DECLARATION

I hereby declare that this Student Industrial Work Experience Scheme (S.I.W.E.S) technical report was solely written by me and I genuinely undertook the 6months training program.

Student's Name Date & Signature

.

ACKNOWLEDGEMENT

First off, I will like to give thanks to GOD for life, provision, protection and guidance during this training and most importantly, the grace to successfully complete my S.I.W.E.S program.

I want to say a big thank you to my parents for their love and support both emotionally and financially during the cause of this training

I will like to express my gratitude to the Industrial Training Fund for providing such a beneficial platform for us students to be gainfully engaged in 6months training which has provided us with some foreknowledge of work experiences in the engineering field.

I want to say thank you to the Department of Mechanical Engineering, University of Benin and all my institution based supervisors.

I cannot forget the family I made at the Nigerian Air force Base Kano State. From my industry based supervisor, MWO Dauda, to all military personnel I worked with, MWO Danladi, Sergeant Emmanuel Oneyi, Sergeant Abubakar, Lance Corporal Mohammed, Lance Corporal Ahmed, Engineer Mike, all other IT students present, etc. The list is endless. I am grateful to you all for welcoming me with open arms. I pray God blesses you all immensely.

ABSTRACT

This technical report focuses on the experience gathered during my 6months industrial training at 403 flying training school, Nigerian Air force, Kano. My training was based on diagnosis, repairs, maintenance of AERO L39 fighter jets, which is the official aircraft for the Nigerian Air force base station in Kano state.

I gained knowledge on how to change main landing gear electrical switches, change hydraulic accumulators, aircraft wheels and tires repairs and alignments, retraction and extension of aircraft landing gears, fueling of fighter jets, etc.

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CHAPTER ONE

1.0 INTRODUCTION

The Industrial training scheme is a periodical training for students in Nigerian Tertiary Institutions which exposes them to practical knowledge of what is being studied in their various classrooms. It is a compulsory standard in the university curriculum which bridges the gap between the classroom theoretical learning and the practical application of these knowledge gained.

It focuses on exposing students to machines and equipment, professional works, methods and ways of safeguard of work areas, workers, industries and organizational activities. It is founded by the federal government of Nigeria and jointly co-ordinated by the industrial training fund (ITF) and Nigerian university commission (NUC).

1.1 MEANING OF SIWES

SIWES, which stands for Student Industrial Work Experience Scheme, is a training program which forms part of the approved minimum academic standard in the various degree programs of Nigerian Tertiary institutions. It is the gap between practical aspect and theoretical aspect of various educational programs.

1.2 AIMS AND OBJECTIVES OF SIWES

- To expose students to work methods and techniques in handling equipment that may not be available in the university.
- To provide student with an opportunity to apply the theoretical in real work situation, thereby bridging the gap between university work and actual work experience.
- To provide avenue for the student in Nigerian universities to acquire industrial training skills and experience in their course of study.
- To make transition from the university to the world of work and this enhances student contact for better job placement
- To enlist and strengthen employers involvement in the entry process of preparing university graduates for employment in industries.

1.3 ORGANISATION PROFILE/HISTORY

The Nigerian Air force is a branch of the Nigerian military organization .The idea of establishing an air force for Nigeria was first mooted in 1961 following the nation's participation in peace-keeping operations in Congo and Tanganyika (now Tanzania). During these peace-keeping operations, foreign air forces aircraft were employed to airlift the Nigerian Army Regiment to and from the theatres of operation. The Nigerian Government at the time, no doubt, recognized the urgent need to establish an air force actively supported by modern facilities to provide full complement of forces to enhance the nation's military posture. Early in 1962, the Government agreed in principle that the Nigerian Air Force (NAF) be established.

The Nigerian Parliament, therefore, approved the establishment of the NAF and recruitment of cadets commenced in June 1962. Consequently, the NAF was officially established by a statutory Act of Parliament in April 1964 to serve four main purposes namely:

a. To achieve a full complement of the military defense system of the Federal Republic of Nigeria both in the air and on the ground.

b. To ensure a fast versatile mobility of the Armed Forces.

c. To provide close support for the ground-based and sea borne forces in all phases of operations and to ensure the territorial integrity of a united Nigeria.

d. To give the country the deserved prestige that is invaluable in international matters.

It was in 1962 that the drive for the required manpower for the planned air force started. Simultaneous with this development, Government was in dialogue with some friendly nations on the possibility of training Nigerian Air Force personnel in various specialist fields. The Nigerian Air Force has personnel strength of about 18,500, comprising of 2,600 officers and 15,900 airmen/airwomen.

