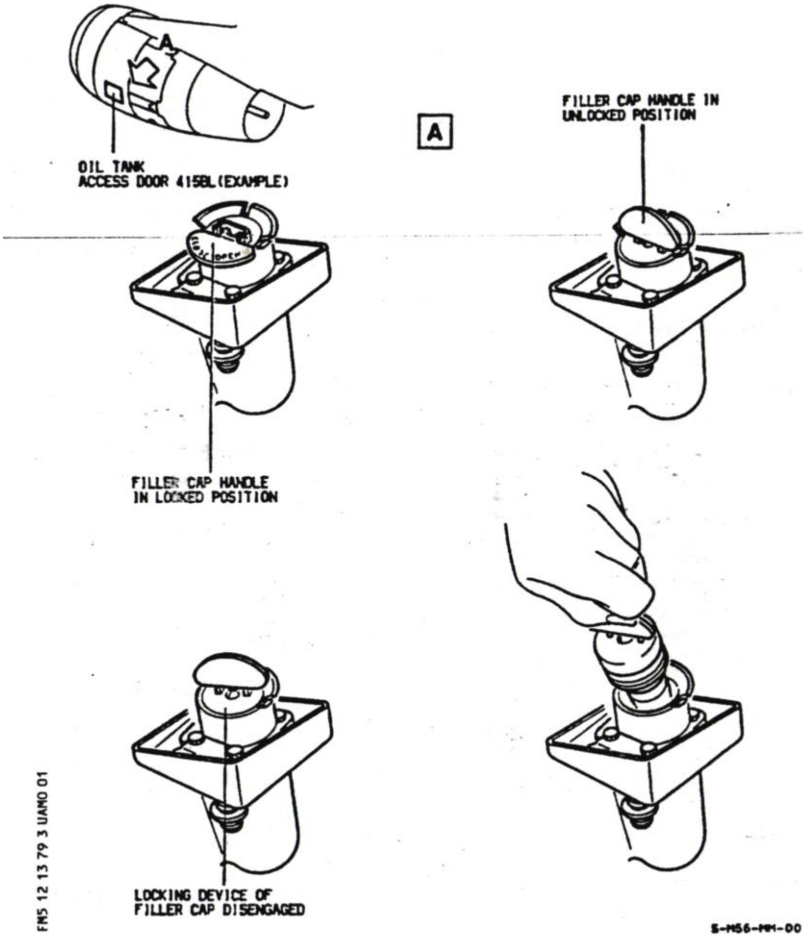
(1) Check the oil level on the sight gage. If the oil is below the full mark, add oil.

Subtask 12-13-79-160-050

B. Clean the oil tank scupper.

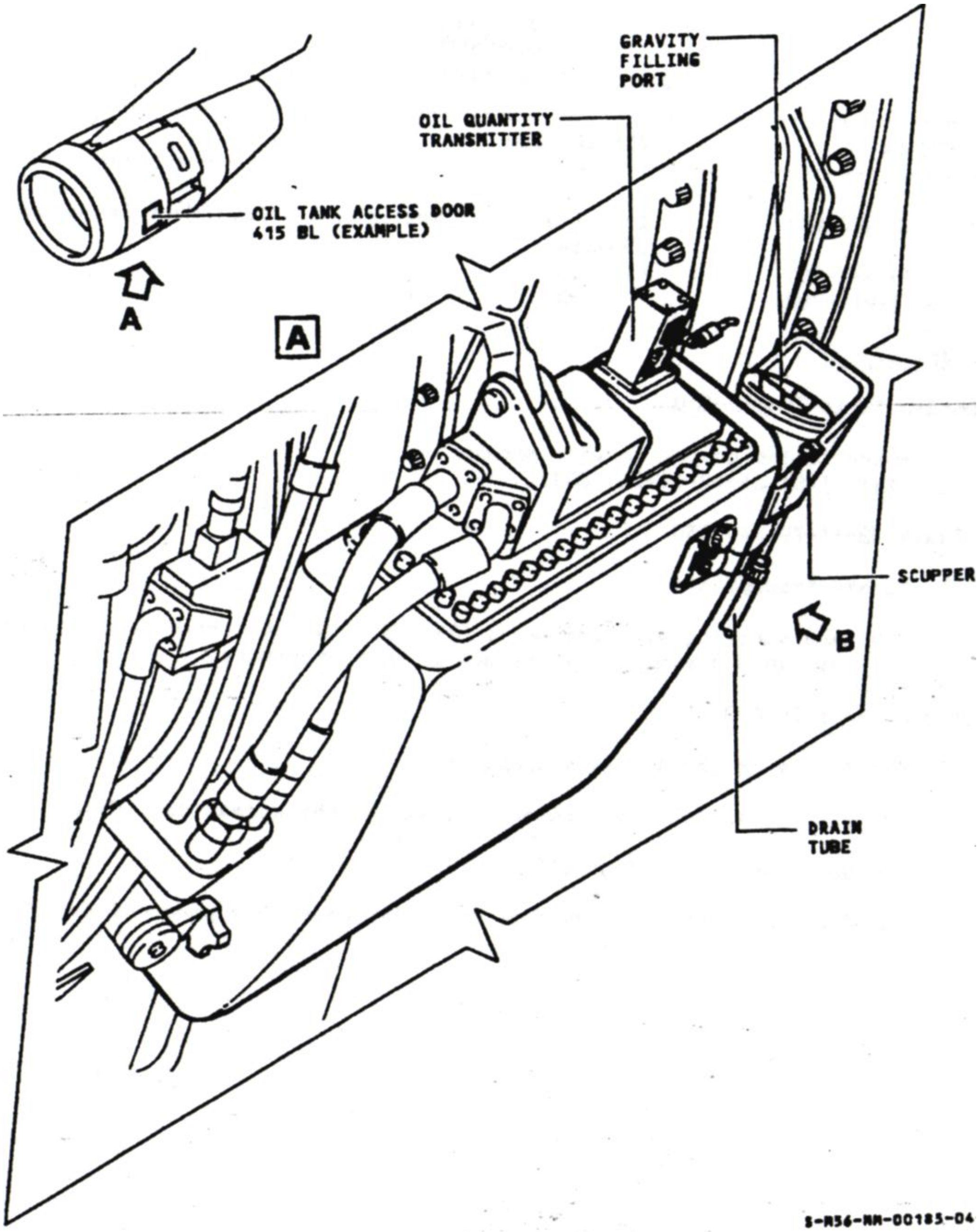
CAUTION: MAKE SURE THAT THE SCUPPER OF THE OIL TANK IS CLEAN TO PREVENT CONTAMINATION OF THE TANK DURING THE SERVICING OPERATION.

(1) Clean the oil tank scupper with a clean and lint-free cloth, before you remove the oil tank filler cap.

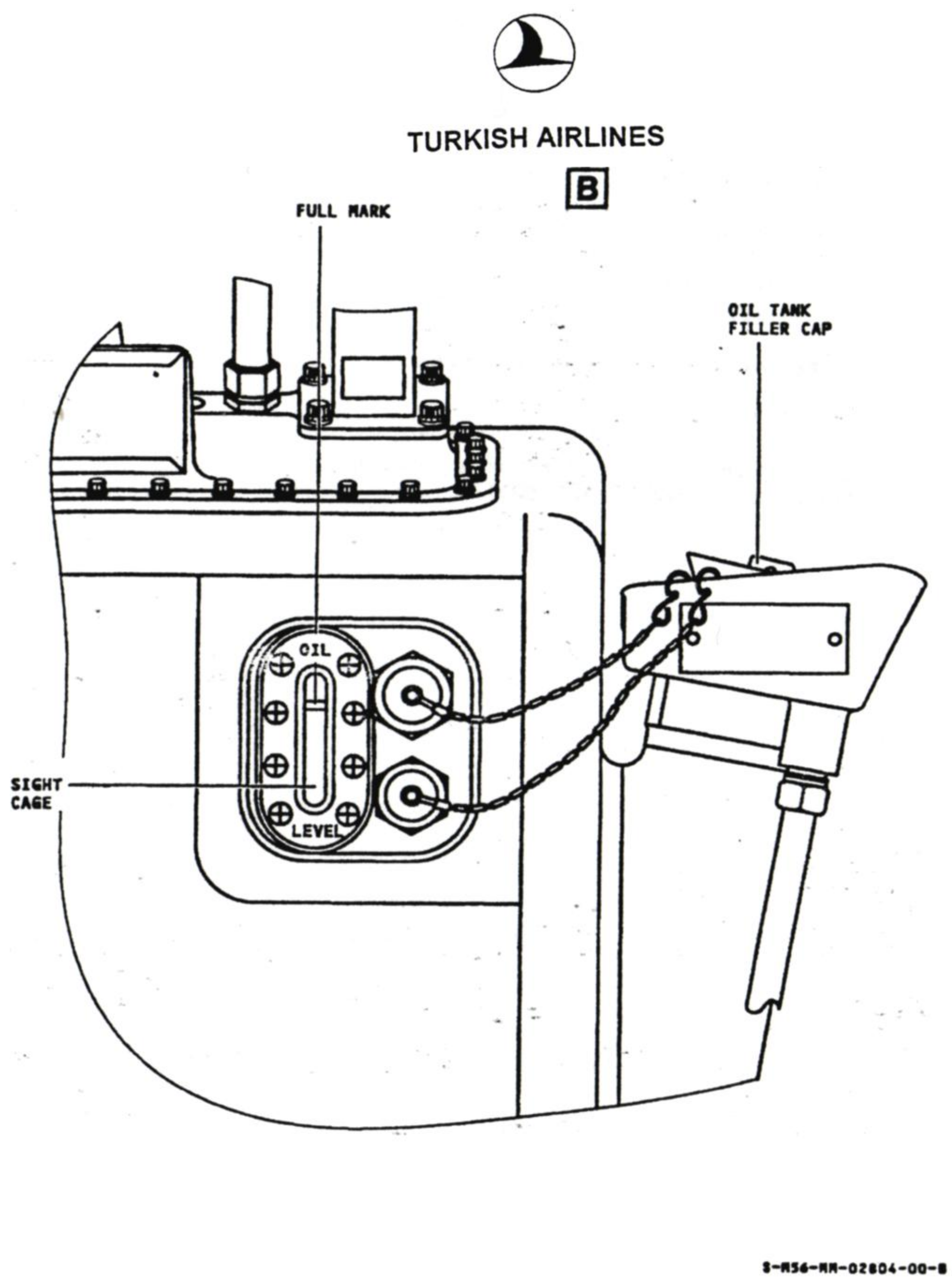


Removal of the Oil Tank Filler Cap
Figure 301/TASK 12-13-79-991-001

TURKISH AIRLINES



Sight Gage of the Oil Tank
Figure 302/TASK 12-13-79-991-002- 12 (SHEET 1)



Sight Gage of the Oil Tank
Figure 302/TASK 12-13-79-991-002- 22 (SHEET 2)

Subtask 12-13-79-160-050

B. Clean the oil tank scupper.

CAUTION: MAKE SURE THAT THE SCUPPER OF THE OIL TANK IS CLEAN TO PREVENT CONTAMINATION OF THE TANK DURING THE SERVICING OPERATION.

