

## **INTERNSHIP REPORT**

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In

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By

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## **Abbreviations**

ALH	Advanced Light Helicopter
LCH	Light Combat Helicopter
LUH	Light Utility Helicopter
RWRDC	Rotary Wing Research & Design Centre
CEMILAC	Centre of Military Airworthiness & Certification
AF	Air Force
CG	Coast Guard
MGB	Main Gear Box
AGB	Auxillary Gear Box
TGB	Tail Gear Box
IGB	Intermediate Gear Box
CNC	Computer Numerical Control
CH	Cheetah (Helicopter)
CK	Cheetak (Helicopter)
AFCS	Automatic Flight Control System
RCMA	Regional Centre of Military Airworthiness

## **Acknowledgement**

This was one of the best opportunity in my life to undergo internship training to one of the biggest defense giants of India namely DRDO. I would like to thank **Mr. D. Arul Kumaresan Sir, Sc 'E'** to accept my request for the internship and provide me an opportunity for the same. I would also like to express my sincere gratitude towards **Dr. G. Sakthivel Sir, Sc 'G'** and **Mr. Prakash Yadav Sir, Sc 'B'** for their guidance and support throughout the period.

I would also like to specially thank Dr. Charulatha Ma'am (professor Hindustan University), Dr. Vasantkumar Sir (HOD, Aerospace Engineering – Hindustan University) & Dr. Asokan Sir (HOD – Aeronautical Engineering) for their help and support in finding out the right opportunity.

## **Abstract**

It was one of the most memorable experience in my life to pursue an internship at RCMA Helicopters – DRDO located at HAL Helicopter Division in Bangalore. We got an opportunity to learn and witness the design, manufacturing, assembly, integration, testing process of India's one of the most robust defense as well as utility equipments namely Advanced Light Helicopters (ALH), Light Combat Helicopters (LCH) and Light Utility Helicopters (LUH).

During this period, we got familiarize with the mechanical, avionics and various other systems of helicopters. We also learnt about the basic fundamental principles responsible for making the helicopter fly.

### **Day 1 (01/06/2022)**

It started with a brief introduction about the CEMILAC – its roles, authority & functions in certifying the defense flying equipment of India. Prakash Sir gave us a brief description about the IMTAR, DGQA, RCMA Helicopters etc. and their role in certifying an aircraft to be airworthy. He also gave us a brief introduction about the types of helicopters – ALH, LCH & LUH and their utility, features & functions. Our first day was a visit to Ground Test Centre (GTC), which is involved in carrying out various structural tests like Break-Away Fuselage (BAF) test, Fatigue Test, Rotor Blade Test, Shake Test etc. We also various testing rigs like Tension-Torsion Test Rig etc.

### **Day 2 - (2<sup>nd</sup> June)**

We spent some of the time in library reading about the operational manuals & technical specifications of ALH – Dhruv (AF & CG versions) such as mission requirements, powerplants used, MTOW, Empty Weights etc. We also went to visit the Whirl Tower Testing Rig which is used for Main Rotor Blade testing. We also saw the Ground Test Vehicle (GTV) for the LUH helicopters. We also visited the Main Rotor Resonance Test Rig, ALH Rotor Root End Test Rig and Main Rotor Tension-Torsion Test. In the afternoon, we got to witness a special type of Test known as Leak Test where the ALH – CG version was kept below the rain water test rig & water was showered from different directions to find out any leaks. From the operational manual, we also came to know about various companies involved in manufacturing avionics equipment such as Honeywell, L3 communications, Elmer etc.

### **Day 3 – (3<sup>rd</sup> June)**

The day started with a quick recap from the operational/technical manual where we got to know about the Airframe structure majorly consisting of Cockpit, Fuselage & Tailboom. We visited the Maintenance, Repair & Overhaul (MRO) facility of helicopters where we got to see all the variants of ALH, LCH & LUH being serviced. We also got to know about the weight and seating capacity of various classes of Helicopters which are as follows :

<b>Sr No</b>	<b>Helicopter Class</b>	<b>Weight</b>	<b>Pax</b>
1	Advanced Light Helicopter (ALH)	5.5T	2+12 (Utility)
2	Light Combat Helicopter (LCH)	5.8T	2 (pilot, gunmen)
3	Light Utility Helicopter (LUH)	3T	2 + 6

We also got to know about the Ground Processing Unit (GPU) capable of performing functions like supplying power to the aircraft, indicating various parameters such as Delivery Pressure, Return Pressure, Flow Control Valve, Pressure Reducing Valve etc. In the afternoon we went to LCH hanger where we got to know about the basic

introduction to Light Combat Helicopters. We also witnessed designers working on a software called 3DNX for constructing various structures on the Jig. We also saw LCH – Technology Demonstrator 3, performing various ground and flying test on the tarmac of the Heliport. The test was all about taking reading at various speeds in air to record in the vibration monitoring system to measure the loads on the blades at different speeds.

**Day 4 (06/06/2022)**

The day started with the refreshment of concepts through the operational manual. We learnt about the Anti-Resonant Isolating System (ARIS) for the aircraft. We also got to know about the flapping, feathering and lead/lag articulations in controls. We visited the CNC machining lab where we saw the working of the two following machines :

**5-axis machine by Ibarria**

It is capable of drilling various parts. The machines had a unique tool magazine consisting of 60 different types of tools for making holes of various shapes & directions. The bed length of the machine was 4000 mm. The input data was in the form of G-codes & E-codes.

**SPC7140 Boring machine**

It is used to make small holes in the MGB Housing.

It is also a 5 axis machines by Siemens Sinumerik and its tool magazine consisted of 80 different categories of tools.

We also learnt about the basic gears and pinions. Our next visit was to transmission assembly lab where we mainly studied about the main gear box (MGB) & tail gear box (TGB).

Sr No	Component	Specification
1	Gearbox	Responsible for reduction of engine rpm from 6000 to 314 (blade rpm).
2	Alternator	Used to produce AC electric currents used for the functioning of various other equipment.
3	Vibration Isolation System	It used for damping the vibration produced due to the main gear box.
4	G – Rotor Pump	Used for self-lubrication inside the MGB through the movement of oils.
5	MCD	The full form is Magnetic Chip Detector. It burns the chip produced in the engine (less than 3 Micron) and gives warning in the cockpit (if greater than 3 Microns).
6	MGB Housing	Used to give a shielding protection to the mechanical control systems inside it.
7	Stub Shaft	It is made up of Titanium. It is used to transmit the rotating power from motor to the blades.
8	Swash Plate	Translate the non-rotating moment of control rods into the rotation action

Moreover, we also witnessed the Electric Oven in which heating of bearing & pinions was taking place and Freezer in which the Housing Part of Transmission was being cooled.

The revolution of Main Rotor Blade (MRB) and Tail Rotor Blade (TRB) should be such that  $\frac{N_{MRB}}{N_{TRB}} = \frac{1}{5}$ . Also the reduction rate of rpm from the gearbox is 19.3.