1.4 ORGANOGRAM OF ORGANISATION

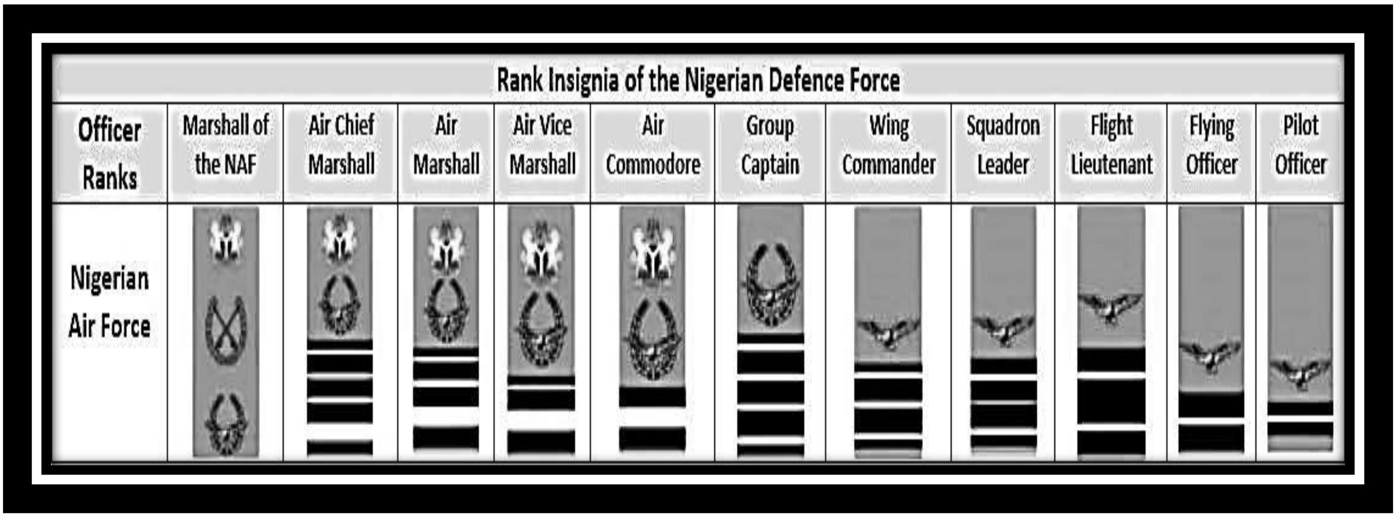

Figure 1 NAF Officers Ranks

1.5 OGARNOGRAM OF AIRCRAFT WORKSHOP

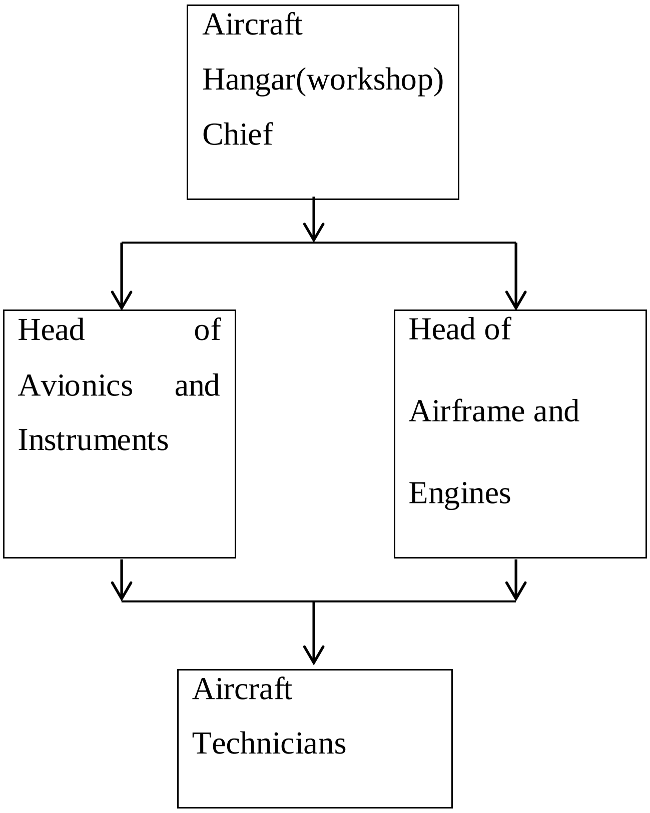

Figure 2 Aircraft Workshop Organogram

I specifically worked with the engineering department of 403 Flying Training School of the Nigerian Air Force Base Kano State.

Our roles and responsibilities were

- Maintaining of Nigerian Air Force AeroL39 fighter jets (this entails oil changing, retraction and extension test, fueling of aircrafts, aircraft preservation with Jet fuel Jet A, regular check and inspection, etc.)
- Preparing of aircrafts for takeoff with marshaling crew.

1.6 SUMMARY OF INTERN'S ROLES AND RESPONSIBILITIES

As an intern, my responsibilities were aligned with those of the aircraft engineers. I was posted to the Airframe and Engines department where I was involved in carrying out major maintenance of different aircrafts and their parts such as hydraulic accumulators, engine filters, pneumatic starters, aircraft flaps, rudders, elevators, landing gears, aircraft wheels, etc.

Some of the work carried out on the aircraft landing gears were dismantling and replacing of landing gears, changing of aircraft tires and wheels, fixing of electrical lines and switches.

I also had some spare time to work alongside the Avionics department. Some of the work we did there were compass swing tests, pitot tube tests and replacing of aircraft batteries.

Thereafter, I also worked with the aircraft flight line department and some of our work duties were towing aircrafts to flight line canopies, preparing aircrafts for takeoff by conducting adequate checks, marshaling of aircrafts for landing, etc.

Work Schedules were mostly daily basis, apart from days of bad weather where all flights were cancelled and days of when courses were to be taken before engaging in the work. Work began at 8am and closed at 4pm.

The type of work done was usually practical engineering which required adequate team working skills, communication skills and proper awareness of health and safety education. Work activities always involve a lot of man power and expertise from more experienced engineers.

CHAPTER 2

TRAINING PROGRAM

This chapter provides an explanation of the work done on a weekly basis during the training period.

Work schedules were usually conducted on a weekly basis, with work orders delivered for each week on which primary task we were supposed to carryout in the workshop.

In the FIRST WEEK, I submitted my final documents to the Airforce Base in Kano and I was posted to my department. Thereafter, I was fully introduced to the aircraft hangar, its personnel, rules and regulations of work in the hangar and also received a general orientation on the type of work I will be involved in for the next 24 weeks in the aircraft hangar. Also, I joined the aircraft engineers in an ongoing course of replacing landing gears.

Figure 3 Aircraft Hangar

Throughout the SECOND WEEK, we were engaged in the practical aspect of the landing gear course. Alongside about 15 other aircraft engineers, we dismantled and replaced the nose and main landing gears for 3 aircrafts (NAF 352, NAF 360, and NAF362). I was also involved in replacing the hydraulic accumulator of an aircraft, NAF 362

Figure 4 Dismantling of Main Landing Gear

In the THIRD WEEK, I work alongside some Engineers in the Avionics department to conduct a compass swing test on an aircraft which we were preparing for flight to Maiduguri. I was also involved in conducting checks on the coms headset and meter gauges on the pilot's onboard panel to ensure they were functioning accurately.

Figure 5 Pilot's On-Board Panel

In the FOURTH WEEK, I was involved in the dressing of all landing gears that were replaced, both main and nose landing gear. Also, we had a number of deflated tires for different aircrafts. The aircrafts were jacked with the use of hydraulic jacks and the tires were inflated with the use of a bodge compressor.

In the FIFTH WEEK, we discovered that aircraft NAF368 after takeoff, had a retraction problem. The pilot was forced to land and alongside my department engineers; we worked on the aircraft landing gears and later discovered it was a problem from the cockpit. We also conducted further checks on the aircraft to ensure proper retraction and extension with grand power units and hydraulic cart as our major tools.

In the SIXTH WEEK, we had a 5 day training course with some NDA cadets from Kaduna. During the training course, we were taught about the Aero L39 airframe (The 3 fuselages and all their components.)

In the SEVENTH WEEK, we conducted a 200hour inspection on NAF 362. I was involved in this inspection process and participated in refilling BV3 coolant into the pneumatic starter, cleaning of the oil and fuel filters in the aircraft engine, checking of the main and hydraulic accumulator pressure, greasing of aircraft flaps.

In the EIGHT WEEK, I also participated in another 200hour inspection of NAF 369. Alongside engineers from the Avionics department, we conducted a pitot tube test on the aircraft. The pitot tube is a flow measurement device used to measure fluid flow velocity. Also, aircraft conservation with Jet Fuel A was carried out on the aircraft

In the NINTH WEEK, we had a training lecture on the onboard panel indicators which includes Speed Indicators, Fuel guage indicators, Cockpit pressure gauges, etc. This lecture was given to us by SGT Emmanuel Oneyi. Aircraft conservation was also carried out on 4 different aircrafts.

In the TENTH WEEK, we did a 200hours inspection on NAF367 and I was involved in routine checks on the airframe and fuselage components. We also performed a pitot tube test on the aircraft. Also, I worked alongside the flight line crew to prepare the aircraft for takeoff.