(1) Clean the oil tank scupper with a clean and lint-free cloth, before you remove the oil tank filler cap.

Subtask 12-13-79-010-055

C. Open the oil tank.

WARNING: AFTER ENGINE SHUTDOWN, LET THE OIL TANK PRESSURE BLEED OFF FOR AT LEAST 5 MINUTES BEFORE YOU REMOVE THE TANK FILLER CAP. IF YOU DO NOT, PRESSURIZED HOT OIL CAN GUSH OUT OF THE TANK AND CAUSE DANGEROUS BURNS.

(1) Move the handle of the oil tank filler cap to the vertical (unlocked) position.

(2) Firmly hold the handle, push down and simultaneously turn counterclockwise to disengage the locking device and remove the cap.

CAUTION: BEFORE YOU ADD OIL IN THE OIL TANK DURING ITS SERVICING, MAKE SURE THE OIL IN TANK DOES NOT CONTAIN FUEL.

(3) If the oil smells fuel, replace the main oil/fuel heat exchanger and the servo fuel heater (Ref. TASK 79-21-20-000-801) and (Ref. TASK 79-21-20-400-801) then flush the engine oil system (Ref. TASK 12-13-79-610-805).

Subtask 12-13-79-612-050

D. Oil Filling

CAUTION: MAKE SURE THAT THE OPENING OF THE CONTAINER USED TO FILL THE OIL TANK IS NOT CONTAMINATED.

**(1) Through the oil tank filling port, add engine oil (Material No.CP2442) up to the full mark.
(Ref. Fig. 302/TASK 12-13-79-991-002)**

Subtask 12-13-79-210-051

E. Inspect the 0-ring of the oil tank filler cap.

(1) Make sure that the 0-ring seal is in good condition or does not show signs of leakage before you install the oil tank filler cap. If not, remove the preformed packing (Ref. TASK 79-11-10-000-802) and replace the preformed packing (Ref. TASK 79-11-10-400-802).
Subtask 12-13-79-410-055

F. Close the oil tank.

(1) Install the oil tank filler cap. With the handle in vertical position, hold the handle, push down the cap and simultaneously turn clockwise to engage the locking device.

(2) Pull up the oil tank filler cap. If the locking device is properly engaged, you cannot pull the cap from the tank.

(3) Push the hinged oil tank cap handle down flat into the locked position.

5. Close-up

Subtask 12-13-79-865-051

A. Remove the safety clip(s) and the tag(s) and close this (these) circuit breaker(s):
FOR 4000EM1
12KS1, 13KS1
FOR 4000EM2
12KS2, 13KS2
FOR 4000EM3
12KS3, 13KS3
FOR 4000EM4
12KS4, 13KS4

Subtask 12-13-79-410-050

B. Close Access

(1) Close the protective door of the AC/DC emergency power center 740VU.

(2) Close the access door 811.

(3) Make sure that the work area is clean and clear of tools and other items.

(4) Close the oil tank access door:

- FOR 4000EM1
415BL
- FOR 4000EM2
425BL
- FOR 4000EM3
435BL
- FOR 4000EM4
445BL.

(5) Remove the access platform(s).

Subtask 12-13-79-862-050

C. De-energize the ground service network (Ref. TASK 24-42-00-862-801).

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TURKISH AIRLINES

Answer the following exercises according to the passage from the aircraft maintenance manual.

<u>Exercise:</u> Which of the four sentences corresponds best to the paragraph?

1. Make sure that the engine (1), (2), (3), (4) shut down occurred not less than 5 minutes before you do this procedure.
   A) You must wait at least 5 minutes after the engine (1), (2), (3), (4) is shut down to do this procedure.
   B) Do this procedure right after the engine (1), (2), (3), (4) shut down occurred.
   C) You mustn't do this procedure before you make sure that the engine (1), (2), (3), (4) shut down did not occur.
   D) You can do this procedure whenever the engine (1), (2), (3), (4) shut down occurred.

2. Make sure that the scupper of the oil tank is clean to prevent contamination of the tank during the servicing operation.
   A) The scupper of the oil tank must be clean *to* cause contamination of the tank during the servicing operation.
   B) If the tank is contaminated during the servicing operation, you must not clean it.
   C) The scupper of the oil tank must be clean so that the tank is not contaminated during the servicing operation.
   D) The tank cannot be contaminated because of the scupper of the oil tank.

3. Check the oil level on the sight gage. If the oil is below the full mark, add oil.
   A) If the oil level is not marked, check it.
   B) You must not add oil when you see the oil is not above the full mark.
   C) Add oil before you check the oil level on the sight gage.
   D) Put more oil in after you make sure that the oil is below the full mark.

4. Before you add oil in the oil tank during its servicing, make sure the oil in tank does not contain fuel.
   A) If the oil in the tank does not have fuel, you can add fuel.
   B) Before you add the oil in the oil tank, you must check that the oil does not have fuel in it.
   C) You must make sure that there is not any oil in the tank before, adding fuel.
   D) Add oil in the oil tank whenever the fuel tank does not contain fuel.

5. Make sure that the opening of the container used to fill the oil tank is not contaminated.
   A) You must check the opening of the container. If it is contaminated, it can be used to fill the oil.
   B) Do not contaminate the oil tank when opening the container.
   C) Make certain that the opening of the container that is used to fill the oil tank is clean.
   D) You must prevent the oil tank from being contaminated.

Exercise:

Fill in the spaces with the following words:

A. Install
B. Sight gage
C. Contaminated
D. Clear of
E. Pressurized
F. Vertical
G. Bleed off
H. Lint-free
İ. Locking device
J. Procedure
K. Adjustable
L. Leakage
M. Replaced
N. Add

1. You must let the oil tank pressure___________ for at least 5 minutes, after the engine shut down.
2. After closing the oil tank you must___________ the oil filler cap.
3. Put the___________ access platform in position on the left side of the engine.
4. Check the oil level on the______ If the oil below the full mark, ___________oil.
5. You have to follow the ________from the documents.
6. You can pull the filler cap from the tank only if the___________ is properly disengaged.
7. You must clean the scupper with a____________ cloth to prevent the oil tank from being ____________.
8. If you want to open the oil tank, you should move the handle of the cap to the__________ position.
9. The main oil/fuel heat exchanger and the servo fuel heater must be __________, if the oil in the tank contains fuel.
10. __________ hot oil can gush out of the tank, if you open the filler cap right after the engine shut down.
11. If the 0-ring seal shows signs of______ remove the preformed packing.
12. When you finish your work, you make sure that the work area is______ tools.

Exercise:

Match the words with the corresponding explanations:

1	**Counterclockwise**	**A**	Force that a quantity of gas has on a surface that it touches
2	**Disengage**	**B**	Take away
3	**Occur**	**C**	An amount of liquid that escapes from a container through a hole or a crack
4	**Pressure**	**D**	At the same time
5	**Level**	**E**	Which keeps you safe
6	**Remove**	**F**	Point on a scale
7	**Protective**	**G**	To the left
8	**Simultaneously**	**H**	Separate things that are connected
9	**Leakage**	**I**	Happen
10	**Clear of**	**J**	Free from

Exercise:

Find the word having the same meaning as the underlined word:

1. Add engine oil up to the full mark.
   A) Until
   B) Below
   C) Above
   D) More than

2. Push the handle down flat into the locked position.
   A) Right
   B) Vertically
   C) Horizontally
   D) Counterclockwise

3. Add oil through the oil tank filling port.
   A) Less than
   B) Under
   C) By way of
   D) Before

4. The scupper of the oil must be clean to prevent contamination.
   A) In order to
   B) Up to
   C) Until
   D) Prior to

4.1.3. A quotation from Aircraft Maintenance Manual

BOEING 737
MAINTENANCE MANUAL

TURKISH AIRLINES
WATER SYSTEM

POTABLE WATER SYSTEM - SERVICING

1. General

A. This procedure has a task to fill the potable water tank.
B. The procedure to drain and clean the potable water tank with a disinfectant is in section 38-11-00/301.

2. Potable Water Tank - Servicing (Fig. 301)

(1) Open the access panel for the potable water service panel.

(2) Remove the cap for the fill connection.

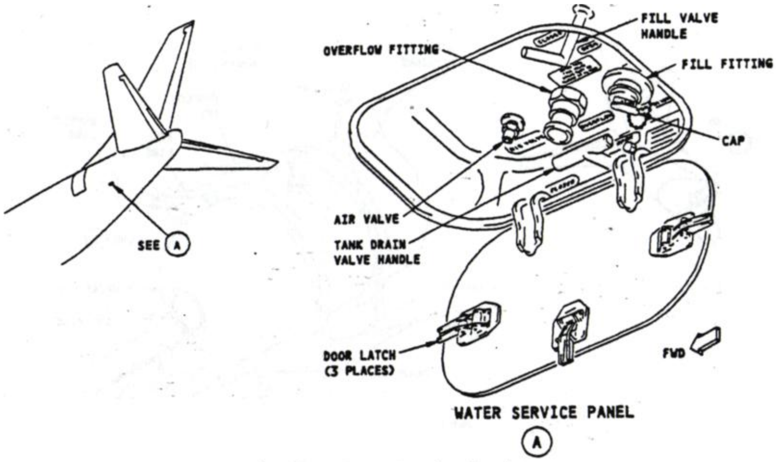
(3) Connect the water supply hose to the fill connection at the service panel.