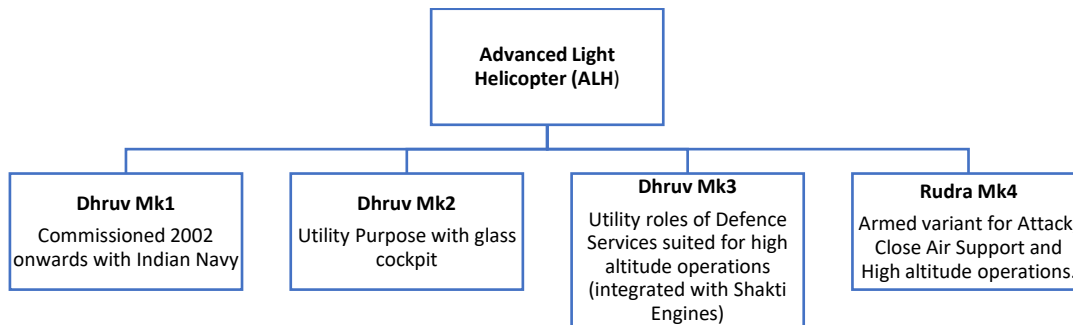
### **Day 5 (07/06/2022)**

We learnt about the Main Gear Box (MGB), Intermediate Gear Box (IGB), Tail Drive Shaft (TDS), Anti-Resonance isolation system (ARIS), Tail Gear Box (TGB) etc. These components forms the main transmission for the helicopters.

Some of the components/systems & its specifications which I learnt are as follows :

<b>Sr No</b>	<b>Component</b>	<b>Function/Specs</b>
1	Freewheel	Used for rotation in one direction
2	Integrated Dynamic System (IDS)	MGB + Upper Control System (UCS)
3	Gears & Pinions	Reduces the rpm from the engine
4	Gear Teeth	To reduce the rpm the no of teeth must increase.
5	Assembly Module	Attached to both the sides. One performs its functions while the other also performs the functions while acting as a backup module.
6	Oil Filter	Used for Filtering the Oil
7	Stub Shaft	Transmits the rotating motion to the blades. It is made up of Titanium
8	Blades	Used for generating the lift. The weight of one blade is 79 kg.
9	Hub Plate	It is used to hold the blades.
10	Control Inputs	Cyclic, Collective & Anti-Torque Pedals
11	Engine rpm	6000 rpm
12	Main Rotor rpm	314 rpm
13	Tail Rotor rpm	1500-1600 rpm
14	Weather Proof Component (WPC)	To protect MGB from weather
15	Lubrication & Coolant	Oil
16	Flexible Drive Shaft (FDS)	Used to transmit the power from engine to MGB
17	Slippage	Red color marks to identify the loose location of bolts
18	Spider	Used to hold the tail rotor
19	Bending Braid	To provide grounding the the static currents
20	Jig	It is used to hold the parts and guide the tools
21	Slushing	It is the process to clean the small holes inside the shaft

After the Lunch, we had visited the LCH hanger where Mr. Kumar Sir & Mr. Anurag Sir helped us to know about the various mechanical & weapon control systems of Light Combat Helicopter (LCH). Some of the knowledge that we gained was,

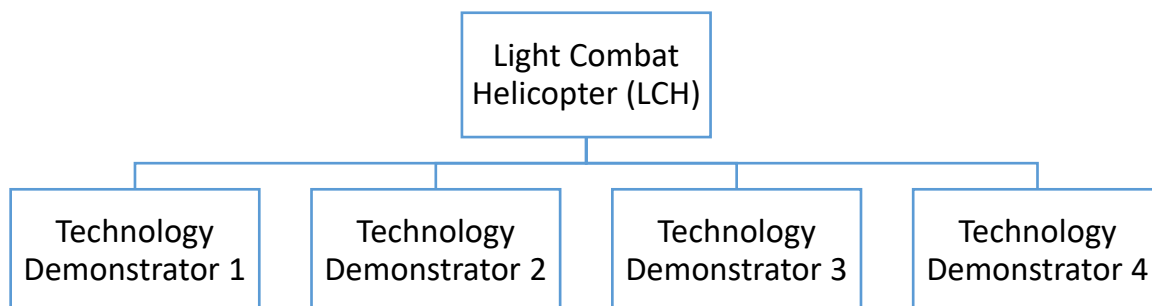


*Fig : Variants of ALH Helicopter*

### **An Answer to : Why Indigenization was needed ?**

- We always needed a helicopter compatible with our climatic conditions (North to South & East to West).
- It can help us to regulate cash flows within India without much caring about the hefty taxes to be paid while importing from outside. It can also lead to increase in employment opportunities.

The only weaponized aircraft to land on Siachen Glacier is LCH.



*Fig : Tech Demonstrator types for LCH*

Some of the functions/systems/components & their specifications that we learn about ALH & LCH are as follows :

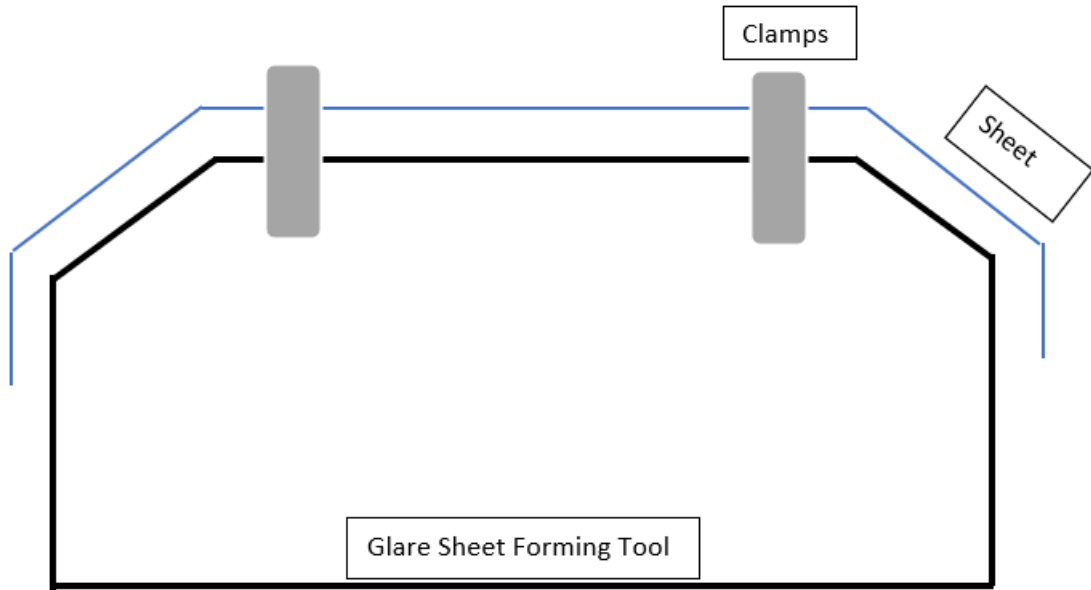
Sr No	Component/System	Specifications
1.	Turret Gun	Used for firing. Area of target covers 190deg Azimuth & 120deg Elevation.
2.	Personal Interface (PI) device	Used to download the flight data from the black box.
3.	Multi-Functional Display (MFD)	It is indigenously made by HAL. It is useful to indicate various flight control & performance parameters.
4.	Automatic Flight Control Systems (AFCS)	It controls the flight automatically (autopilot)

5.	Surveillance Radar	Fixed at the nose of the fuselage. Used for the surveillance purposes.
6.	Emergency Flotation Gear	Used in helicopter in case of water landing.
7.	Sonoboy	Detects the target inside
8.	ADELT	The full form is Automatic Deployable Emergency Location Transmitter. It is used to detect the debris of aircraft in case of an accident.
9.	Global Proximity Warning System (GPWS)	It is used to locate the position of aircraft.
10.	Jettison Handle	To pull the pilot out during emergency.