In the ELEVENTH WEEK, we had a couple of malfunctioning PNI’s (Pictorial Navigation Indicators) in two aircrafts. I worked with the avionics department and we dismantled and replaced the Pictorial Navigation Indicators for these two aircrafts.

Figure 6 Repair of Pictorial Navigation Instrument

In the TWELVETH WEEK, I was taught about some aircraft safety mechanisms. This lesson was on how to do wire locking on aircraft nuts and how to use split pins. I applied wire locks for hydraulic accumulators, landing gear nuts, etc. also I replaced split pins on the landing gear actuator.

Figure 7 Dismantling of Main Landing Gear

In the THIRTEENTH WEEK, I was involved in the ground running operation an aircraft with the use of the Grand Power Unit. This ground running operation is done to test and ensure that the aircraft is working properly. Retraction and extension test were also conducted.

In the FOURTEENTH WEEK, we had a lecture on the AI 25TL engine of the Aero L39. This lecture was given to us by SGT Emmanuel Oneyi.

In the FIFTEENTH WEEK, an aircraft, NAF 365 was to be prepared for takeoff to Abuja. I was involved in conducting a compass swing test for the aircraft and towed it to the flight line for takeoff. We also did aircraft conservation with Jet fuel A. This conservation is done to preserve the aircraft from corrosion problems.

Figure 8 Aircraft Conservation

In the SIXTEENTH WEEK, I worked alongside MWO Danladi who is in charge of the workshop store. We serviced the tires, checked the tire pressure and also checked for leakages. This was done for both nose and landing gear tires.

In the SEVENTEENTH WEEK, We worked on the flaps of NAF 373 for easy retraction and extension. Also, we replaced the wheels of the landing gear tires. This involved coupling of cylinders, anchor bolts and brake pads for the new wheels. We also filled the aircraft with fresh hydraulic fluids.

In the EIGHTEENTH WEEK, I worked alongside the store unit to do a general inspection of all aircrafts and take note of faulty instruments that were to be taken for overhauling. Some faulty components identified were Pictorial Navigation Indicators, hydraulic accumulators, oil filters, etc.

In the NINTEENTH WEEK and TWENTIETH WEEK, we also had a lecture on the airframe and AI 25TL engine of the Aero L39. This lecture was carried out for two weeks.

In the TWENTY-FIRST WEEK, we were thought on the controls and functions of basic aircraft components like flaps, ailerons, rudders and elevators.

In the TWENTY SECOND WEEK, I was involved I changing faulty pictorial navigation indicators 3 aircrafts and replacing them with new ones. These faulty PNIs were taken to the workshop store.

In the TWENTY THIRD WEEK, I started my sign out process and submitted my logbook to the hanger chief for signing. I also participated in aircraft conservation with JET FUEL A.

In the TWENTY FOURTH WEEK, I participated in aircraft conservation and completed my sign-out process at the Airforce Base. After this, I collected my logbook and said goodbye to my colleagues.

CHAPTER 3

DISCUSSION, ANALYSIS AND EVALUATION

3.0 ABOUT THE AIRCRAFT

Aero L-39 is a high performance trainer jet which was developed in Czech Republic. It was designed during the 1960s as a replacement for Aero L-29. It is a trainer jet exported to a very wide range of countries due to its distinction. More than 2,800 L-39s have served with over 30 air forces around the world, including Nigeria.

Figure 9 AERO L-39 MODEL

History	
Year taken into Nigerian Air Force	1986
Country of Origin	Czech Republic
Role	Basic/Advance Trainer and Ground Attack
Engine	
Type	AI 25TL Twin Shaft Turbofan Engine
Compressor type	Axial 12 Stages with Bye-pass duct
Maximum Thrust	16.867kN
Specific Fuel Consumption	56.9kg/hr
Air Frame	
Wing Span	9.46m
Length Overall	12.13m
Height Overall	4.77m
Wing Area	18.8m^2
Weights and Loadings	
Basic Empty Mass	4200Kg
Maximum Weight	5600Kg (Takeoff)
Fuel Tank Capacity	
Fuselage Tanks	1,100 Litres
Tip Tanks	2*100 Litres
Drop Tanks	2*150 Litres
Performance	
Maximum Level Speed	750Km/h
Never-exceed Speed	910Km/hr
Maximum rate of climb	21m/s
Maximum Range (With Drop Tanks)	1350Km
Maximum Endurance (with Drop Tanks)	2hrs 45mins