(4) Turn the handle for the fill valve to the open position.

NOTE; you will not have sufficient pressure in the pneumatic system with the fill valve in the open position. A fill valve in the open position will not prevent high pressure in the pneumatic system when the tank is full.

CAUTION: THE WATER PRESSURE MUST NOT BE MORE THAN 35 PSI. IF WATER PRESSURE IS MORE THAN 35 PSI, IT CAN CAUSE DAMAGE TO THE WATER TANK.

(5) Use a pressure of 25-30 psi to fill the tank with water.



Passenger Water Service Panel
Figure 301

(6) Stop the procedure to fill the water tank when the water flows from the overflow port.

(7) Turn the handle for the fill valve to the closed position.

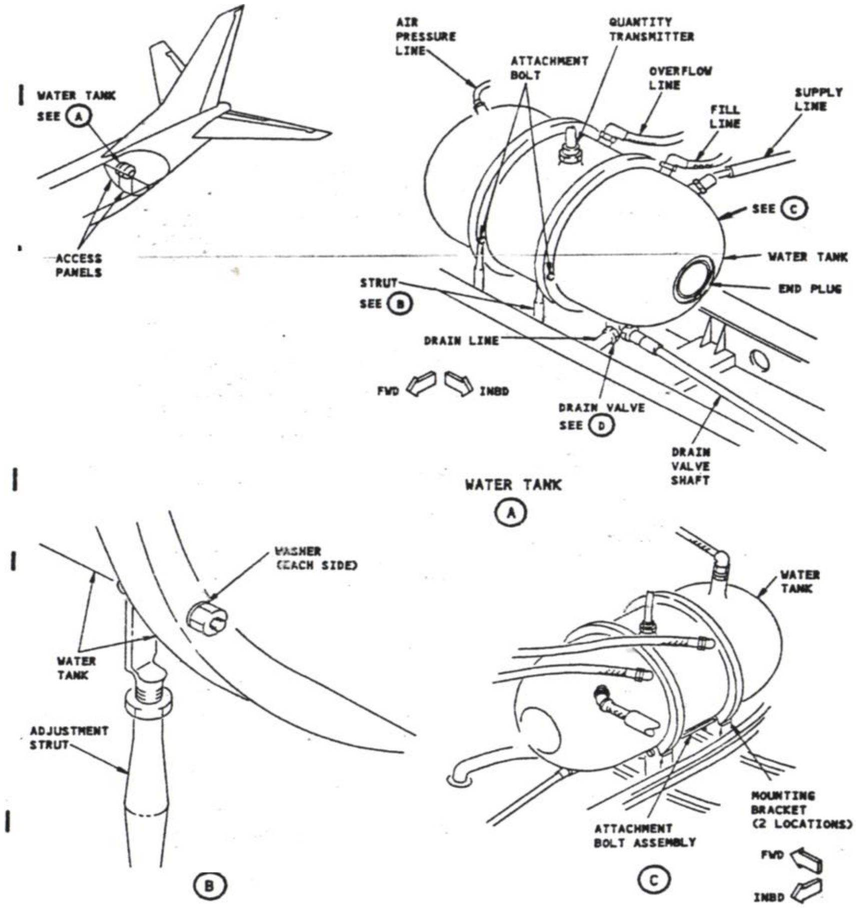
(8) Disconnect the water supply hose from the fill connection.

(9) Drain the water supply hose.

(10) Install the cap on the fill connection.

(11) Add pressure through the air valve on the service panel to use the water system, if it is necessary (Ref 38-41-00/201).

(12) Close the access panel for the potable water service panel.



Potable Water Tank Installation
Figure 401 (Sheet 1)

PASSENGER WATER SYSTEM - SERVICING

1. General

A. It is necessary to completely drain the water system before disinfecting it or when parking the airplane in freezing weather.

B. The water system should be disinfected routinely at regular intervals, whenever it is contaminated or when maintenance is performed that could cause contamination.

2. Pressure Draining Passenger Water System

A. Open all lavatory water heater circuit breakers on P18.

B. Pressurize water system (Ref 38-41-00, MP).

C. Open tank drain valve:
D. In each lavatory, open sink cabinet door and position lavatory drain valve handle to DRAIN.
E. When water stops flowing from drain outlets close tank drain valve. Position lavatory drain valve handles to ON.
F. Allow 2 minutes for pressure to stabilize.
G. In each lavatory, position lavatory drain valve handle to DRAIN to exhaust residual water, then to ON.
H. In each lavatory allow 2 minutes for pressure to stabilize, open each water faucet for 1/2 minute, then close.
I. Allow 2 minutes for pressure to stabilize, then open each galley water outlet and drain water into gallon container. Close galley water outlet.
j. Where applicable, disconnect coffeemaker and repeat step I.
K. Restore airplane to normal.
(1) Depressurize water tank (Ref 38-41-00, MP).
(2) Where applicable, connect coffeemaker to water supply in galley.

3. Gravity Draining Passenger Water System

A. Open all lavatory water heater circuit breakers on P18.
B. Open fill and overflow valve and tank drain valve. In each lavatory, position lavatory drain valve handle to DRAIN.
C. When water stops flowing from drain outlets, close fill and overflow valve and tank drain valve. Position lavatory drain valve handles to ON.
D. Open each galley water outlet and drain water into gallon container. Close outlet.
E. Where applicable, disconnect coffeemaker and repeat step D.
F. Install towel disposal container as necessary and close doors.

4. Disinfect Passenger Water System

A. General
(1) The passenger water system may be disinfected with an application of the following:
(a) 50 parts per million of chlorine acidified with vinegar
(b) 100 parts per million of chlorine - not acidified
(c) 50 parts per million of chlorine - not acidified

NOTE: Disinfecting time for (a) and (b) is 1 hour.

Disinfecting time for (c) is 4 hours.

(2) Recommended chlorine solution (concentrated). The following concentrated solution will result in a 50 parts per million of acidified chlorine solution when added to a 30-gallon water tank. This solution minimizes the objectionable taste normally attributed to disinfectants and requires a shorter disinfecting time.

(a) 9 fluid ounces (266 ml) chlorine dioxide stabilized 2%

(b) 9 fluid ounces (266 ml) acetic acid (vinegar)

(c) Approximately 1 gallon (4 liters) clean water

<u>NOTE</u>: Let mixture stand 5 minutes to complete activation.

B. Remove all filter cartridges from water system, where applicable, including coffeemakers. Reinstall filter caps.

<u>NOTE</u>: An excessive amount of disinfectant in the passenger water system may contaminate filters and give an objectionable taste of chlorinated water. Use of the recommended chlorine solution (Ref par. A. (2)) will minimize the objectionable taste.

C. Drain system (Ref par. 2 or 3).

D. Fill system with chlorinated water which contains 50 or 100 parts per million of chlorine (12-14-00, SRV).

(1) Water may be chlorinated in three different ways.

(a) A concentrated chlorine solution may be introduced first and the system then be filled with drinkable water.

(b) A concentrated chlorine solution may be mixed with drinkable water and then pumped into system.

(c) A concentrated solution may be added while system is being filled with drinkable water.

E. After system is filled with chlorinated water and chlorinated water has appeared at overflow fitting on service panel, close fill and overflow valve.

F. Pressurize system (Ref 38-41-00, MP).

G. Open each lavatory faucet and each galley water outlet(s) until chlorinated water appears at each.

H. Connect hose from chlorinated water source to fill connection.

I. Connect a length of hose to overflow fitting to avoid contact with chlorinated water under pressure.

J. Slowly open fill and overflow valve.

K. Top off tank with chlorinated water (Ref step D).

L. Let chlorinated water stand in system for 1 hour if filled with 50 parts per million of acidified chlorine or 100 parts per million of chlorine (not acidified) solution. Let chlorinated water stand for 4 hours if filled with 50 parts per million of chlorine (not acidified).

M. Drain system (Ref par. 2 or 3).

N. Fill system with drinkable water (12-14-00, SRV).

0. Repeat steps E through N, substituting drinkable water for chlorinated water, as many times as necessary until chlorine content in water is not objectionable.

P. Return system to normal as follows:

(1) At each lavatory, position lavatory drain valve handle to ON.

(2) Install clean filter cartridges and coffeemaker as applicable.

(3) Rewove hose from overflow fitting.

Answer the following exercises according to the passage from the aircraft maintenance hand book.

Exercise:

Fill in the gaps with one of the following words:

A. procedure
B. drain
C. clean
D. disinfectant
E. access
F. remove
G. connect
H. sufficient
İ. prevent
J. damage
K. necessary
L. through

1. After you have removed this panel you will have ____________ to the parts.
2. If you find any contamination in the system you must______________ it immediately.
3. If the plane is parked overnight at sub-zero temperatures it is always _________to drain the water tank.
4. Drain the water tank as stated in the____________ which you will find in the maintenance manual.
5. You must use______________ disinfectant otherwise there will still be some bacteria in the system.
6. Let the water flow _____________ this line into the drain tank.
7. First you have to_____________the filler cap then you can add the oil.
8. Make sure there is no personnel near the system before you _____________the power supply.
9. A thick coat of primer will_____________ rust.
10. Too much stress on the part will cause structural___________.
11. Only use approved___________ to clean the water system.
12. Use the pressure method to____________the water tank - this is much faster than the gravity method.