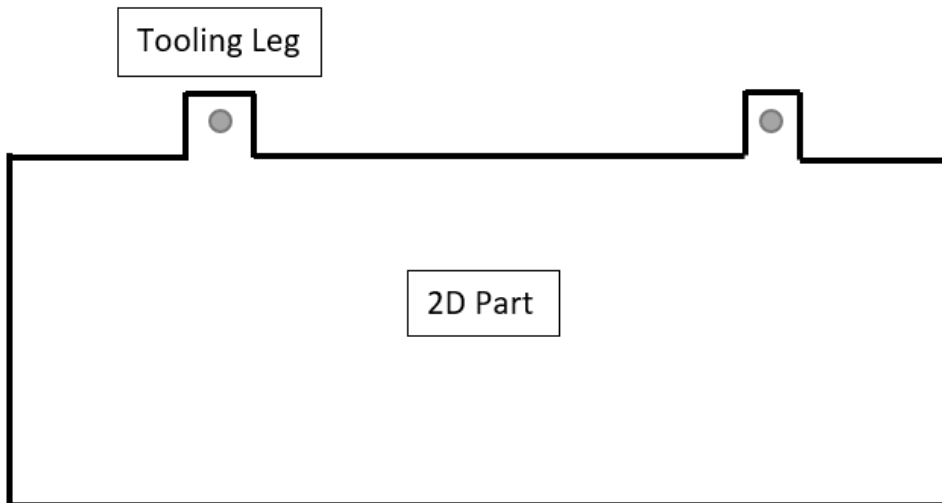
### **Day 6 (08/06/2022)**

On this day, we met to sheet metal shop in the morning where we learnt about the works done on sheets right from material selection.

Besides this the important criteria for the metals on which the job is done is the thickness which should be below 3mm and capacity to carry loads.



*Fig : Forming Tool to prepare Glare Sheet for LCH  
(diagram as per practical observation)*



*Fig : Illustration of Tooling Leg on 2D Part  
(diagram as per practical observation)*

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**Material Selection**

Materials type, dimensions such as thickness etc. has to be pre-decided before any other job done on it.

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**Routing (Routing Mill)**

It is used for making the contours inside the materials. For e.g. FXB1 CNC Router

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**Flat Pattern (with Tooling Legs)**

A flat material with tooling legs

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**Nesting/Adaptive Testing**

Nesting is the process of laying our cutting patterns into the materials to avoid the wastage of raw material.

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**Spot Welding Machine**

It is used to fuse two or more metal sheets via a fusing process.

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**Light Press**

It is used to deform the metal sheet under high pressure,

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**Bending Machine**

It is used to give appropriate shape to the sheet by bending it.

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**Punch Press**

It is used to cut the holes in the material.

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**Glaring Sheet**

It is used in LCH cockpit to give protection to the pilot from the cockpit light's glare.

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**Shearing Machine**

It is used to cut the sheet as per requirement.

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**Ply Machine**

Used to make components out of ply.

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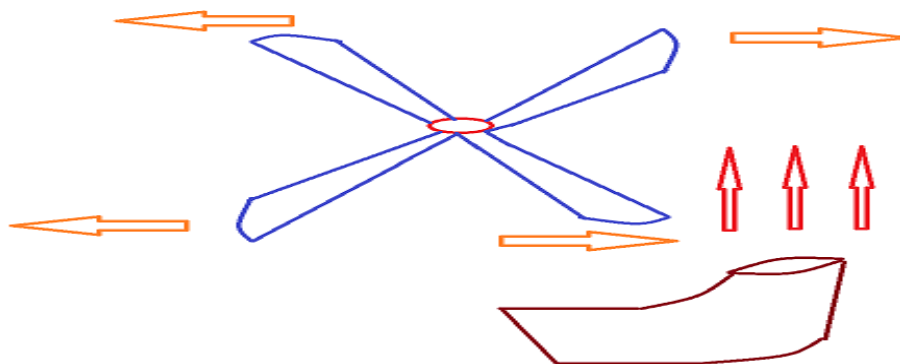
In the afternoon, we went to Light Combat Helicopter (LCH) Hanger where a very knowledgeable apprentice Mr. Jaffer taught us about the basic construction and systems.

Some of the specifications that we got to know are as follows.

<b>Sr No</b>	<b>Component/Systems</b>	<b>Specs/Remarks</b>
1	EOPOD (Electrical Optical Pod)	Used for Target Detecting & Ranging & FLIR (Forward Looking Infrared). It worths rupees 4 crore.
2	LCH Structure Type	Monocoque
3	Pitot Tube Type	Single Hole Pitot Tube on both LHS & RHS
4	ELT (Emergenct Locator & Transmitter)	Sends signals to locate the aircraft/debris in case of accident. Get activated due to the high G impact of aircraft with ground.
5	Turret Gun	Used for firing, fixed below the nose.
6	Fuel Capacity of LCH	1295 Litres, Total 5 fuel tanks
7	Stub Wing	Used to hold the rocket/missile launcher
8	Example of Missile Type Used	2mm Missile, Air-to-Air or Air-to-Ground
9	Yellow Color paint in LCH	Anti-Corrosive Paint
10	Cement Colour Paint	Depicts pure composite material
11	Composition Inside Fuel Tank	Bag – capable of withstanding high impact compared to conventional hard structures
12	IRSS (Infra-Red Suppression System)	Make the aircraft undetectable by external sources by suppressing the IR radiation emitted.
13	Flares	It is used to counter (confuse) the missile aiming to shoot the aircraft based on aircraft's IR emissions.
14	Chaffs	It is used to counter (confuse) the external radars aiming to trace the aircraft based on aircraft's IR emissions.

15	HPS (Helmet Pointing System)	Used to aim the target via EO Pod for shooting.
16	Photovoltaic Sensor/Interrupter	To sense the rpm of tail rotor based on the light energy absorbed by sensor.
17	FCD (Flares & Chaffs Dispenser)	Used to manage the operations of release of Flares/Chaffs.
18	Battery used in LCH	Ni-Cd Battery
19	Types of Locks used in LCH	Blade Lock, Parking Brakes
20	Radar (Radio Detection & Ranging)	Used to track the aircrafts/flying objects.
21	SONAR (Sound Navigation & Ranging)	Used to Track the under-water objects.

An Answer to : Why the Engine Exhaust of LCH is inclined Upwards when compared to other helicopters in which exhaust is inclined straight horizontally ?



*Fig : Photo & Diagram showing the distribution of heat by the blades when the exhaust is inclined upwards*

The main aim is to distribute the heat uniformly in the atmosphere so that the exhaust doesn't get heated uniformly in one direction & emit excessive radiation being sensible to infrared homing missiles.

**Day 7 (09/06/2022)**

We visited the Systems Integration Lab (SIL) in the morning where Ms. Sindhu Ma'am gave us a brief overview about the Avionics Systems of the aircraft.