Table 1 AERO L-39 Specifications

3.1 AIRCRAFT DESIGN

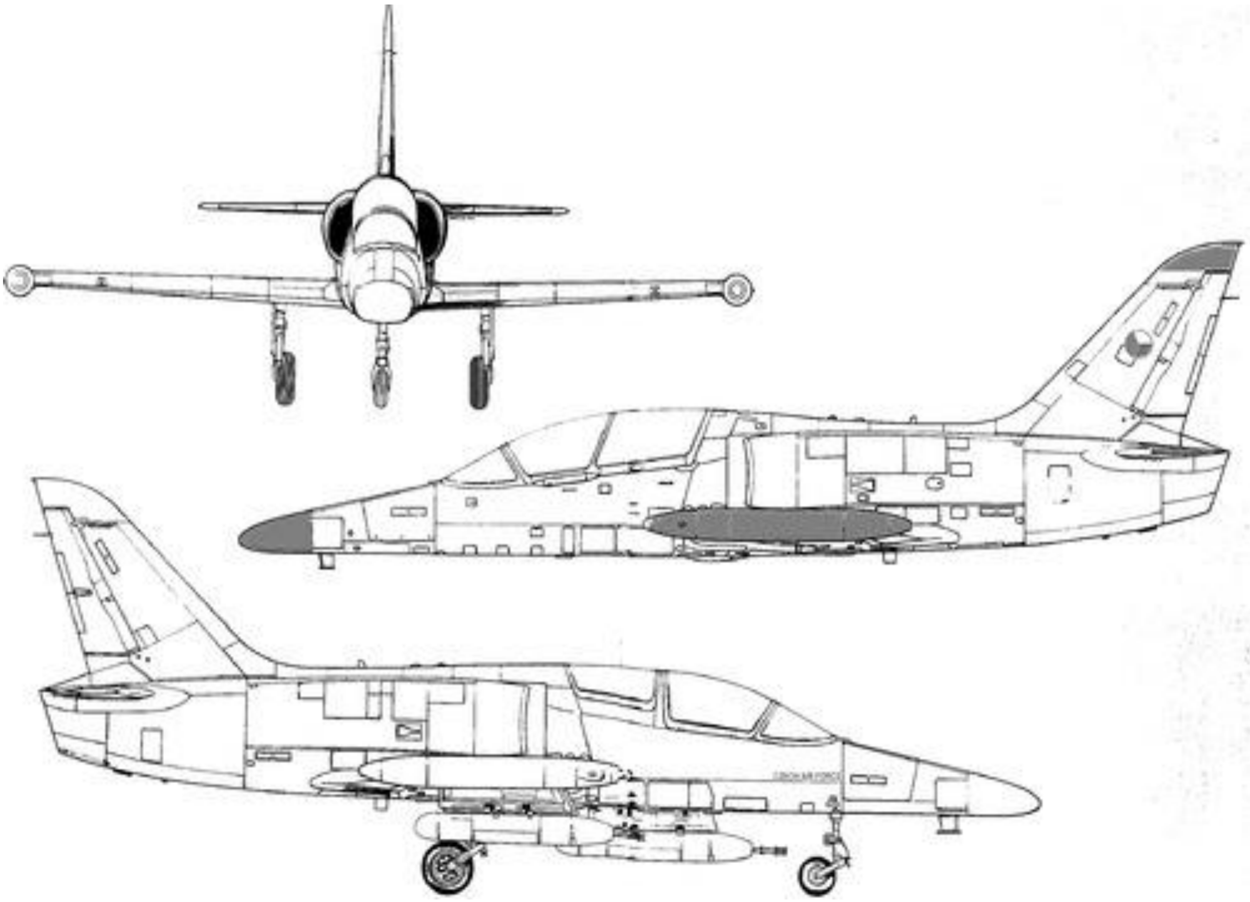

Figure 10 AERO L39 Schematics Diagram

In addition to performing basic and advanced pilot training, it can play a light attack role in combat missions. It was designed to be cost effective with major of its onboard systems simplified to avoid incurring high level maintenance and to minimize damage caused by mishandling when flown.

The straight wings of the Aero L-39 have two 100litres fuel tanks permanently attached to the wingtips. Additional tanks can be fitted in the rear cockpit position and underneath the wings. These are known as the tip tanks. The trailing edge has double-slotted flaps which are separated by small wing fences from the ailerons.

At the tail end is the elevator and rudder attached to the horizontal and vertical stabilizers respectively. They are mounted just over the exhaust nozzle. Two airbrakes are located under the fuselage. The wheel brakes, airbrakes, flaps and landing gears are all powered by the aircrafts hydraulic system.

The cockpit of the Aero L39 is highly pressurized requiring the use of oxygen masks only at above 23,000 feet. The student pilot sits in front while the instructor pilot sits in the rear seat. This rear seat is slightly elevated to enable observation and guidance of the student pilot in the front position. The aircraft has ejection seats under individual canopies which are opened manually. Five rubber fuel tanks are also located in the fuselage behind the cockpit.

The engine of the Aero L39 is a twin shaft turbofan engine and is positioned in the rear fuselage of the aircraft

3.2 OUTLINE OF WORKDONE

During my period of training in the Nigerian Air force, I was assigned to the Airframe and Engines department as an Aircraft Engineer. This department is basically concerned with the maintenance and repair of military aircrafts in Kano State Base station (AERO L39).

Job duties in the department includes

- Completing maintenance operations like regular check and inspection of aircraft and engines involving retraction and extension test, fueling of aircrafts, aircraft preservation with Jet fuel Jet A, cleaning of aircrafts, greasing of flaps, rudders and elevators, cleaning of aircraft filters, conducting of pitot test etc.
- Repairs of aircraft components like the changing of bad main and nose landing gears and replacing them with new ones, coupling of aircraft tyre wheels, changing of bad hydraulic accumulators and replacing with new ones etc.

3.3 <u>DESCRIPTION OF WORKDONE</u>

AIRCRAFT MAINTENANCE & REPAIR OPERATIONS

3.31 <u>200Hours Inspection Check</u>

The Aero L39 200hours inspection is a maintenance operation carried out after each aircraft has undergone 200hours of flight. This inspection is done to identify components for overhaul, repair or modification. It is done to ensure correct functioning of the aircraft for its next 200hours flight operation. This 200hours inspection is usually carried out by our engineering crew within two days. During the 200hours inspection, the following operations are carried out:

3.32 Inspection and Lubrication of Airframe Exterior:

During the 200hours inspection, the Aero L39 airframe undergoes necessary structural checks to locate corrosion, damages due to fatigue and also stiffness of movable components like ailerons, flaps, rudders, etc. The aircrafts airframe components are completely loosed, like the flaps, the elevators, Proper care must be taken when loosing these parts so as not to worn the nuts which have stayed for a very long period.

3.33 FLAPS:

The flaps of the Aero L39 are called Krueger Flaps, because of their designed and position at the leading edges of the wings. This is employed in most jet airliners. Flaps are high-lift devices used to increase the lift of the aircraft wing at a given air speed. Flaps in general are mounted on the wing trailing edges of fixed wings aircrafrs. They give extra lifts on takeoff . They also cause an increase in drag in mid-flight, so they can be retracted.