Exercise:

Try and connect the following sentences:

1. The procedure to drain and clean the

2. Connect the water supply

3. You will not have sufficient pressure in the pneumatic

4. The water pressure must

5. Use a pressure of 25-

A. 30 psi to fill the tank with water.

B. hose to the fill connection at the service panel.

C. not be more than 35 psi.

D. potable water tank with a disinfectant is in section 38-11-00.

E. system with the fill valve in the open position.

Exercise:

Try and connect the following sentences:

1. Stop the procedure to fill the water tank

2. Turn the handle for the fill

3. Open all lavatory water heater

4. Where applicable, connect

5. When water stops flowing from drain outlets,

A. circuit breakers on P18. B.

B. coffeemaker to water supply in galley.

C. close fill and overflow valve and tank drain valve.

D. when the water flows from the overflow port.

E. valve to the closed position.

4.2. Structure Repairing Manual

Figure 4.3: A technician repairing an aircraft engine

4.2.1. Aircraft Metallic Repair

One of the most important jobs you will encounter is the repair of damaged skin and material. All repairs must be of the highest quality and must conform to certain requirements and specifications.

You must be familiar with the principle of streamlining, the behavior of various metals in high-velocity air currents, and the torsioned stress encountered during high-speed flying and maneuvering. You must also be familiar with the tools, special equipment, terms, and techniques used to accomplish this type of maintenance.

When any part of the airframe has been damaged, the first step is to clean all grease, dirt, and paint in the vicinity of the damage so the extent of the damage may be determined. The adjacent structure must be inspected to determine what secondary damage may have resulted from the transmission of the load or loads that caused the initial damage. You should thoroughly inspect the adjacent structures for dents, scratches, abrasions, punctures, cracks, loose seams, and distortions. Check all bolted fittings that may have been damaged or loosened by the load that caused the damage to the structure.

4.2.1.1. Causes of Damage

Collision: This type of damage is often the result of carelessness by maintenance personnel. It varies from minor damage, such as dented or broken areas of skin, to extensive damage, such as torn or crushed structural members and misalignment of the aircraft. You should exercise extreme care in all ground-handling operations.

Corrosion: Damage to airframe components and the structure caused by corrosion will develop into permanent damage or failure if not properly treated. The corrosion control section of the maintenance instructions manual describes the maximum damage limits. These limits should be checked carefully, and if they are exceeded, the component or structure must be repaired or replaced.

Fatigue: This type of damage is more noticeable as the operating time of the aircraft accumulates. The damage will begin as small cracks, caused by vibration and other loads imposed on skin fittings and load-bearing members, where the fittings are attached.

Foreign Object: This damage is caused by hand tools, bolts, rivets, and nuts left adrift during ground operations of the aircraft. Because of jet aircraft design, large volumes of air are required for its efficient operation. During ground operations, the inlet ducts induce a strong suction that picks up objects that are left adrift. Therefore, it is of utmost importance that the area around the aircraft be clean and free of foreign material before ground operations begin.

Combat: Damage from enemy gunfire is usually quite extensive and often not repairable. When a projectile strikes sheet metal, it heats the metal in the vicinity of the damage. The metal becomes brittle around the damaged area as a result of the heat, and minute cracks are created by the impact of the projectile. These cracks open up under vibration. If the projectile passes through the component or structure, it will leave a larger hole on the opposite side from where it entered. The repair procedures for combat damage should be followed with extreme care.

Heat: Certain areas of high-performance air-craft are exposed to high temperatures. These areas usually include the engine bleed lines, fuselage sections around the engine, the aft fuselage and horizontal stabilizer, and the wing sections around the boundary layer control system. Some aircraft structural repair manuals include diagrams that illustrate the heat danger areas.

Stress: This type of damage is usually identified by loosened, sheared, or popped rivets; wrinkled skin or webs; and cracked or deformed structural members. This damage is usually caused by violent maneuvers or hard landings. When the pilot reports these discrepancies on the yellow sheet, a thorough inspection of the entire aircraft must be performed.

4.2.1.2. Classification Of Damage

After the extent of damage has been determined, it should be classified in one of the following categories: negligible damage, damage repairable by patching, damage repairable by insertion, or damage requiring replacement of parts. See figure 4.4 before proceeding with the repair of the airframe, it is necessary that the applicable structural repair manual be consulted for the procedures and materials to be used.

Negligible Damage: Negligible damage is that damage or distortion that may be allowed to exist as is or corrected by some simple procedure, such as removing dents, stop-drilling cracks, burnishing scratches or abrasions, without placing a restriction on the flight status of the aircraft. Before classifying damage as negligible, make sure the damage complies with the manufacturer’s specified limits of negligible damage.

Damage Repairable by Patching: Damage that can be repaired by installing a reinforcement or patch to bridge the damaged portion of a part may be classified as a damage repairable by patching. Reinforcement members are attached to the undamaged portions of the part to restore full load-carrying characteristics and airworthiness of the aircraft. Damage repairable by patching is specified for each member of the airframe.

Damage Repairable By Insertion: The damage that is extensive enough to involve a major portion of a member, but which is not so extensive as to require replacement, is classified as damage repairable by insertion. The repair is made by inserting a new section and splicing it to the affected member.

Damage Requiring Replacement: Damage that cannot be repaired by any practical means is classified as damage requiring replacement. Short structural members usually must be replaced because repair of such members is generally impractical.

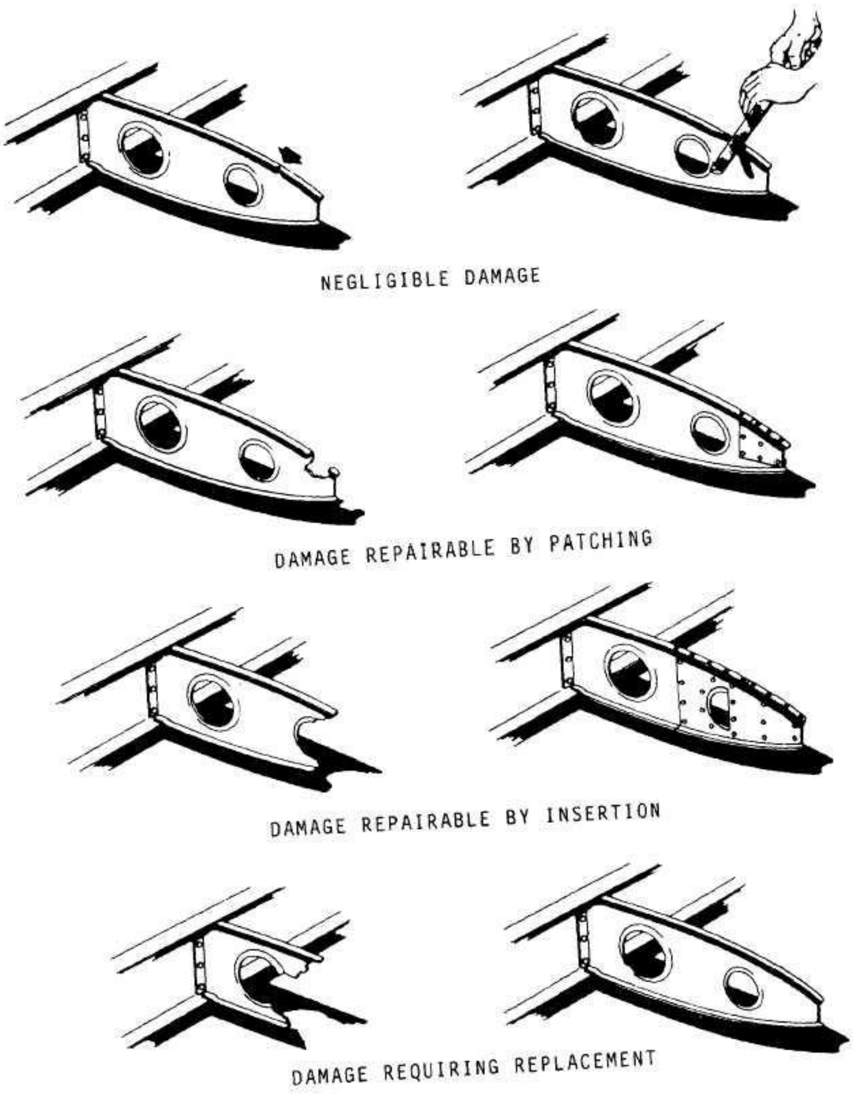


Figure 4.4: Classification of damages

4.2.1.3. Selection of Repair Material

The major requirement in making a repair is the duplication of strength of the original structure. You should consult the structural repair manual for the aircraft concerned for the alloy thickness and temper designation of the repair material to be used. This manual will also designate the type and spacing of rivets or fasteners to be used in the repair.

In some instances, substitutions of materials are allowed. When you are making a substitution of materials and conflicting information between manuals exists, the structural repair manual for the aircraft being repaired should be used.

You have several steps to take to find the correct repair materials and procedures in a structural repair manual.

NOTE: The aircraft structural repair manual, was selected as a typical manual. The procedures that follow are typical but are not standard. Various manufacturers use different methods to indicate the types of materials used and special instructions for using their particular manual.

1. The extent of the damage to the aircraft is determined by the inspection of the damaged area.
2. Using a master index diagram, identify the damaged group of the aircraft. From the table shown on the diagram, determine the section of the manual where the component is found.
3. After locating the correct group master index diagram, obtain the correct item number for the damaged component from the illustration.
4. Find the index number for the damaged unit from the component diagram.
5. The index number is then matched with the item number on the repair material chart. This chart will normally give the part’s description, drawing number, gauge, type of material, and location of repair diagram.
6. You can find the repair diagram by locating the required section of the manual and turning to the correct figure in that section. Access provisions and negligible damage information are given on the repair diagrams. After the damage has been cleaned, determine whether or not the damage is negligible according to the repair diagram. If the damage is within the limits of negligible damage, it may be disregarded unless it is necessary to close the hole for aerodynamic smoothness. If the damage exceeds the limits of negligible damage, it must be repaired according to the repair diagram or replaced.