**Some Elements of Avionics System**

<b>Communication System</b>	<b>Navigation System</b>	<b>Surveillance System</b>	<b>Recording Systems</b>
<ul style="list-style-type: none"> <li>•V/UHF Communication</li> <li>•Some of the notable communication frequencies are 121.5 MHz (for ELT), 243 MHz (Rescue Ops), 406 MHz (for Satellite Navigation)</li> </ul>	<ul style="list-style-type: none"> <li>•GPS</li> <li>•VOR/ILS</li> <li>•DME</li> <li>•TACAN (VOR + DME) - Range, Range Hold, Decision Height</li> <li>•INS/GNSS (Gyros, Accelerometer)</li> <li>•DOK (Data on Key) : Used to insert flight plans into FMC for planned missions</li> <li>•Radio Altimeter etc.</li> <li>•AFCS (Automatic Flight Control System)</li> </ul>	<ul style="list-style-type: none"> <li>•Identification of Friend &amp; FOE (IFF)</li> <li>•Squawk Code - a unique identification code given to aircraft for communication &amp; getting flight information.</li> </ul>	<ul style="list-style-type: none"> <li>•Black Box (can record 512 bits - 25 hrs of data &amp; communication using 4 audio channels)</li> </ul>

In the afternoon, we visited MGB Transmission assembly for CH/CK (Cheetah & Chetak Helicopters). There Mr. Jagdeesh Sir & Mr. Bhagyaraj Sir explained us about the various components involved in MGB transmission. The MGB majorly consists of 5 subassemblies namely

1. Input Stage
2. TPTO (Tail Power Takeoff)
3. VDS (Vertical Drive Shaft)
4. 1<sup>st</sup> Stage Sub-Assembly
5. 2<sup>nd</sup> Stage Sub-Assembly

The first stage consists of approximately 6 pinions and the second stage consists of approximately 9 pinions. The main aim is to reduce the rpm from engine to MRB (Main Rotor Blades).

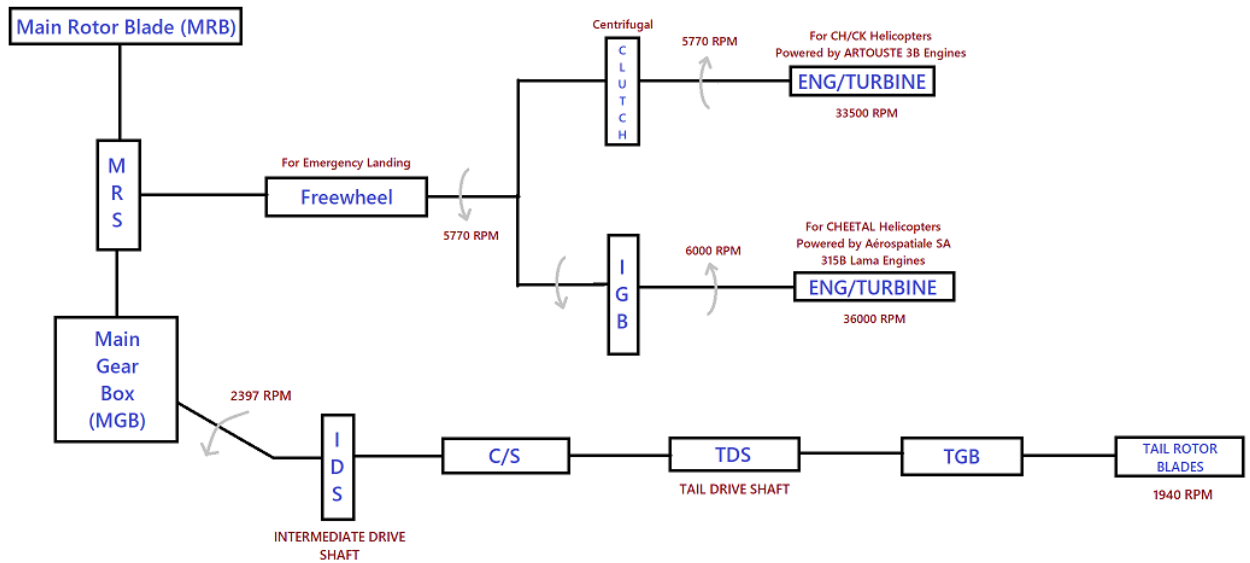


Fig : The diagram shows the mechanical system for RPM reduction & transmisson in case of Cheetah & Cheetak Helicopters

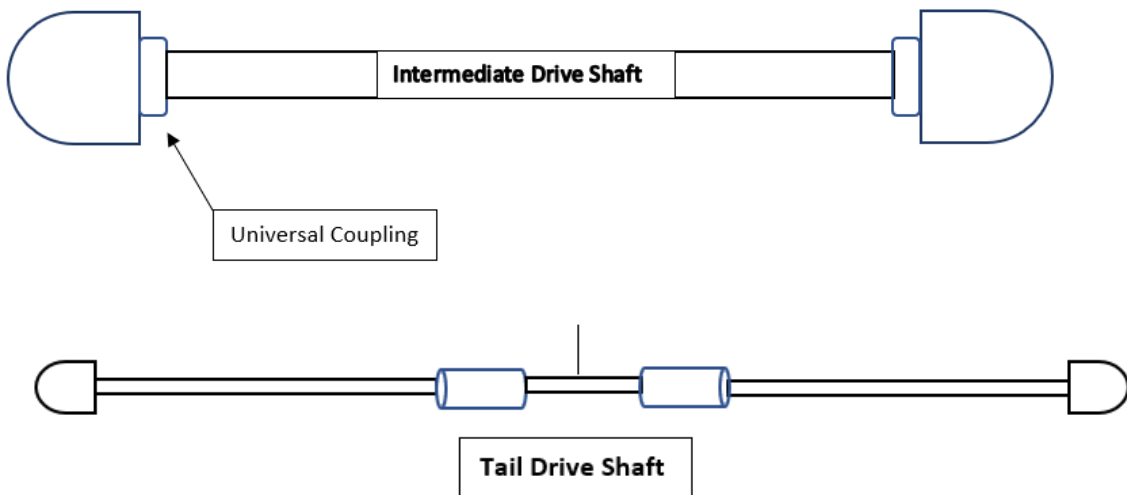


Fig : Schematic Diagram of Tail Drive Shaft

**Day 8 (10/06/2022)**

In the morning, we got a very comprehensive lessons from Mr. Srikanth Sir, related to Aerodynamics. Generally, there are two types of bodies – (1) Lift Generating Bodies (2) Non-Lift Generating Bodies. We also got to know about some of the prominent softwares used for analysis at the organization namely Ansys (CFX & Fluent). The loads acting on the body, Effective Angle of Attack (AOA), Effective Free-Stream Velocity, Profile etc. have significant effects on the Aerodynamic characteristics of the bodied.

**Swash Plate Mechanism** : It is mainly used to convert the non-rotating input (Moment) to the rotating input through control rods.

Moreover, while rotating each and every blade follows a sinusoidal with the phase of individuals being varied. This allows the blade to simulate a disk type rotation. According, to this the lift vector gets tilted and the helicopter performs maneuver accordingly.