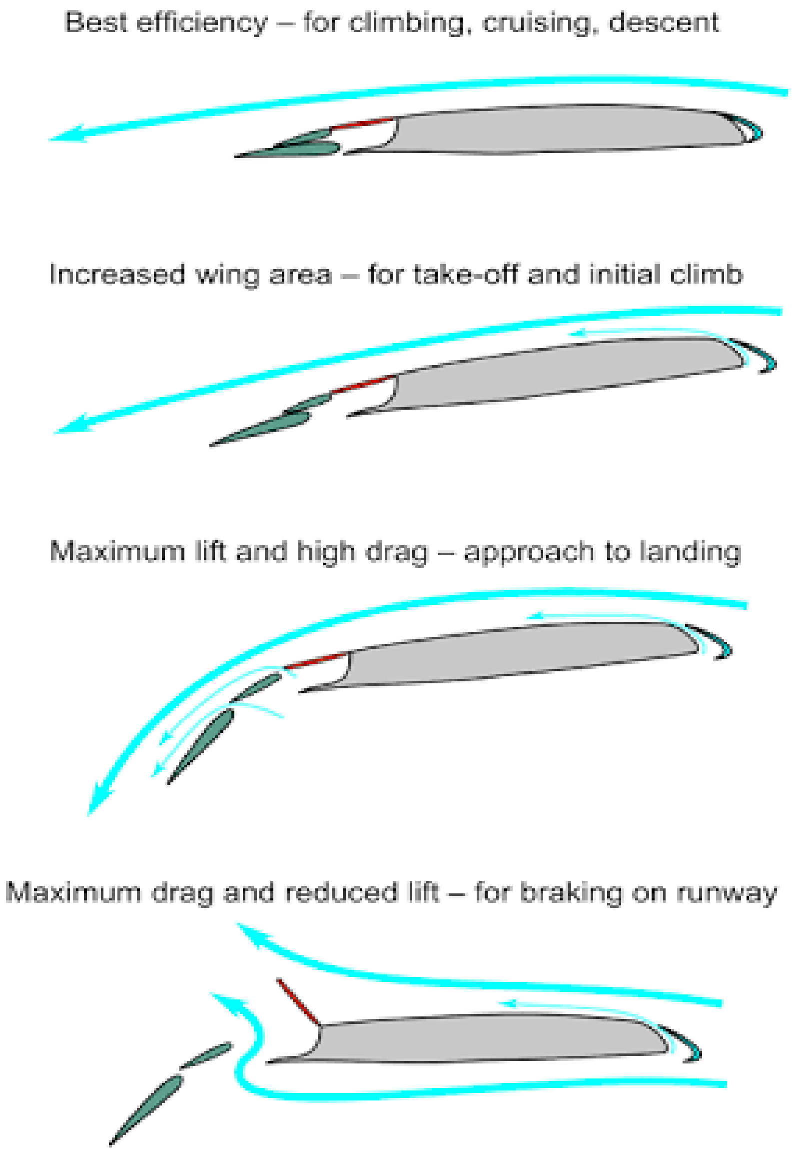

Figure 11 Flaps Positioning

As shown in Fig.3.2 above, the flaps of the Aero L39 are positioned at 25º when prepared for takeoff. This increases the wings area and raises the lift coefficient to cause lift to be generated at the most minimum speed possible. The lift of the aircraft is as a result of Isaac Newton's third law of motion which states that "action and reaction are equal and opposite". During cruising, the flaps of the flaps of the Aero L39 are on a neutral position, at angle 0º. On approach to landing, the flaps are deployed to angle 45º. This causes an increase in drag which in turn reduces the aircraft speed. This reduction in speed is very beneficial for landing because it allows the aircraft land in a shorter distance but can also impose handling difficulties. The side effect of these flap deployment causes a decrease in aircraft pitch angle and in turn improving the pilot's view of the runway. The general airplane lift equation is given by:

$$L=\tfrac{1}{2}\rho V^2 S C_L$$

Where

C_L= Coefficient of Lift

ρ = Density

V^2= Speed

S= Wing surface area.

During the 200hour inspection, the flaps are dismantled, by loosening it from the wing section. The attachment to the wing sector is by connectors and pins. After loosening them, the old grease in the pins and connectors are wiped off and new grease is applied so as to ensure easy deployment of flaps on pilot's request. This greasing is also done to the flaps motors.

3.35 ELEVATOR AND RUDDER

The elevator and rudder are attached to the horizontal and vertical stabilizers of the aircraft. They are located just at the tail end of the aircraft. The elevators move in an up and down motion and they can manipulate the air flowing over and under it. During takeoff, the pilot pulls back the control stick, and this causes the nose of the aircraft to pitch up. As the elevator moves up, the speed of air passing over the horizontal stabilizer decreases. This generates an area of low pressure under the stabilizer and then causes the tail of the aircraft to move down. The aircraft **pitches** over its center of gravity in the Y axis. During the 200hour inspection, the access panel which connects the elevator to the horizontal stabilizers is loosed and the elevator actuators are cleaned and re-greased. Also, the hydraulic lines connected to the elevators are checked. The elevator actuators are the link for the extraction and contraction of the elevators.

The rudders are used for steering the nose of the aircraft from left to right. This is called **yawing** of the plane and is done in the Z axis. When the rudder moves right, the aircraft yaws to the right too. The rudder actuators are cleaned and re-greased.

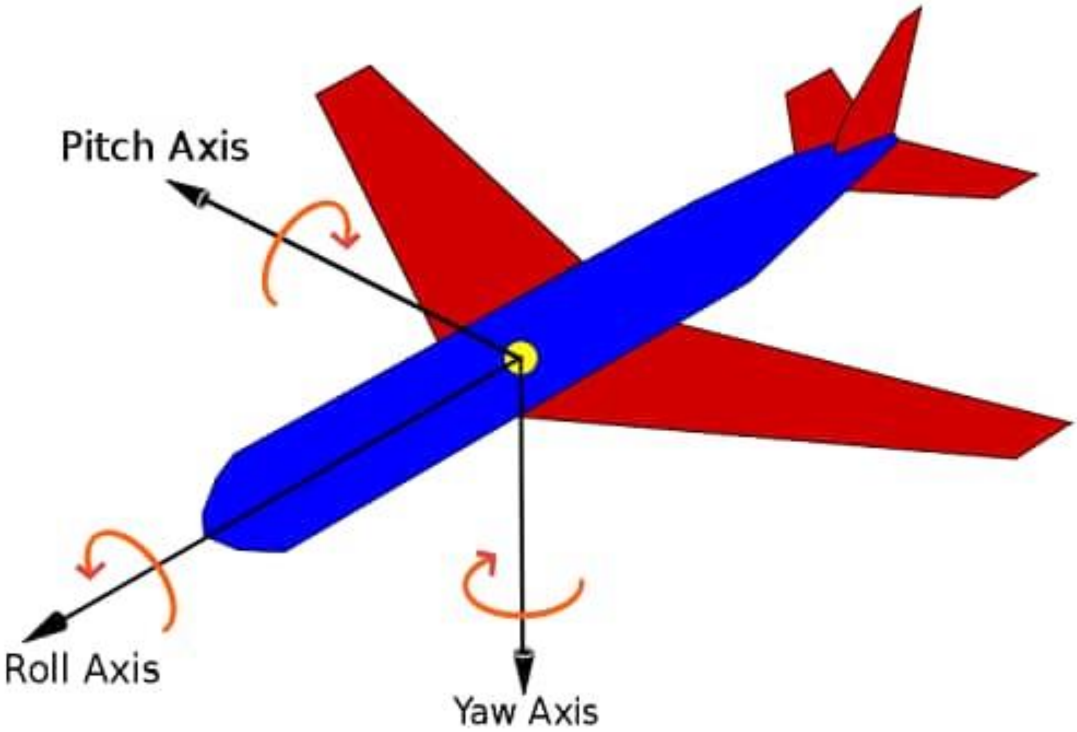

Figure 12 Aircraft Movement about COG

3.36 PITOT TUBE:

The pitot tube is a flow measurement device used to measure fluid flow velocity. It simply measures the airspeed of an aircraft. Recall that Bernoulli's equation states that:

Stagnation or Total Pressure= Static Pressure + Dynamic Pressure.

$\mathbf{P_t = P_s + P_d}$

But $\mathbf{P_d = \frac{\rho u^2}{2}}$

So, flow velocity, $\boldsymbol{u} = \sqrt{\frac{2}{\rho}}\,\mathbf{(P_t - P_s)}$

Where

- $\boldsymbol{u}$ is flow velocity
- $\mathbf{P_t}$ is stagnation or total pressure
- $\mathbf{P_s}$ is static pressure
- $\boldsymbol{\rho}$ is fluid density

The dynamic pressure is the difference between the stagnation and static pressure. It is determined using a diaphragm inside an enclosed container. In aircraft, the static pressure is measured using static ports and the dynamic pressure when measured, can be used to obtain the aircraft speed as shown above. The diaphragm contains an airspeed indicator which converts the dynamic pressure to airspeed reading by means of mechanical levers.