4.2.1.4. Types of Repairs

The type of repair to be made will depend on the materials, tools, amount of time available, accessibility to the damaged area, and maintenance level. The types of repair are permanent, temporary, and one-time flight (ferry). Repairs are also classified as either internal or external. A permanent repair is one that restores the strength of the repaired structure equal to or greater than its original strength and satisfies aerodynamic, thermal, and interchangeability requirements, This ensures the designed capabilities of the aircraft. The temporary repair restores the load-carrying ability of the structure but is not aerodynamically smooth or able to satisfy interchangeability requirements. This repair should be replaced by a permanent type as soon as possible in order for the aircraft to be restored to its normal condition.

4.2.2. Aircraft Nonmetallic Repair

4.2.2.1. Maintaining Transparent Plastic Materials

Because of the many uses of plastic materials in aircraft, optical quality is of great importance. These plastic materials are similar to plate glass in many of their optical characteristics. Ability to locate and identify other aircraft in flight, to land safely at high speeds, to maintain position in formation, and in some cases, to sight guns accurately through plastic enclosures all depend upon the surface cleanliness, clarity, and freedom from distortion of the plastic material. These factors depend entirely upon the amount of care exercised in the handling, fabrication, maintenance, and repair of the material.

Plastics have many advantages over glass for aircraft application, particularly the lightness in weight and ease of fabrication and repairs. They lack the surface hardness of glass and are very easily scratched, with resulting impairment of vision. You must exercise care while servicing all aircraft to avoid scratching or otherwise damaging the plastic surface. Specific procedures are described later in this section for minor maintenance; however, the following general rules are emphasized:

1. Transparent plastic materials should be handled only with clean cotton gloves.
2. The use of harmful liquids, such as cleaning agents, should be avoided.
3. Fabrication, repair, installation, and maintenance instructions must be closely followed.
4. Operations that might tend to scratch or distort the plastic surface must be avoided. You must take care to avoid scratching plastic surfaces with finger rings or other sharp objects.

Just as woods split and metals crack in areas of high, localized stress, plastic materials develop, under similar conditions, small surface fissures called *crazing.* These tiny cracks are approximately perpendicular to the surface, very narrow in width, and usually not over 0.01 inch in depth. These tiny fissures are not only an optical defect, but also a mechanical defect, as there is a separation or parting of material.

If the crazing is in a random pattern, it is usually caused by the action of solvent or solvent vapors. If the crazing is approximately parallel, it is usually caused by directional stress, set up by cold forming, excessive loading, improper installation, improper machining, or a combination of these with the action of solvents or solvent vapors.

Crazing can be caused by improper cleaning, improper installation, improper machining, or cold forming. Once a part has been crazed, neither the optical nor the mechanical defect can be removed permanently; therefore, prevention of crazing is very important.

Cleaning Plastic Surfaces: Masking paper should be left on the plastic as long as possible. When it is necessary to remove the masking paper from the plastic during fabrication or installation, the surface should be remasked as soon as possible. Either replace the original paper or apply masking tape.

NOTE: Water containing dirt and abrasive materials may scratch the plastic surface. A clean, soft cloth, sponge, or chamois may be used to apply the soap and water to the plastic. The cloth, sponge, or chamois should not be used for scrubbing; use the hand method as described for removing dirt or other foreign particles.

Dry with a clean, damp chamois, a soft, clean cloth, or a soft tissue by blotting the surface until dry. Rubbing the surface of the plastic will induce (build up) an electrostatic charge that attracts dust particles to the surface. If the surface does become charged, patting or gently blotting with a damp, clean cloth will remove this charge as well as the dust.

4.2.2.2. Repairing Reinforced Plastic

The repair of any damaged component made of reinforced plastic requires the use of identical materials, whenever they are available, or of approved substitutes for rebuilding the damaged portion. Abrupt changes in cross-sectional areas must be avoided by tapering joints, by making small patches round or oval instead of rectangular, and by rounding the corners of all large repairs. Repairs of punctured facings and fractured cores necessitate removal of all the damaged material, followed by replacement with the same type of material and in the same thickness as the original. All repairs to enable it to carry its portion of the load. If a plastic panel is installed in a binding or twisted position and screws are not torqued correctly, the plastic panel may fail while the aircraft is undergoing normal taxiing and flight operations.

When you remove a plastic panel, there may be several different lengths of screws to be removed. You will save a lot of time by acquiring the habit of keeping screws separated. An easy way to do this is to draw a diagram of the panel on cardboard. Puncture each screw hole, with an awl, through the cardboard. As each screw is removed from the panel, it is installed in its respective position on the cardboard. This is done with each screw as it is removed.

During installation of the panel, remove each screw from the cardboard and reinstall it in the same hole from which it was removed until all of the screws are reinstalled. If any screws or other fasteners are damaged during removal or reinstallation, the part replaced must be the same part number as the damaged part. Some fasteners are required to be of nonmagnetic material because of their location near compasses and other instruments.

4.2.2.3. Repairing Surface Damage

The most common types of damage to the surface are abrasions, scratches, scars, dents, cuts, and pits. Minor surface damages may be repaired by applying one or more coats of room-temperature catalyzed resin to the damaged area. More severe damages may be repaired by filling with a paste made from room-temperature resin and short glass fibers. Over this coated surface, apply a sheet of cellophane, extending 2 or 3 inches beyond the repaired area. After the cellophane is taped in place, start in the center of the repair and lightly brush out all the air bubbles and excessive resin with your hand or a rubber squeegee towards the outer ridge of the repair. Allow the resin to cure at room temperature, or if necessary, the cure can be hastened by the use of infrared lamps or hot sandbags. After the resin has been cured, remove the cellophane and sand off the excess resin; then, lightly sand the entire repaired area to prepare it for refinishing.

4.2.2.4. Repairing the Trailing Edge of an Airfoil

A trailing edge is the rearmost edge of an airfoil (wing, flap, rudder, elevator, etc.). It maybe a formed or machined metal strip or possibly a metal-covered honeycomb or balsa wood core material that forms the shape of the edge by tying the ends of a rib section together and joining the upper and lower skins. These trailing edges are very easily damaged. The majority of this type of damage can be avoided if care is taken when moving aircraft in confined spaces, and/or when positioning ground support equipment around parked aircraft. The trailing edges on some high-performance aircraft are almost knife edge in construction. You must take extreme care when working around these surfaces to avoid injury.

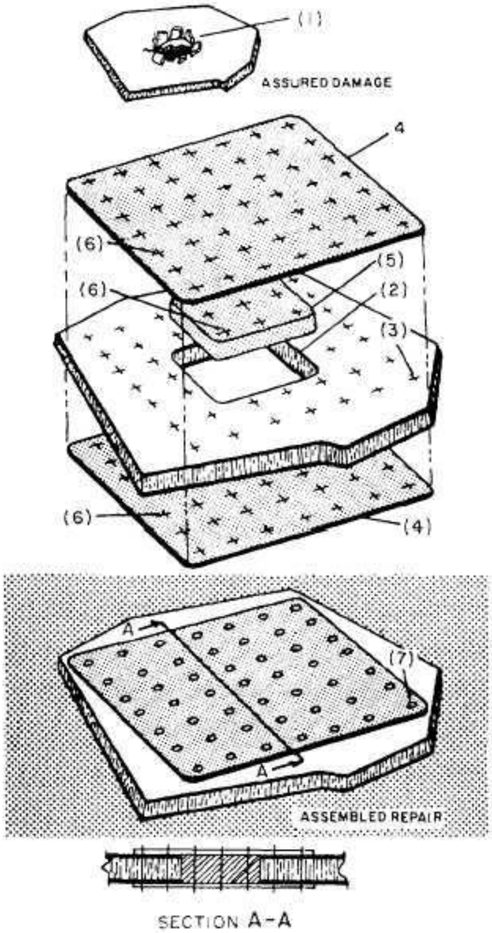


Figure 4.5: Balsa wood repair with nonflush patch.

Trailing edge repairs to all-metal construction assemblies and/or control surfaces are performed by using basically the same procedures outlined in the chapter titled "Aircraft Metallic Repair." You may use the lap or flush patch, depending on the size of the damage, the type of aircraft, and the assembly or control surface to be repaired. Normally, the flush patch is used on control surfaces to ensure aerodynamic smoothness. When aerodynamic smoothness is not desired, a nonflush patch such as the one shown in figure 4.5 can be used. Notice that this type of repair uses two patch plates, a wood filler, and nonflush rivets.

4.2.2.5. Repair Criteria

Repair criteria differ in the same way that initial design requirements for aircraft differ. Criteria for a repair can be less demanding if the repair is considered to be temporary. Temporary repairs are performed for such requirements as a onetime flight to a repair facility or one more mission under combat conditions. However, most repairs are intended to be permanent, and, except for special conditions, criteria are applied so that the repair will remain acceptable for the life of the aircraft.

One of the major factors that influence the repair quality is the environment where the repairs are made. For example, the presence of moisture is critical to bonded repairs. Epoxy resins can absorb 1.5 to 2 times their weight in moisture, thereby reducing the ability of the resins to support the fibers. Dirt and dust can seriously affect bonded repairs. Oils, vapors, and solvents prevent good adhesion in bonded surfaces and can lead to voids or delamination. To perform quality repairs, personnel must have knowledge of the composite system to be repaired, type of damage, damage limitations/classifications, repair publications, materials, tools and equipment, and repair procedures. The repair facilities where the work is to be performed will be clean and climate controlled if possible. The relative humidity should be 25 percent to 60 percent and temperatures stable at 65° to 75°F. If repairs are to be made in an uncontrolled environment (hangar/flight deck), patches and adhesives will be prepared in a controlled environment and sealed in an airtight bag before being brought to the repair site.

Exercise: Interpretation of words and phrases: Circle the letter next to the best answer.