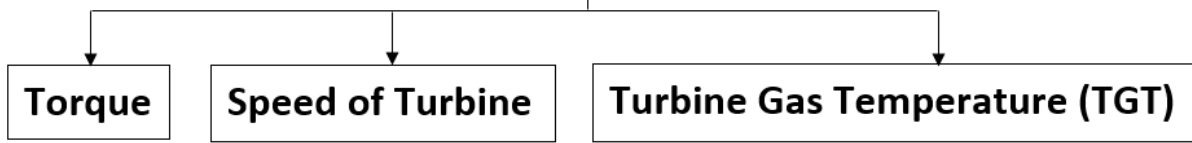


*Fig : A rough representation of how the phase of blade varies at different position according to sinusoidal waveforms.*

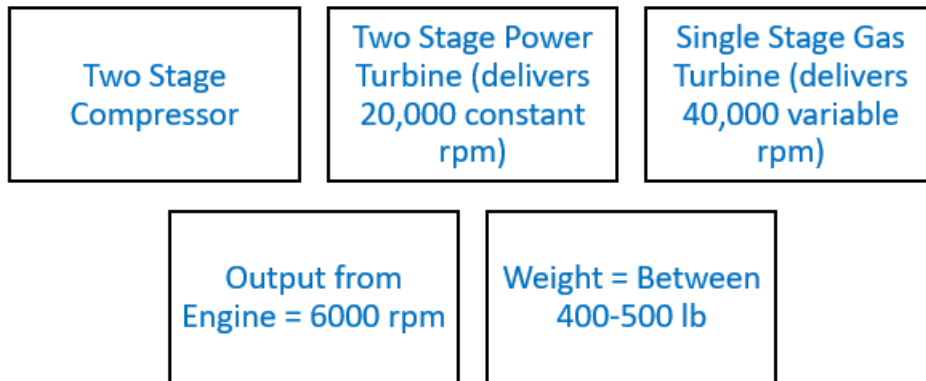
After Aerodynamics, we went to Mr. Krishnaprasad Sir, in FADEC – RWRDC. We got an introduction to Full Authority Digital Engine Control (FADEC).

Sr No	Helicopter Type	Powerplant Used
1	Cheetak	Artouste IIIB
2	Cheetah	Artouste IIIB (initially) which got replace by TM333 2B2
3	Cheetal	TM333 2B2
4	Dhruv Mk1, Mk2	Turbo Meca TM333 2B2 (twin engine)
5	Dhruv Mk3, Mk4	Shakti Engine
6	Light Combat Helicopter (LCH)	Shakti Engine
7	Light Utility Helicopter	Safran Ardiden

### Three Basic Engine Parameters



### Specifications of Shakti Engine



### Fully Authority Digital Engine Control (FADEC)

It is the system used to monitor the health of the engine. It monitors parameters like Power Turbine Shaft Speed ( $N_f$ ), Gas Turbine Shaft Speed ( $N_G$ ), Turbine Gas Temperature (TGT) etc. Under it, an engine has two major types of starting modes namely (1) Cold Start : It is used to start the engine from cold condition. (2) Hot Start : It is used to start the engine before allowing it to cool.

#### *Different Power Levels for the Engine*

Sr No	Abbreviation	Full Form
1	MCP	Maximum Continuous Power
2	TOP	Take-Off Power
3	ICR	Intermediate Contingency Rating
4	MCR	Maximum Contingency Rating
5	SCR	Super Contingency Rating

The helicopter blades, works on the principal of CENTRIPETAL FORCE which pushes the air down thereby generating the lift.

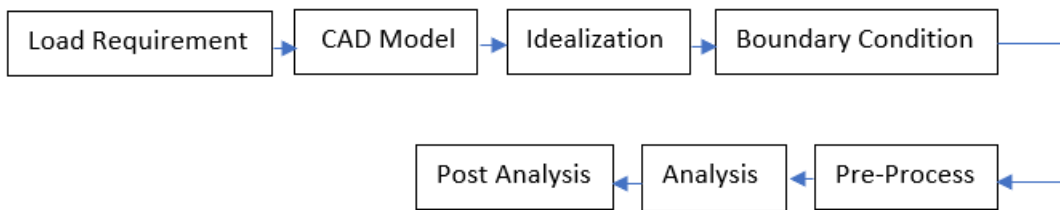
In the afternoon, we had a visit to the blade shop which is involved in the ab-initio manufacturing of the blades. Mr. Giri Sir firstly conducted a rapid fire round asking us some of the fundamental questions related to our subject.

Sr No	Component/System	Function
1	Sulphochromic Picking Tank	It is used to remove the impurities

2	Burner	Used for polymerisation of the skin with sheets
3	Molto-Prene Blocks	It is used in the 2 <sup>nd</sup> stage bonding
4	Araldite	It is used as an adhesive
5	Static Balancing	The setup is such that the net balance on the rotor has to be zero in order to fulfill the static balancing criteria.
6	Static Discharge Port	It is used to discharge the static charges
7	Trim Tabs on Blade	It is used to adjust the lift on the tip
8	Colours on Blade Spoon	Used for reference (w.r.t Datum Line)
9	Width of Blade (CH/CK)	35 cm approx
10	Twist of Blade (CH/CK)	6 deg 30 mins
11	Airfoil Profile	MRB Skin Stretching MIC (setup). Skin is made up of Al alloy.

**Day 9 (10/06/2022)**

We got a chance to interact with the structural analysis team under RWRDC in the morning. AT Rao Sir & Kalinga Gulbarga Sir explained us in detail about the direct application of the structural theory in our curriculum into the industry. The two main criteria that should be kept in mind while designing any helicopter is its performance & safety.



*Fig : The basic process for any structural development of the model*

The load requirement is decided and issued by the Aerodynamics Team. Various Parameters like Factor of Safety, Allowable Stress etc. is pre-decided. Various theories like Von-Mises Theory, Stress/Strain Theory etc. is also taken into account. Various instability criterion like Vibration, Buckling etc. is also taken care-off.

Moreover, we also visited the Ground Test Centre (GTC) and witnessed the pre-test preparation for the Landing Skid Drop Test which was going to happen the next day.

Sr No	Component/Systems	Description
1	Bross Tube	It is used to absorb the energy
2	Laser Sensor	It is used to measure the horizontal and vertical displacement.
3	Flare	It is used to counter the infr-red homing missile
4	Chaff	It is a radar countermeasure
5	Inquisite Analysis	It does no depend on time domain
6	Exquisite Analysis	It depends on the time domain
7	Coupon Test	Used in Stress Analysis for the selection of appropriate materials based on their properties.