3.38 Inspection of Hydraulic Accumulators

The hydraulic accumulator is a device used for storing energy of a liquid in the form of pressure energy. It is a pressure storage reservoir in which a non-compressible hydraulic fluid is held under pressure applied by an external source to be supplied when needed. The particular type of accumulator used in the Aero L39 is the **Bladder Hydraulic Accumulator**. This is because it has an instantaneous response time that can provide fluid very quickly to fast acting valves and it also has high energy retaining power.

In the case of a faulty hydraulic accumulator, like the one in the figure below, the faulty accumulator has to be replaced by a new and working one.

Figure 13 Faulty Hydraulic Accumulator

To do this replacement, the safety wire locks and cutter pins are first removed from the 17mm nuts and then with the use of a 17mm spanner, the outlet connecting nuts are loosed from the outlet pipes at the bottom of the bladder. This is also done for the inlet nuts at the top of the bladder. Proper care is taken so as not to snap the nut or damage its thread. When replacing the faulty accumulators, we ensure that the hydraulic accumulators are placed

In the working process of a hydraulic accumulator, the accumulator is pre-charged with the gas volume. Then, the hydraulic pumps raise the system pressure and force the hydraulic fluid to enter the accumulator (the inlet and outlet valves control the inflow ant outflow). The bladder then moves and compresses the gas volume because the fluid pressure exceeds the pre-charge pressure. This is the source of the stored energy. Movement automatically stops when the system is balanced. When a system demand occurs such as actuator movement, the accumulator pressure falls and it releases that stored energy i.e. pressurized fluid to the required section. The cycle begins again. As shown below.

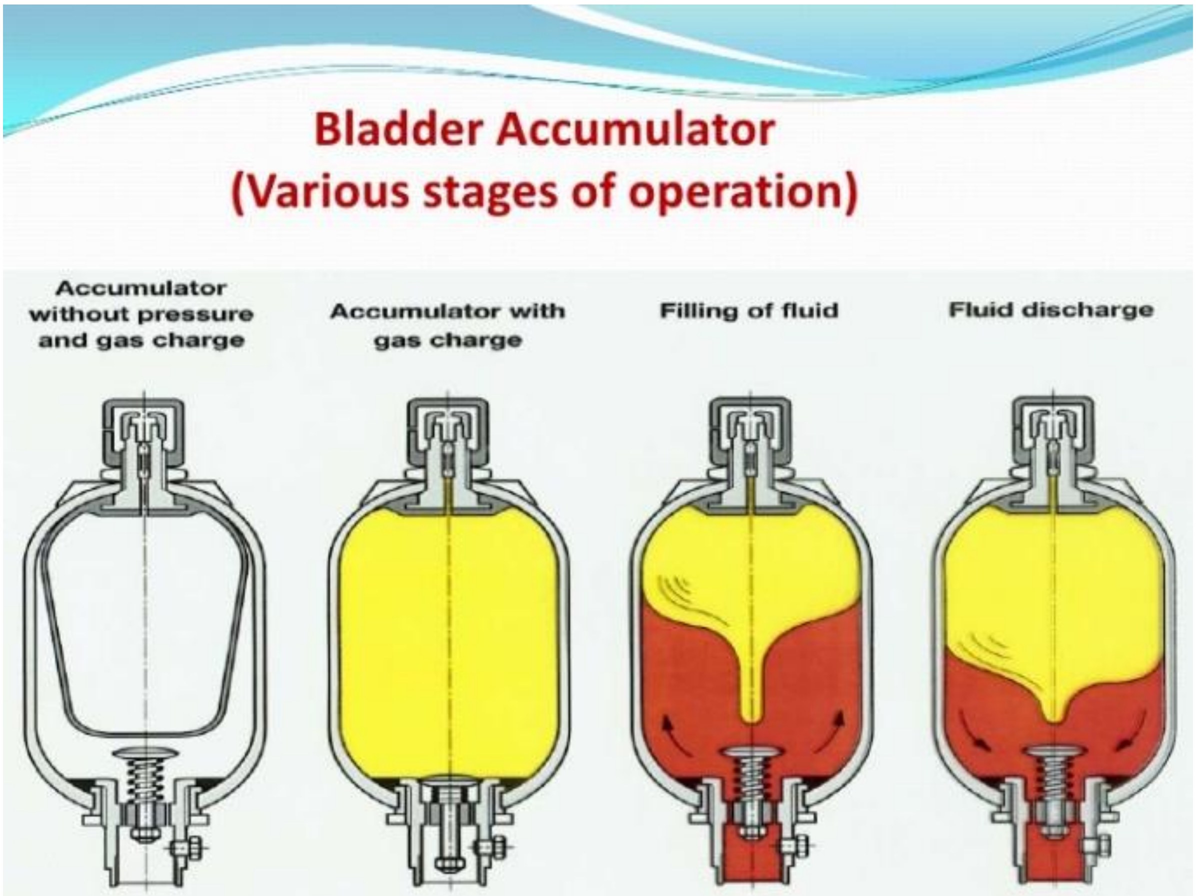

Figure 14 Bladder Accumulator Mode of Operation

3.39 Landing Gear Inspection and Maintenance

The Aero L39 has a tricycle type landing gear system with pneumatic shock absorbers on each unit. 1 of which is located at the nose of the aircraft and is called the Nose Landing Gear while the other 2 are located just below the mid fuselage and are called the Main Landing Gears. These landing gears undergo what we call retraction after takeoff and extension just before landing and are operated hydraulically with electrical control. The main landing gears retract inwardly into the wings while the nose retracts into the fuselage. The Aero L39 landing gears are made up of steel and this account for its heavy weight.

- **Replacing Landing Gears**

The landing gears of Aero L39 are usually replaced and taken for overhauling after every 500 takeoff and landing session it undergoes. To detach the landing gears from the aircraft, the first thing to do is to jack the aircraft. This is done with the use of 3 hydraulic jacks which are mounted at each landing gear point.

1. **Nose Landing Gear Replacement**

   To replace the nose landing gears, the housing of the electrical components which is located at the nose fuselage is opened. This enables us access the top end of the nose landing gear. Firstly, we remove the 450 x 165mm tubeless tire by unlocking the tire key with a screwdriver and hammer and removing the axle which attaches the tire to the nose landing gear. Next, we take off the electrical lines on the nose landing gear, which contains the landing gear bulbs and wiring.

   Then the ground wiring cables which are located at the top of the landing gear housing is loosed with 7mm spanners. A second axle is located right at the top of the landing gear and is attached to the bottom of the nose fuselage. This axle is responsible for keeping the nose landing gear in an aligned position. The cutter pin used to lock this axle must first be detached with the use of a screw driver and a hammer. This cutter pin is actually a safety mechanism to ensure firm fitting. After the cutter pin is loosed, we detach the second axle.