1. When any part of the airframe has been damaged, the first step is to clean all grease, dirt, and paint in the ***vicinity*** of the damage so the extent of the damage may be determined.
   A) Cause
   B) Surroundings
   C) Harm

2. During ground operations, the inlet ducts induce a strong ***suction*** that picks up objects that are left adrift.
   A) Absorption
   B) Condition
   C) Ignition

3. The metal becomes ***brittle*** around the damaged area as a result of the heat, and minute cracks are created by the impact of the projectile.
   A) Thin-skinned
   B) Wide
   C) Too hot

4. When the pilot reports these ***discrepancies*** on the yellow sheet, a thorough inspection of the entire aircraft must be performed.
   A) Faults
   B) Incompatibilities
   C) Weaknesses

5. They lack the surface hardness of glass and are very easily scratched, with resulting ***impairment*** of vision.
   A) Wrinkle
   B) Blur
   C) Deformation

6. Operations that might tend to scratch or ***distort*** the plastic surface must be avoided.
   A) Warp
   B) Tear
   C) Remove

7. These tiny ***fissures*** are not only an optical defect, but also a mechanical defect, as there is a separation or parting of material.
   A) Shapes
   B) Bulges
   C) Slots

8. ***Abrupt*** changes in cross-sectional areas must be avoided by tapering joints, by making small patches round or oval instead of rectangular, and by rounding the corners of all large repairs.
   A) Complex
   B) Sudden
   C) Destructive

9. ***Puncture*** each screw hole, with an awl, through the cardboard.
   A) Mark
   B) Drill
   C) Fix

10. Allow the resin to cure at room temperature, or if necessary, the cure can be ***hastened*** by the use of infrared lamps or hot sandbags.
    A) Accelerated
    B) Treated
    C) Applied

11. The majority of this type of damage can be avoided if care is taken when moving aircraft in ***confined*** spaces, and/or when positioning ground support equipment around parked aircraft.
    A) Clear
    B) Wide
    C) Limited

12. Oils, vapors, and solvents prevent good ***adhesion*** in bonded surfaces and can lead to voids or delamination.
    A) Attachment
    B) Operating
    C) Protection

<u>Exercise:</u> Vocabulary

1. Maneuvering
2. Adjacent
3. Wrinkled
4. Abrasion
5. Duplication
6. Emphasize
7. Improper
8. Reinforce
9. Acquire
10. Squeegee

4.2.3. A quotation from constructional manual

A320

STRUCTURAL REPAIR MANUAL

MATERIALS

1. General

The structure construction of the aircraft is made of different metallic and nonmetallic materials. To repair a damage at the structure it is recommended to use "original repair materials". These materials are divided in different chapters which also contain more information about it. The relevant chapters are given in the paragraph below.

A. Information about metallic materials are given in the subsequent chapters:

Chapter 51-31-00 METALLIC MATERIALS

B. Information about nonmetallic materials and their location are shown in:

Chapter 51-33-00 NONMETALLIC MATERIALS

C. Information about all necessary consumable materials are shown in:

Chapter 51-35-00 CONSUMABLE MATERIALS

FLAP PEENING

1. General

CAUTION: THE PROCEDURE GIVEN IN THIS CHAPTER MUST ONLY BE DONE BY TRAINED PERSONS.

A. This Chapter gives you the information necessary for the flap peening procedure. This procedure is usually used when it is necessary to pre-stress the surface of a component or part of the structure. This procedure will improve the fatigue performance of the component.

B. This procedure is suitable for in-situ repair work, the repair of small areas up to 10000 sq. mm (15.5 sq. in.), holes down to 25 mm (0.984 in.) diameter and fillets (Refer to Figure 1 for the applicable minimum fillet radii).

C. This procedure is not to be used on clad aluminum alloys, plated, primed or painted surfaces on steels, titanium or aluminum alloys.

NOTE: All coatings must be stripped prior to peening.

D. To do the peening, a flexible flap is secured in a mandrel. The flaps have shot particles of tungsten carbide bonded to them. The mandrel is fitted to a suitable power tool, and then rotated at a specific speed.

E. Peening flaps must be discarded after 30 minutes use, or, after the loss of 20 % of the tungsten carbide balls if this occurs sooner.

F. You must only use this procedure when it is specified in a repair procedure.

2. Safety Precautions

The flap peening procedure can be dangerous. You must obey the warnings that follow to make sure you do not cause injury or damage:

WARNING: YOU MUST WEAR APPROVED SAFETY CLOTHING WHEN YOU DO FLAP PEENING. THIS PROCEDURE CAN BE DANGEROUS.

WARNING: OBEY THE MANUFACTURER'S INSTRUCTIONS WHEN YOU USE THE CLEANING MATERIALS AND THE OTHER ASSOCIATED MATERIALS SPECIFIED IN THIS PROCEDURE. THESE MATERIALS ARE DANGEROUS.

4. Preparation

A. General

(1) Before you do the peening procedure you must do a test. This test is done on an Almen test-piece, referred to as the test-piece in the steps that follow (Refer to Figure 3).

(2) The purpose of the test is to establish the applicable rotational speed in revolutions per minute (r.p.m.) at which the flap must be turned. This speed is determined by measuring the achieved Intensity (Arc Height) on the test-piece. The repair procedure will give the Intensity to be achieved. The Intensity will be given either as a range (for example, 0.016 - 0.020 in.), or a single dimension on which a tolerance of plus 10 % is permitted.

(3) The test procedure is given in Paragraph 4.B.

5. Peening Procedure

A. Preparation

(1) Remove the paint/primer from the required area (Refer to Chapter 51-75-11).

WARNING: CLEANING AGENT (MATERIAL NO. 11-003) IS DANGEROUS.

WARNING: CLEANING AGENT (MATERIAL NO. 11-004) IS DANGEROUS.

(2) Clean the area with cleaning agent (Material No. 11-003 or 11-004).

(3) Do the flaw detection and subsequent repairs if called up in the repair procedure.

(4) Make sure that all sharp edges, fillets and radii in the area are blended and smooth. Minimum radius and chamfer is 3 mm (0.12 in.).

(5) Protect adjacent surfaces that are not to be peened.

B. Peening

WARNING: YOU MUST WEAR APPROVED SAFETY CLOTHING WHEN YOU DO FLAP PEENING. THIS PROCESS CAN BE DANGEROUS.

(1) Peen the area specified in the repair procedure. Make sure that:

- you use the parameters established in Paragraph 4.B.,
- you keep the mandrel parallel to the surface,
- you move the mandrel around the inner face of a hole so that the shot does not drag on the surface.

(2) To achieve a uniform coverage move the flap in a 0 ° (lengthwise), a + 45 ° and - 45 ° alternate criss-cross pattern (Refer to Figure 9).

(3) Examine the area to make sure that you have achieved full coverage (Refer to Paragraph 4.C.(1).

C. Treatment after Peening

(1) Clean and re-protect the peened surface (Refer to Chapter 51-21-11).

<u>NOTE:</u> This must be done within 2 hours of completing the peening step.

(2) Repaint/prime the peened surface as applicable (Refer to Chapter 51-75-12).

4.3. Illustrated Parts Catalogue

4.3.1. A quotation from the Illustrated Parts Catalogue

ILLUSTRATED PARTS CATALOGUE

INTRODUCTION

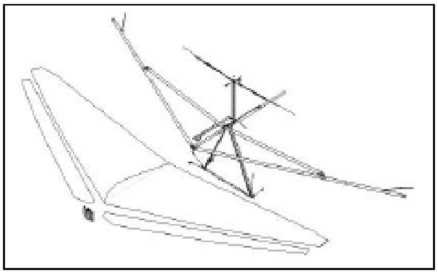
WARNING

SOME PARTS WHICH ARE LISTED ARE COMPONENTS OF PARTS WHICH ARE NOT USER SERVICABLE. ONLY MAINTENANCE WHICH IS SPECIFIED IN THE MAINTENANCE MANUAL SHOULD BE ATTEMPTED AND ONLY THE EXACT SPARE SHOULD BE USED TO REPLACE PARTS. THE FOLLOWING DRAWINGS ARE PROVIDED AS A CONVIENIENCE TO AID IDENTIFICATION OF PARTS WHICH ARE USER MAINTAINABLE.

This manual should be used in conjunction with the correct maintenance manual, and repairs should only be carried out by competent people. Read the Maintenance manual before proceeding.

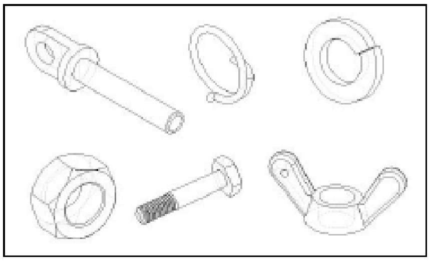
This parts catalogue has been prepared to aid in the identification of components that may effect the airworthiness of the Airborne Streak 3-B Series of Wings.
Drawings with various levels of detail are supplied that include all of the spare parts available – specific to the serial number identification of the wing.
Most of the parts listed are available as spare parts. If a component is not listed then it may only be available as a complete part. For example spare parts are not available for the base bar, only the entire base bar assembly is supplied as a spare part.
All parts available are named and have part numbers, this is the identification system that should be used to order spares, eg: Shackle RF615 4mm, Part Number 100406, and the quantity required.
NB. Some parts may have been used from other wings, and therefore have other model names in the title. The most important thing in ordering spare parts is the part number.

TABLE OF CONTENTS



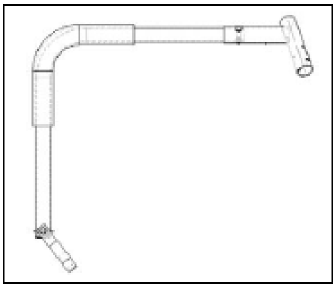
2 MISCELLANEOUS COMPONENTS

2.1 Dee Shackle Drawing - Drawing # 6338
2.2 Batten End Assembly - Drawing # 5321
2.3 AN3 Bolts - Drawing # 5449
2.4 AN4 Bolts - Drawing # 5450
2.5 AN5 Bolts - Drawing # 5493
2.6 Socket Cap Screws - Drawing # 5668



3 OPTIONS – TRAINING BARS

3.1 Training Bars - Drawing # 6505



NAVIGATING

This manual is constructed in a hierarchal manner, which is the same as a family tree, where the "Highest Level Drawing" of assembly is at the front of the manual, which is equivalent to the oldest member of the family tree, and it contains "Main Sub Chapters", which are the equivalent of it's children. In turn each of these four "Main Sub Chapters" operates in the same way, whereby the order of the drawings that it contains defines the order "underneath" it, and so on.