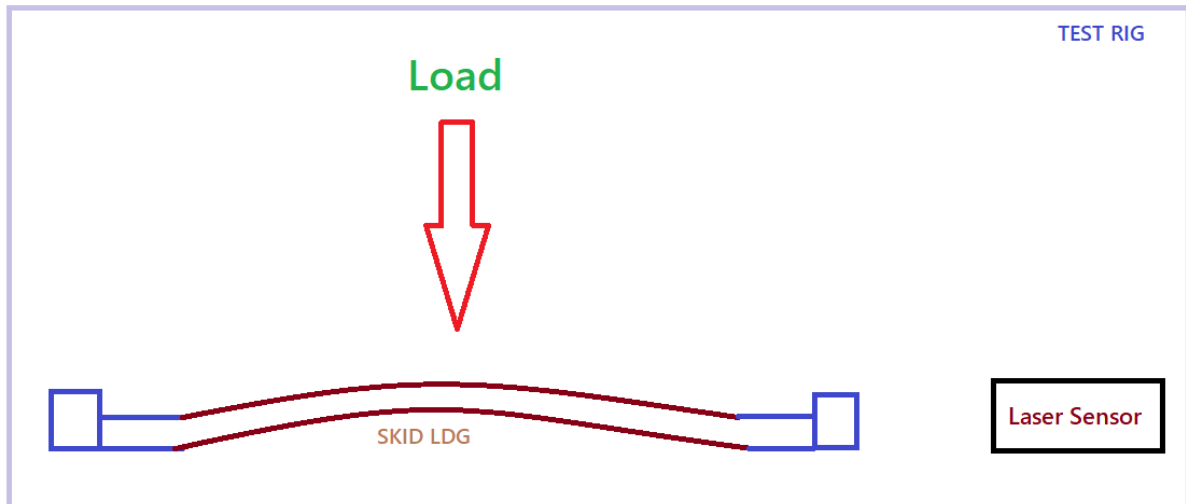
### **Day 10 (14/06/2022)**

In the morning, we got a chance to visit the hanger of Cheetak/Cheetah/Cheetal aircraft and meet Mr. Chandru Sir. He made us familiar with the CH/CK aircrafts. Some of the systems that we witnessed practically was the Airframe, Powerplant, Flight Controls, Cockpit Instruments etc.

Cheetah/Cheetal helicopter is a 5-seater helicopter with 575 Litres of fuel capacity. The Rescue Hoist can carry the weight of approximately 175kg. While the Chetak helicopter is a 7-seater helicopter. The airframe consists of Main Gear Box (MGB), Blades and the Controls. The cockpit consists of the analogue instruments like altimeter, attitude indicator, airspeed indicator, tachometer etc.

**Skid Drop Test :** We got a chance to witness the Skid Drop Test in which the loads in the speed of 2 m/s and 1 m/s have been dropped and check in two cycles. Some of the notable parameters about the test are as follows :

Sr No	Component/System	Description
1	Aim	To check for permanent deformation & strength of skid
2	Avg Impact Speed	2 m/s
3	Avg RUAV Speed	210 kmph
4	Max RUAV Speed	310 kmph
5	Laser Tracker	Horizontal & Vertical Displacement
6	Drop Height	200mm/20cm
7	Width	200mm/20cm
8	Weight	85kg each skid
9	Strain Gauge	Used to Measure Displacement
10	Accelerometer	Used to measure the Acceleration
11	Test Cycle	Conducted till permanent deformation occurs



*Fig : A schematic of the skid drop test  
(diagram as per practical observation)*

**Day 11 (15/06/2022)**

In the morning, we had a session with Ms. Karuna Tomar, Chief Manager of Design at RWRDC who gave us a thorough introduction about the Automatic Flight Control Systems (AFCS) which is also commonly known as autopilot systems. It includes various aspects such as Operational Requirements, Architecture, Output Systems, Quality Rating etc. The AFCS works by comparing the current state of the aircraft with the desired reference through sensors and pilot inputs. The AFCS is a closed-loop system, where small errors are corrected in the preceding cycles through the feedback loops.

The two basic criteria to be taken care while designing the AFCS is :

1. Stability
2. Controllability

Some of the common types of AFCS systems used in helicopters are as follows :

<p><b><u>2-Axis AFCS</u></b></p> <ul style="list-style-type: none"> <li>- Controls the Pitch &amp; Roll Axis</li> <li>- It is used in Light Weight Helicopters</li> </ul>	<p><b><u>3-Axis AFCS</u></b></p> <ul style="list-style-type: none"> <li>- It controls the Pitch, Roll &amp; Yaw Axis</li> <li>- It is used in Medium Weight Helicopters</li> </ul>	<p><b><u>4-Axis AFCS</u></b></p> <ul style="list-style-type: none"> <li>- It controls the Pitch, Roll, Yaw and Collective.</li> <li>- It is used in medium to heavy class of helicopters</li> </ul>
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AFCS can also be classified in two types based on the sources

1. **Simplex** : All the systems/functions is having a single source.
2. **Duplex** : There are two sources of information for redundancy purposes.

AFCS can be classified in two types based on its authority :

1. Limited Authority AFCS
2. Full Authority AFCS

Sr No	Helicopter Type	AFCS System Used
1	Advanced Light Helicopter (ALH)	4-Axis Duplex AFCS (includes Air Data Sensor, Inertial Sensor etc.)
2	Light Combat Helicopter (LCH)	4-Axis Duplex AFCS (indigenously made)
3	Light Utility Helicopter (LUH)	3-Axis Simplex AFCS (VFR version)

In the afternoon, we acquired knowledge about the powerplant at RWRDC-Powerplant section. Mr Sandeep Kumar gave us a brief introduction about the various parameters that needs to be considered while designing any engine, some of them are :

1. Specific Fuel Consumption (SFC)
2. Weight of the Engine
3. Dimensions
4. Air Mass Flow Rate (More Power  $\propto$  More Air Mass Flow Rate)
5. Best Condition for Engine Operation (High Pressure, High Temperature Conditions)

He also gave us inputs about the Shakti Engine which was manufactured in India which requires overhaul every 2000 hours. Some of the fuels used are Jet A1 : Highly Graded Kerosene GP4. We also got some inputs regarding the On-Board Inert Gas System (OBIGCS).

Later, we also had a visit to Light Utility Helicopter (LUH) hanger, where Mr. Amit Kumar Sir gave us knowledge about the processes happening them and the main difference between a Jig & Fixture.