   Due to the detachment of these necessary fitting components, the landing gear becomes loosed and easy to remove. So, we simply remove the eye of the landing gear (a short wide pin found at the top end) and then rock the landing gear back and forth gently and then the landing gear drops down and is carried off.

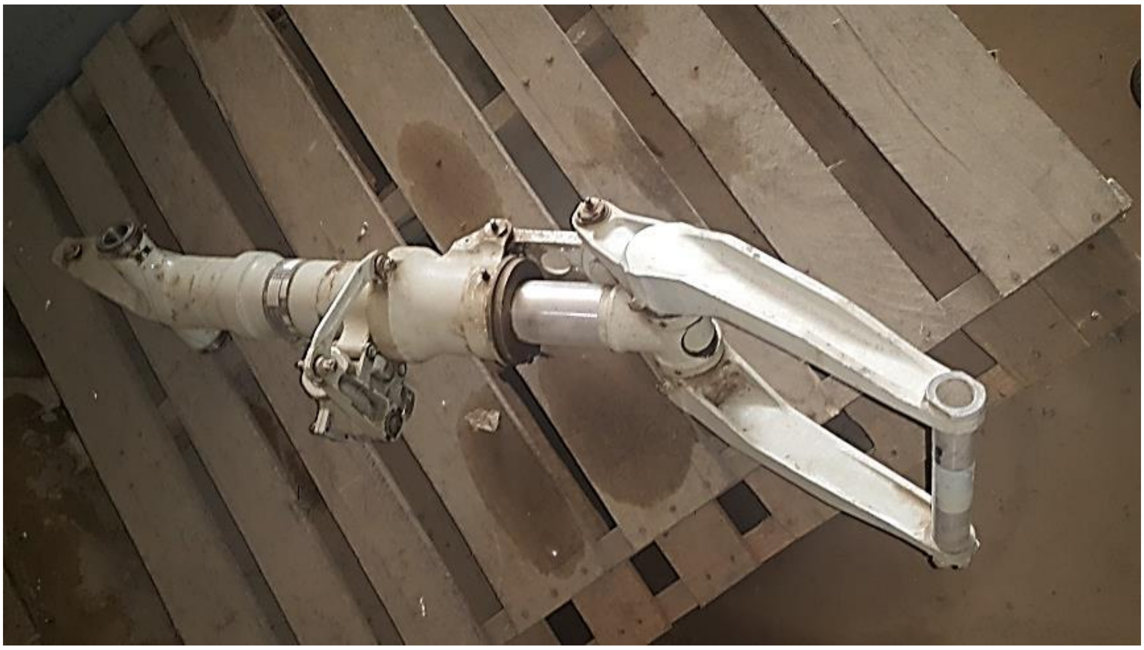

Figure 15 A loosed Nose Landing Gear

2. **Main Landing Gears Replacement**

The two main landing gears of the Aero L39 are located below the mid fuselage of the aircraft. Removing a main landing gear is more technical than the nose landing gear, due to its greater weight and tight housing. During retraction, the main landing gears are retracted to a hydraulically operated access panel just below the wing. In removing the main landing gears of the Aero L39, the first thing to do is to detach the tires. These tires are held in place with an axle connected to the wheel and locked with set keys and wirelocks. These wirelocks and keys are removed with the use of cutters and screwdrivers before the proper work begins. The first thing we do is that we loosen the access panels in order for us to have space to access the landing gear inner parts. After the access panel, the electrical line of the landing gear which also contains the landing gear bulbs is loosened. I loosened these lines with the use of screwdrivers and 10mm spanners.

Also, an electrical switch which controls the landing gear must also be loosened so as to allow for safe removal of the landing gear. This switch contains 4 7mm nuts. With the use of a socket and extension spanner, I loosened out the electrical switch so as to allow for easy removal of the landing gear. The landing gear indicators are also loosed. The work of these indicators is to make the pilot know when the landing gears are retracted or extended. I was able to also loose this indicator with the use of a screwdriver so as to allow for easy removal of the landing gear.

After all these are taken off, the actuator which is the main link responsible for the retraction and extension is loosed. Alongside a team if other engineers, we make used of a 22mm spanner to loosen the eye of the actuator. This eye is a pin used to hold the actuator in place. The eye is used by making use of two 22mm spanners. One of which was to lock one side of the eye nut to prevent it from free rolling when being loosed. I held one side of the eye nut firmly while another engineer loosened the nut itself.

3.40 Retraction and Extension Test

The retraction and extension test for an aircraft is carried out to test the efficiency of the landing gears. These landing gears must be firmly fixed and deployed instantly on request by the pilot.

The retraction and extension test is usually carried out after the landing gears have been worked on or replaced, so as to ensure 100% serviceability. This is done with the use of a Grand Power Unit and a hydraulic cart. The grand power unit supplies the needed electrical energy to power the aircraft while the hydraulic cart provides the hydraulic pressure that powers the landing gears.

Tools Used

- **Grand Power Unit** used to ground run the aircraft, i.e, provide the necessary electrical energy to power the aircraft as in the case of active flight mode.

Figure 16 Grand Power Unit

- **Hydraulic Cart:** used to provide the necessary hydraulic pressure to deploy and retract flaps, landing gears, etc. when ground running the aircraft.

Fig 16.1 A hydraulic cart

- **Hydraulic Jack:** Used to jack the aircrafts when operations are to be carried out below the aircraft.

Figure 17 An Aircraft Hydraulic Jack

3.5 AI 25TL ENGINE

The AI 25TL engine of the Aero L39 is a fmily of military and civilian twin-shaft turbofan engine developed by Ivchenko which produces a maximum thrust of about 16.867kN. This thrust is made by making the air accelerate from the front to the back of the engine. The AI 25TL turbofan engine consists mainly of an inlet guide vane, a low and high pressure compressor with 12stages (3 stages for low pressure and 9 stages for high pressure) which step by step increases the pressure of the air as it flows through them, the combustion chamber in which jet fuel is mixed with air and burns, the high and low pressure turbines with 3 stages (1 stage for high pressure, 2 stages for low pressure) in which the pressure of the hot gas is reduced as they drive the compressors and fans and finally the exhaust nozzle.

Figure 18 AI 25 TL Engine

ENGINE SPECIFICATIONS:

Engine Type	Turbofan
length	3.36m
Diameter	0.61m
Combustor	Annular
Fuel Type	Aviation Kerosene
Oil System	Pressure Spray with Return

Table 2: Engine Specs

AI 25TL Mode of Operation

This turbo fan engine is a flow cycle engine. Air is compressed, heated by a burning fluid and passes through a turbine which drives the compressors and fan.