The top level assembly however contains individual parts as well, some of which do not require drawings, and some of which are included in the miscellaneous chapter 2.

NOTE

The item numbers do not always apply because not all of the next level of drawings are required. With some attention to the method of the system this manual is simple to navigate. The main thing to recognise is that each drawing underneath the "Main Sub Chapter" is pointed out by the balloon number on it so that the general area of the trike may be visually identified, and then the drawing number which is needed can be found.

Step 4. Order!

Now that the actual component has been found the Part Number **AND THE DESCRIPTION** can be recorded in order to make the spare part order.

E.g. Knob - Hand Plastic 30, Part # 106530.

APPLICATION ACTIVITY

Make conversations with each other in classroom, laboratory, workshop or wherever you are using terms and sentences involved technical English you have learned by the learning activity of metallic and non-metallic repair:

Figure 4.6: The metallic repair

Examples:

- All repairs made on an aircraft must be of the highest quality.
- Transparent plastic materials should be handled with clean cotton gloves.

CHECKLIST

If you have behaviors listed below, evaluate yourself putting (X) in “Yes” box for your earned skills within the scope of this activity otherwise put (X) in “No” box.

Evaluation criteria	Yes	No
1. Can you read the maintenance manual?		
2. Could you read the structure repairing manual?		
3. Are you able to translate from English to Turkish?		
4. Are you able to translate from Turkish to English?		

EVALUATION

Please review your “No" answers in the form at the end of the evaluation. If you do not find yourself enough, repeat learning activity. If you give all your answers "Yes" to all questions, pass to the "Measuring and Evaluation".

MEASURING AND EVALUATION

Evaluate the given knowledge, If the knowledge is TRUE, write “T” , if it is FALSE, write “F” to end of the empty parenthesis.

1. ( ) When any part of the airframe has been damaged, the first step is to clean surrounding of the damage.

2. ( ) According to the text from the manual, there are five different classes of damage for metallic repair.

3. ( ) All manufacturers use exactly the same methods to indicate the types of materials used.

4. ( ) If a structure’s damage exceeds the limits of damage repairable by patching, we’d better replace it.

5. ( ) One matter which affects the type of metallic repair is the available duration to repair the damage.

6. ( ) If a surface fissure of a nonmetallic structure is approximately parallel, it is probably caused by the action of solvent or solvent vapors.

7. ( ) Improper cleaning or improper installation may result with forming crazing.

8. ( ) All screws of a plastic panel are standardized and the same in size.

9. ( ) While dealing with trailing edges, some extreme care should be taken to prevent injury.

10. ( ) Procedures of trailing edge repairs for both metallic and non-metallic repairs are nearly identical.

EVALUATION

Please compare the answers with the answer key. If you have wrong answers, you need to review the Learning Activity. If you give right answers to all questions, pass to evaluation of the module.

MODULE EVALUATION

GENERAL EXERCISE

Read the following text which is quoted from aircraft maintenance manual, and then try to answer questions of the module evaluation exercise.

HYDRAULIC SYSTEM

AIRCRAFT MAINTENANCE MANUAL
GENERAL - SERVICING

WARNING

Before proceeding with maintenance work on or near mechanical flight controls or primary flight control surfaces, landing gears, associated doors or any moving component, make certain that ground safeties and/or warning notices are in correct position to prevent inadvertent operation of controls.

Before power is supplied to the aircraft make certain that electrical circuits upon which work is in progress are isolated.

Before pressurizing hydraulic systems, make certain that hydraulic system under maintenance has been isolated.

1. Hydraulic System Pressurization

A. Prior to pressurizing hydraulic system:

1. Ensure all personnel and equipment is clear of flight controls and landing gear doors.
2. Obtain clearance to pressurize hydraulic system from ground personnel by use of the ground interphone system or other means.

2. Hydraulic Fluid Safety Precautions

Mixing of phosphate ester type hydraulic fluid, with mineral-base fluid is prohibited. Such a mixture produces a jelly in hydraulic systems, and aircraft safety may be adversely affected.

Since these types of fluid are used in the hydraulic systems and landing gear shock absorbers respectively, fool proofing precautions shall be taken to prevent any inadvertent mixing.

A. Precautions to be observed by personnel

Prior to any servicing of the hydraulic system, personnel should observe and thoroughly understand the following precautions when working with hydraulic fluid.

WARNING:

Observe the following safety precautions when working on the hydraulic system. Long exposure to hydraulic fluid can cause skin dehydration and chapping.

1. Wash hands thoroughly with soap and water before starting work.
2. Airbus does not recommend the use of protective barrier creams as they do not provide complete protection.
3. Wear goggles when pressure testing components or systems, and whenever there is a possibility of hydraulic fluid splashing into the eyes.
4. If hydraulic fluid splashes into eyes, treat eyes immediately by irrigating thoroughly with clear cold water, and report the incident.
5. Wash hands, wrists, and forearms with soap and hot water whenever they have been in contact with hydraulic fluid.
6. If clothing becomes soaked with hydraulic fluid, remove clothing as soon as possible.

3. Technical Precautions

CAUTION:

Observe the following technical precautions when working on the hydraulic system. Hydraulic fluid will attack a wide range of materials including rubber, copper, titanium, various plastics and paints.

A. Ensure that hydraulic fluid does not come into contact with aircraft outside of hydraulic system. Keep spillage to an absolute minimum. Clean up spilled hydraulic fluid immediately to prevent entry into adjacent areas and to prevent future false hydraulic leak reports. If spillage occurs, wipe up the fluid with a dry cloth, and wash contaminated area with solvent.

WARNING:

Cleaning operations using solvents should be performed in a well ventilated atmosphere. Exercise normal safety precautions during use.

B. When washing metal parts before assembly, use only solvent, and ensure that all traces of the solvent are removed before assembly.

C. Use only approved hydraulic fluid when filling reservoirs, filter bowls, pumps, etc., before installation of components.

D. Take care to prevent contamination of hydraulic fluid with other unapproved fluids, fuel, oils, water or dirt.

E. If a system becomes contaminated, reclaim the hydraulic fluid.

F. Prior to connecting hydraulic power or replenishing carts to the aircraft make certain that cart fluid specification meets aircraft requirements.

4. System Line and Component Identification

(Ref. Fig. 1)
The lines of each hydraulic system are placarded with Skydrol-resistant bands or identification rings, on which are indicated the system color code, a brief description of the line function and the direction of fluid flow. A number is marked on each line in accordance with NSA standard 0143-0144. Hydraulic components are identified by means of self-adhesive placards showing the component number as given on the hydraulic system general drawing. The identification placards must also indicate NSA standard 307110, which states the hydraulic fluids which may be used. As a rule, numbers beginning with 1, 2 or 3 are used for Green, Blue or Yellow system components respectively.

Electro-hydraulic components bear only hydraulic numbers. Electrical identification is not shown.

5. Draining of Hydraulic Reservoirs

WARNING:

Check that the landing gear ground safeties including wheel chocks are in position.

Before applying or relieving hydraulic system pressure, make certain that the travel ranges of the control surfaces are clear.

Before pressurizing hydraulic systems, check that all controls are set to correspond with the actual position of the services they operate.

HYDRAULIC SYSTEM NUMBER AND COLOR CODE		
NUMBER	COLOR CODE	SYSTEM
1	GRCEN	GREEN SYSTEM
2	BLUE	BLUE SYSTEM
a	YELLOW	YELLOW SYSTEM

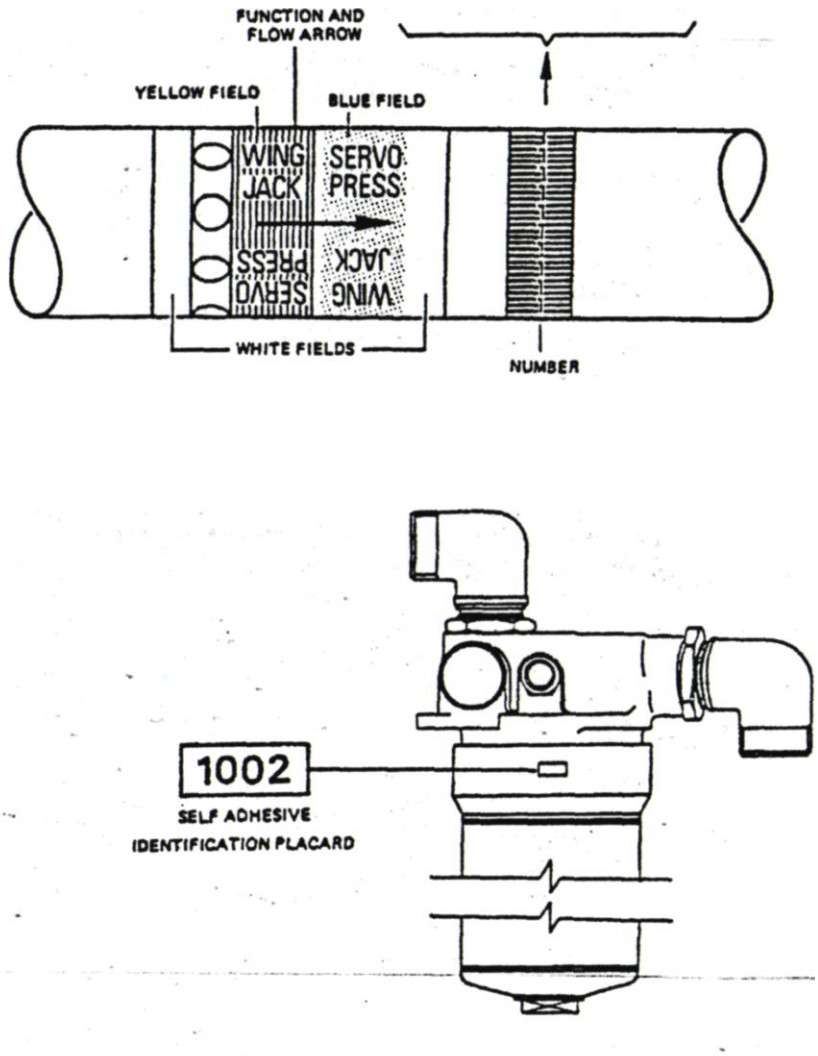


Figure 4.7: Line and Component Identification

<u>NOTE</u>: Draining described in this section is effective for Green, Blue and Yellow reservoirs, 291000, 292000 and 293000 respectively.