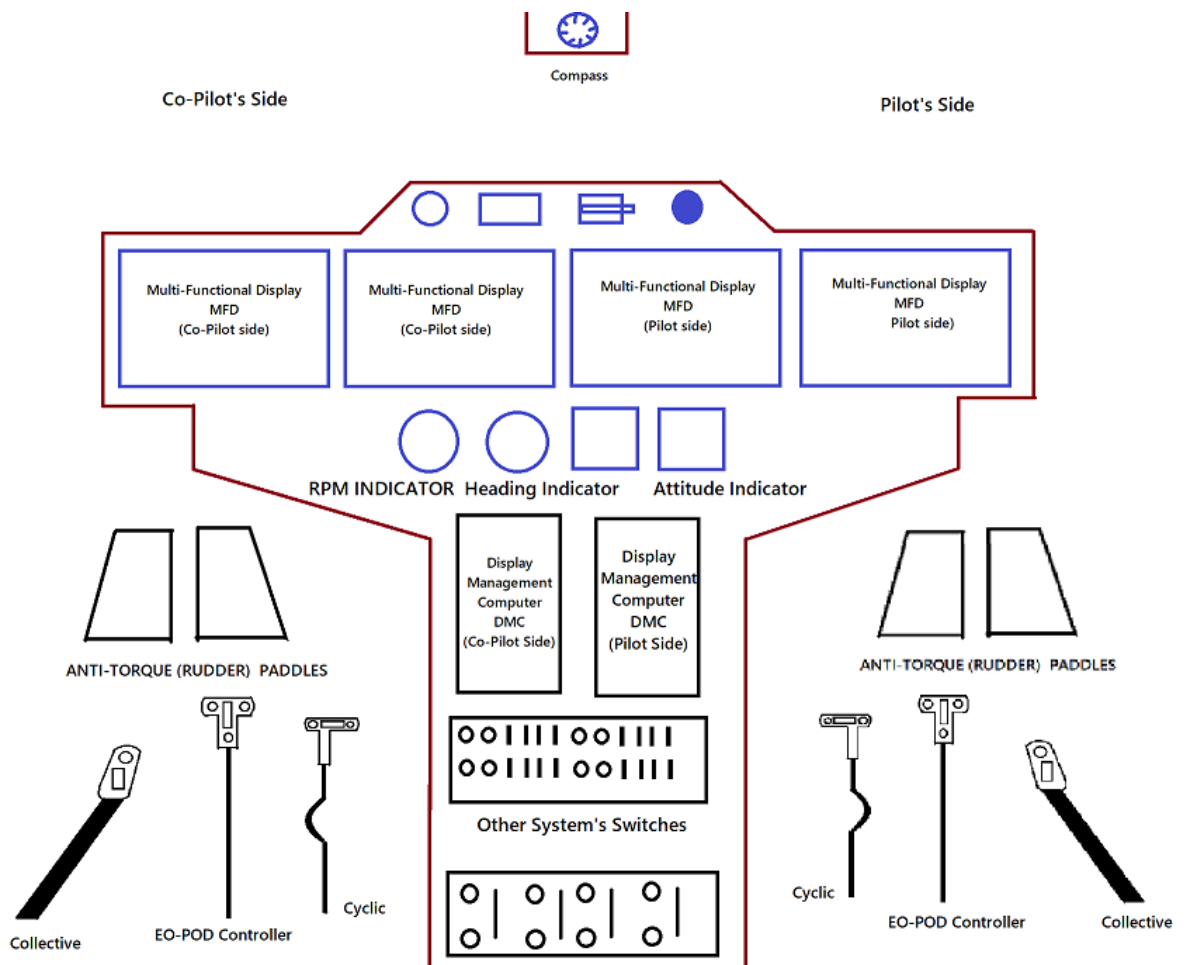
Fixture
<ul style="list-style-type: none"> <li>• It is the tool to hold the component</li> </ul>

Jig
<ul style="list-style-type: none"> <li>• It is the tool which not only hold the component but also guides the tool.</li> </ul>

### **Day 12 (16/06/2022)**

This was one of the most memorable day of our internship. We got a chance to sit in the cockpit of ALH Dhruv Mk IV helicopter at the hanger. We got to learnt about various cockpit systems such as Navigation Systems, Flight Management Systems etc. Some of the systems/component that we observed and learned are as follows :

Sr No	Component/System	Description
1	Data on Key (DOK)	Used to load Flight/Mission Plan
2	Display Management Computer (DMC)	Used for multiple applications such as tuning comm frequencies, waypoints etc.
3	Fuel Systems	Used for functions such as fuel feed, temp indications etc.
4	Multi-Functional Display	Displays various Flight Controls & Performance Parameters such as attitude, altitude, airspeed, rpm, torque, TGT, Mass Moment etc.
5	Automatic Flight Control System (AFCS)	Used for tuning of autopilot features such as trim, roll etc.



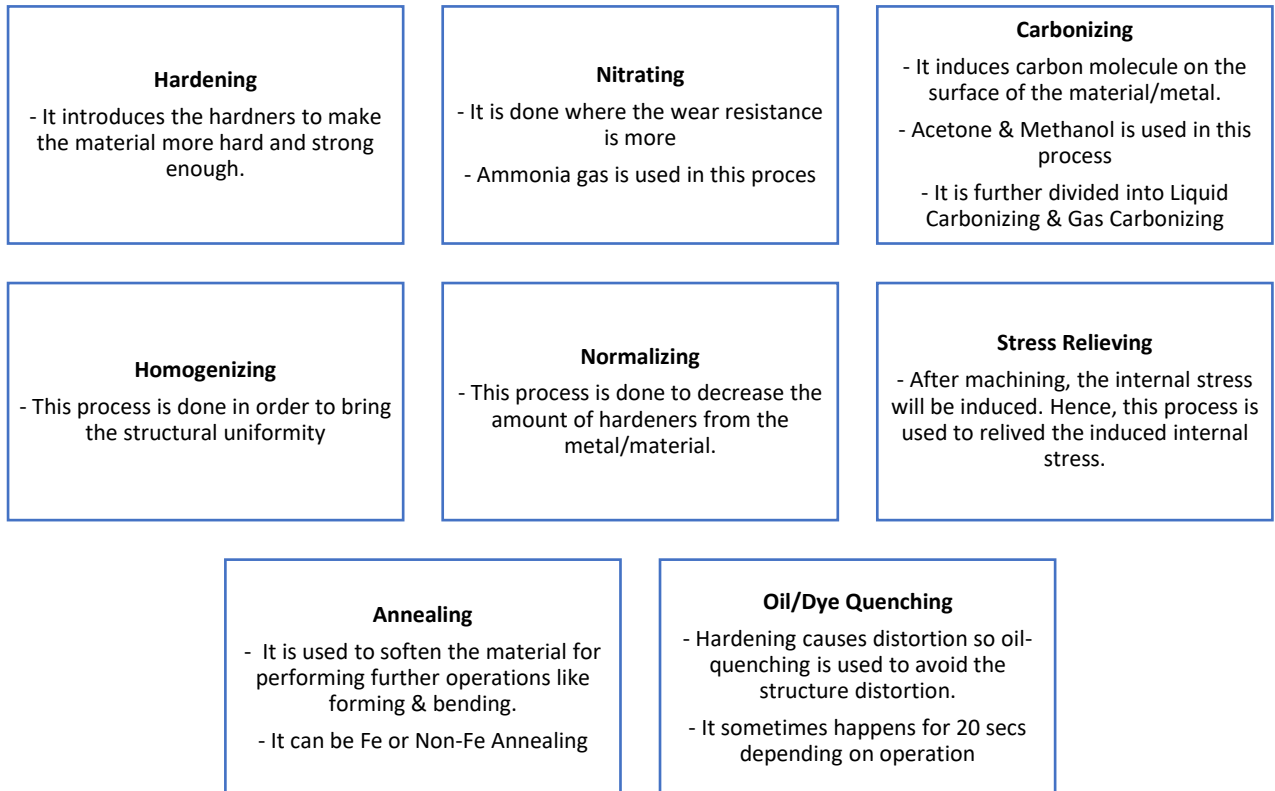
*Fig : A rough schematic of the cockpit layout of ALH MkIV  
(diagram as per practical observation)*

**Day 13 (17/06/2022)**

We have visited heat treatment shop where Mr. Swamy explained us in depth about various processes on-going in the plant.

*Heat Treatment* : It is a process where we can heat the material to make the structural changes or alter its properties to increase its strength.