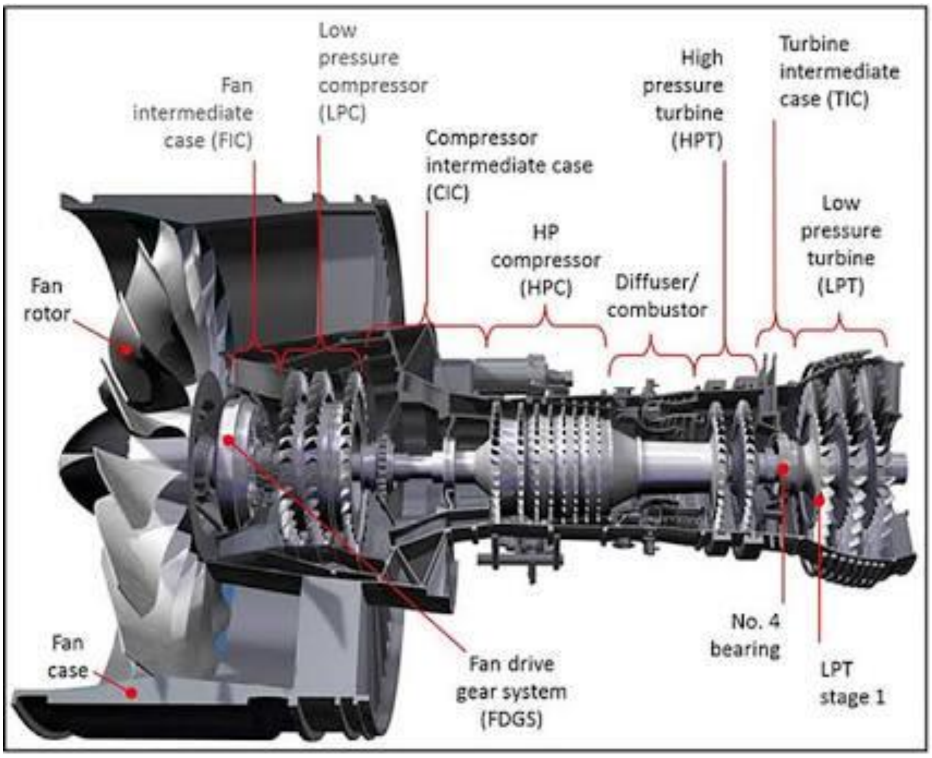

Figure 19 AI 25 TL Engine

Air enters through the inlet guide vane and passes into the low pressure compressor, which is made up of 3 stages. A stage consists of 1 stator and 1 rotor. The stator helps to direct the airflow and also the pressure increases in this process. The air is the divided into two parts in the intermediate casing, just before the high pressure compressor, which is the **inner and the outer air**. This outer air is $\frac{2}{3}$ of the total air which enters into the system. This air does not take part in the chemical reaction but rather has two functions. One of these functions is its participation in producing thrust. It proceeds through the narrow duct to the exhaust nozzle where it mixes with the resulting hot gases from the inner air that under goes combustion and there is an expansion of gases which produces thrust. The other function is that it acts as a cushion to reduce the noise which is produced from the AI 25TL engine.

The remaining $\frac{1}{3}$ of the total air that enters the system is the **inner air** and it proceeds into the high pressure compressor. In the 9 stage high pressure compressor, the air is compressed to a compression ratio of 9:1 and the pressure of the air is increased with temperature reaching up to 450ºC. This resulting air is further split into two parts which is the **primary** and the **secondary air**.

The primary air goes into the combustion chamber and mixes with the fuel. The pressure of the fuel is about 3.0Kpa while ejecting from the fuel line. So, the primary air mixes with this highly pressurized fuel and is ignited by the high ignition box and combustion then takes place.

The secondary air has a function of cooling the combustion chamber and enveloping the fire in the flame tube, to confine them within the combustion chamber so as to avoid excess heat from damaging the material of the combustion chamber.

After the combustion process, the hot gases stream out to the high pressure and low pressure turbines. The pressure of the air drops as it passes through the turbines and makes them spin. These turbines have two shafts which drive the compressors and the fan. The resulting hot gases escape through the nozzle and mix with the initially separated $\frac{2}{3}$ outer air and expand which produces a resulting thrust.

The AI 25TL turbofan engine has a number of gearing accessories, which all have various functions and work together to keep the system running. Some of these accessories include:

- The High Ignition Box: the high ignition box of the AI 25TL is located at 3'O clock and 9'O clock of the turbofan engine. These ignition boxes have a power of about 1.7kVA
- The Fuel-Oil Heat Exchanger: Fuel Oil heat exchanger exchanges the heat between the engine oil and fuel streams. Heat is exchanged in a manner that the engine oil is cooled whilst the fuel is heated up.
- The Fuel pump
- The Oil Tank
- The bye-pass filter

CHAPTER 4

CONCLUSIONS, LIMITATIONS AND RECOMMENDATION

CONCLUSION

With regards to the 6 months industrial training undergone, I can strongly attest to the fact that the Student Industrial Work Experience Scheme is a highly important program for all engineering students. This training **has exposed me to skills that a mechanical engineer needs to utilize and apply in the engineering field**, **bridged the gap between theory and practical engineering** and has also given me a **sense of professional work ethics as a mechanical engineering to ensure efficiency and safety.**

I have gained a great deal of knowledge on an area which is not effectively explored in Nigeria which is Aircraft Engineering. This has increased the passion in me to further on this subject area. Also, I have gained a great deal of confidence and knowledge to the fact that health and safety must not be traded with, as an engineer for speed, money or working under intense pressure.

I want to say a big thank you to my lecturers, supervisors and co-workers I worked with during my training period. Each and every one of you has played an important role in this awesome experience. This training has showed me some of the challenges I will face and most importantly technical skills that I will need as a mechanical engineer.

LIMITATIONS IN PROCEDURES AND USE OF EQUIPMENT

There were some limitations I observed during my training period at the Nigerian Air force 403 Flying Training School, Kano State.
Some of these limitations include:

1. The major limitation in I observed was that repair operations are not majorly carried out at workshop. Mostly maintenance operations are carried out here in Nigeria while complete repair and overhaul are taken abroad. This limits the skill set utilization of Nigerian Engineers and increased repair cost.
2. There are a lot of old and aging equipment that may likely affect the speed and efficiency of work done in the hangar.

3. Some of the equipment is not maintained regularly, like the hydraulic cart and the bodge compressors. Most of these equipment are used till they breakdown and are finally repaired. This can lead to total failure of the machine beyond repair overtime.

RECOMMENDATIONS

1. Training should be given to our Nigerian Engineers to engage in full overhaul and repair operations. This will improve their skill set, expertise and also minimize repair cost for the Nigerian Air force.
2. New and more advanced equipment should be purchased to increase the speed and efficiency of work done.
3. Regular maintenance of equipment should be carried out to avoid machine breakdown and failure.

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