A. Reason for the Job

1. Draining to change hydraulic fluid.

B. Equipment and Materials

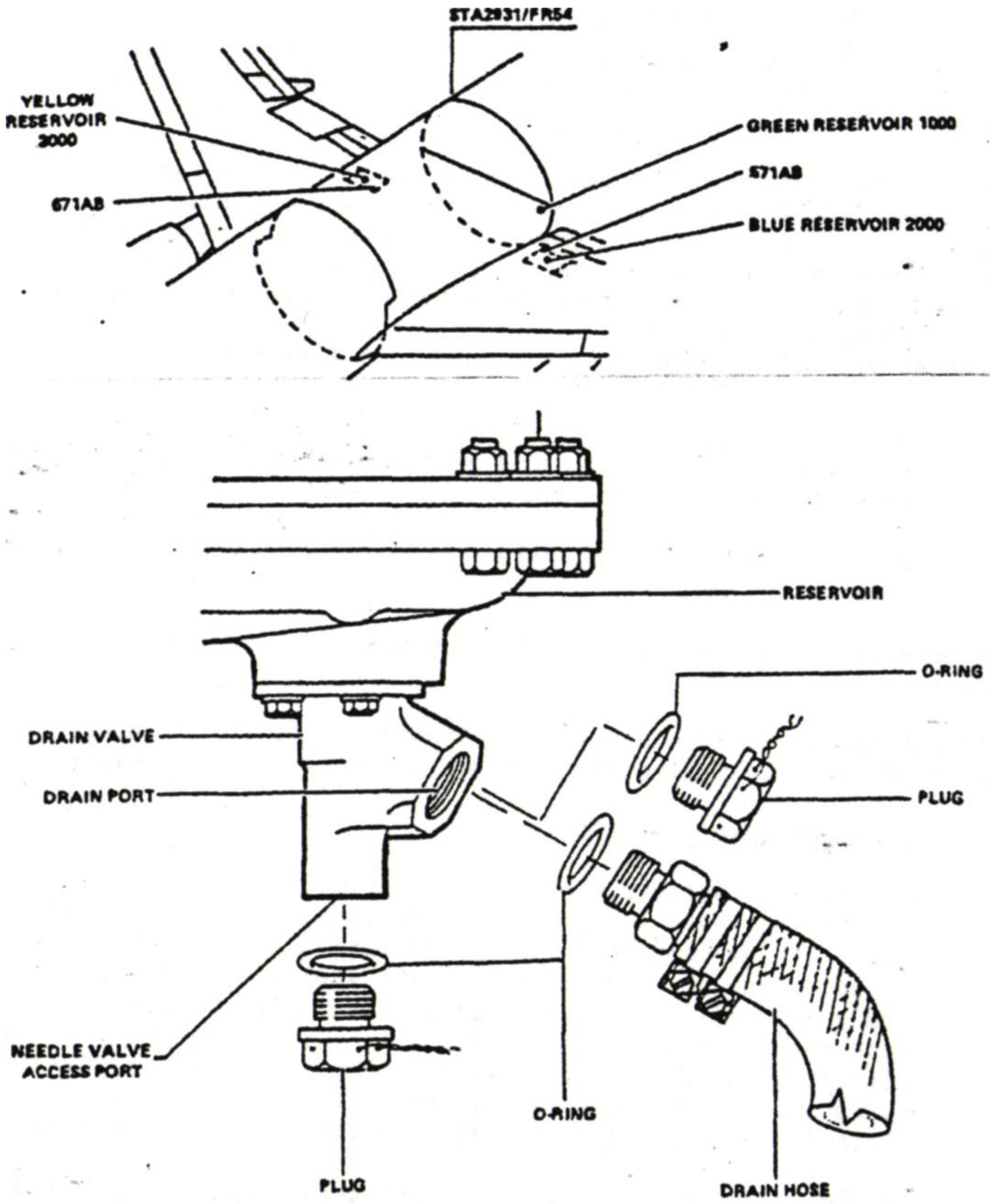


Figure 4.8: Draining of Hydraulic Reservoirs

QUESTIONS

For questions from 1 to 7, find the sentence which corresponds best to the paragraph:

1. **Before pressurizing hydraulic systems, make certain that hydraulic system under maintenance has been isolated.**

   A) You needn't check that hydraulic system under maintenance has been isolated before pressurizing hydraulic systems.
   B) You should check that hydraulic system under maintenance has been isolated after pressurizing hydraulic systems.
   C) You must check that hydraulic system under maintenance has been isolated prior to pressurizing hydraulic systems.
   D) You mustn't check that hydraulic system under maintenance has been isolated before pressurizing hydraulic systems.

2. **Before power is supplied to the aircraft, make certain that electrical circuits upon which work is in progress are isolated.**

   A) It is forbidden to isolate electrical circuits upon which work is in progress.
   B) Electrical circuits upon which work is in progress must be insulated before power is supplied to the aircraft.
   C) Electrical circuits upon which work is in progress must be disconnected before power is supplied to the aircraft.
   D) Don't activate the electrical circuits upon which work is in progress after power is supplied to the aircraft.

3. **Long exposure to hydraulic fluid can cause skin dehydration and chapping.**

   A) Long exposure to hydraulic fluid is safe for your skin.
   B) Avoid long exposure to hydraulic fluid.
   C) Long exposure to hydraulic fluid isn't dangerous for your skin.
   D) Long exposure to hydraulic fluid doesn't have any harmful effects on your skin.

4. **Clean up spilled hydraulic fluid immediately.**

   A) You are not allowed to clean up spilled hydraulic fluid immediately.
   B) You should clean up spilled hydraulic fluid as soon as possible.
   C) You can clean up spilled hydraulic fluid later.
   D) You must clean up spilled hydraulic fluid at once.

5. **Mixing of phosphate ester type hydraulic fluid with mineral-base fluid is prohibited.**

- **A)** It is allowed to mix phosphate ester type hydraulic fluid with mineral-base fluid.
- **B)** You must mix phosphate ester type hydraulic fluid with mineral-base fluid.
- **C)** Mix phosphate ester type hydraulic fluid and mineral-base fluid.
- **D)** It is forbidden to mix phosphate ester type hydraulic fluid with mineral-base fluid.

6. **If spillage occurs, wipe up the fluid with a dry cloth, and wash contaminated area with solvent.**

- **A)** Avoid wiping up the fluid with dry cloth if spillage occurs.
- **B)** If spillage happens, don't wash contaminated area with solvent.
- **C)** Use a dry cloth to wipe up the fluid and then clean it with a solvent.
- **D)** Wipe up the fluid with a dry cloth and wash contaminated area with water after the spillage.

7. **Check that the landing gear ground safeties including wheel chocks are in position.**

- **A)** It is not necessary to check that the wheel chocks are in position.
- **B)** Make certain that only wheel chocks are in position.
- **C)** You needn't check that the landing gear ground safeties including wheel chocks are in position.
- **D)** Make certain that the landing gear ground safeties and also the wheel chocks are in position.

For questions from 8 to 11, complete the sentences with the technically correct answer according to the text:

8. **Mineral-base fluid......**

- **A)** is used in the hydraulic systems.
- **B)** is used in the landing gear shock absorbers.
- **C)** produces a jelly in hydraulic systems.
- **D)** can be mixed with phosphate ester type hydraulic fluid.

9. **Airbus does not recommend the use of protective barrier creams……**

- **A)** because they are dangerous.
- **B)** as they don't provide absolute protection.
- **C)** because they provide complete protection.
- **D)** since they are very safe.

10. …... when filling reservoirs, filter bowls or pumps, etc., before installation of components.

A) It is forbidden to use approved hydraulic fluid
B) Use different kinds of hydraulic fluid
C) Avoid using approved hydraulic fluid
D) Approved hydraulic fluid must be used

11. When washing metal parts before assembly, …………..

A) check that there are no traces left before assembly.
B) don't use any kinds of solvent.
C) make certain that all of the traces of the solvent are removed.
D) avoid using solvent.

EVALUATION

Please compare the answers with the answer key. If you have wrong answers, you need to review the Learning Activity. If you give right answers to all questions, pass to the next learning activity.

ANSWERS KEYS

ANSWER KEY OF LEARNING ACTIVITY-1

1	False
2	True
3	True
4	False
5	False
6	False
7	True
8	False
9	False
10	True
11	False
12	False
13	True
14	False
15	True
16	False
17	False
18	False
19	True
20	False

ANSWER KEY OF LEARNING ACTIVITY-2

1	True
2	False
3	True
4	False
5	False
6	True
7	True
8	True
9	False
10	False
11	True
12	False
13	True
14	True
15	False
16	False

ANSWER KEY OF LEARNING ACTIVITY-3

1	True
2	False
3	True
4	False
5	False
6	True
7	True
8	False
9	True
10	True
11	True
12	False
13	True
14	False
15	True
16	False
17	False
18	False
19	True
20	False
21	True
22	True
23	False
24	True
25	False
26	False
27	True
28	False
29	True
30	False
31	True
32	True
33	False
34	False
35	True

ANSWER KEY OF LEARNING ACTIVITY- 4

1	True
2	False
3	False
4	True
5	True
6	False
7	True
8	False
9	True
10	True

ANSWER KEY OF MODULE EVALUATION

1	C
2	B
3	B
4	D
5	D
6	C
7	D
8	C
9	B
10	D
11	C

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