Various Operations occurring in the heat treatment plant are as follows :

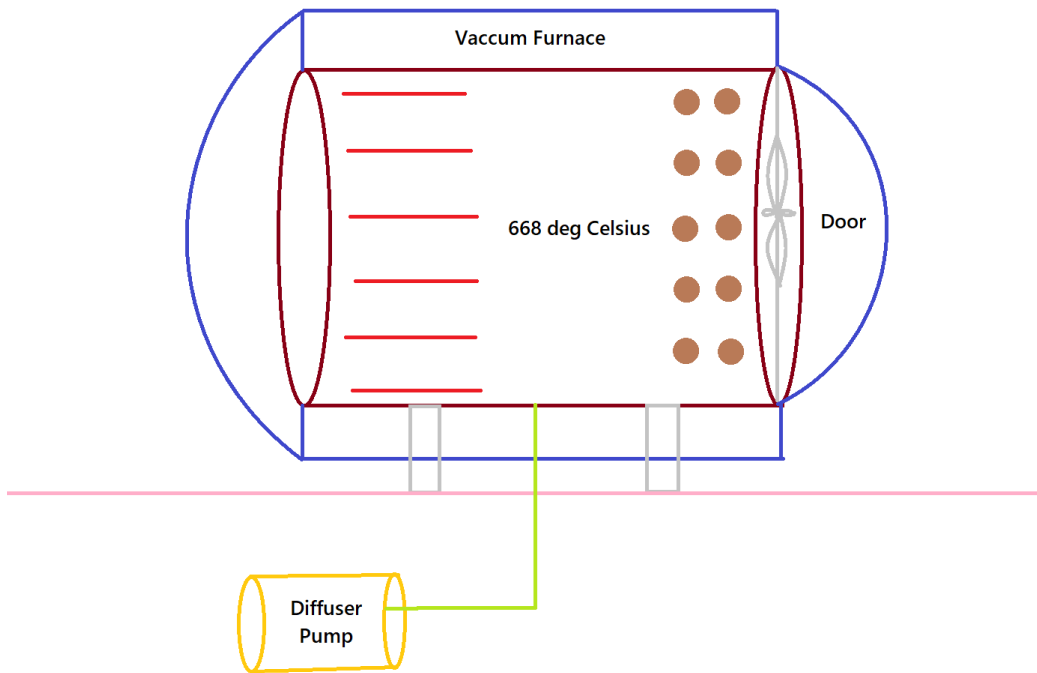


Some of the other processes also include Ageing, Solutionizing, Shoe Brazing etc.

*Various Types of Furnaces & Machineries in Heat Treatment Plant*

Sr No	Furnace Type	Utility
1	Muffle Furnace	Used for low temperature and high temperature heating processes. Sometimes, the material inside it subjects to oxidation due to air inside it.
2	Vaccum Furnace	The air inside the furnace is sucked out through the diffuser pump attached outside.
3	Vaccum Hardening & Dye Quenching	Performs both the processes, hardening and quenching under vaccum conditions
4	Pit Furnace	It is used for metalurgical processes which requires low temperatures.

5	CNC Shot Peening Machine	It is used for shot peening of ferrous components to increase the hardness of the material and for stress relieving purposes.
6	Ultrasonic Cleaning Machine	It is used for cleaning of ferrous components from the material.
7	Robotic Arms	It is used to hold the material and put it into the furnace. It is used especially in case of heavy materials.

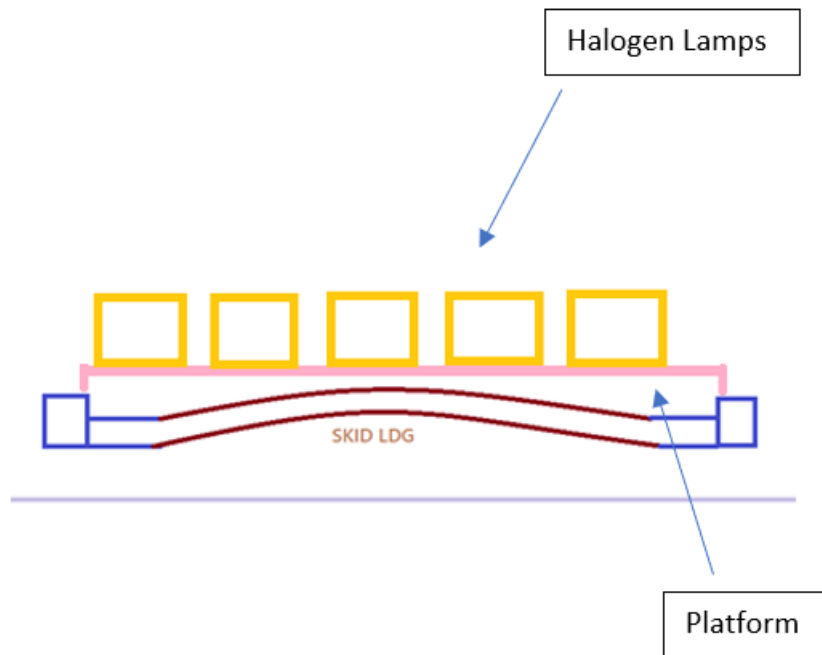


*Fig : A schematic of the Vacuum Hardening Furnace*

**Day 14 (20/06/2022)**

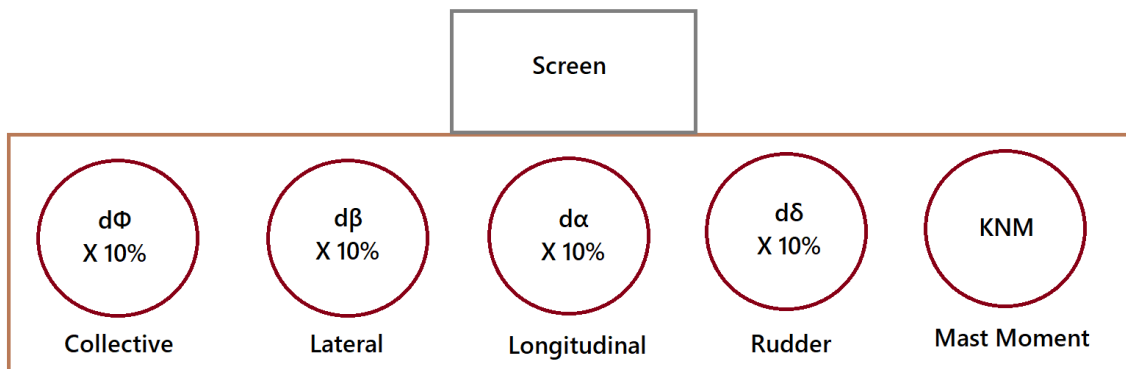
We had a visit to Light Utility Helicopter Hanger (LUH) and got an idea majorly about various types of rigs used to manufacture the structure and also various testing systems used for testing.

**Testing System :** One such testing system was use of Halogen Lamps to draw all/maximum current from the alternator (which provides AC current to the instruments requiring AC power) to examine its cooling capability. It is also known as alternator cooling test. The Halogen Lamps are heated to the temperature of about 200 degrees Celsius derieving of about 150 rms Power at about 400 Hz. The Halogen Lights are used as they are the most inefficient power consumption source and can draw maximum current to test alternator upto its extreme limits. Till the date 4 test flights have been done for this particular test.



*Fig : Schematic of the Alternator cooling Testing System  
(diagram as per practical observation)*

Moreover, as a part of a testing system the slideslip, roll angle, pitch angle etc. indications were also included in the front panel so that pilot can know the percentage of deflections. For example, some tests requires 50% rudder deflection/Side-Slip angle, hence based on the indicator the pilot can provide the necessary inputs.



*Fig : Schematic of various equipment for testing fixed inside the cockpit of LUH  
(diagram as per practical observation)*

### **Day 15 (21/06/2022)**

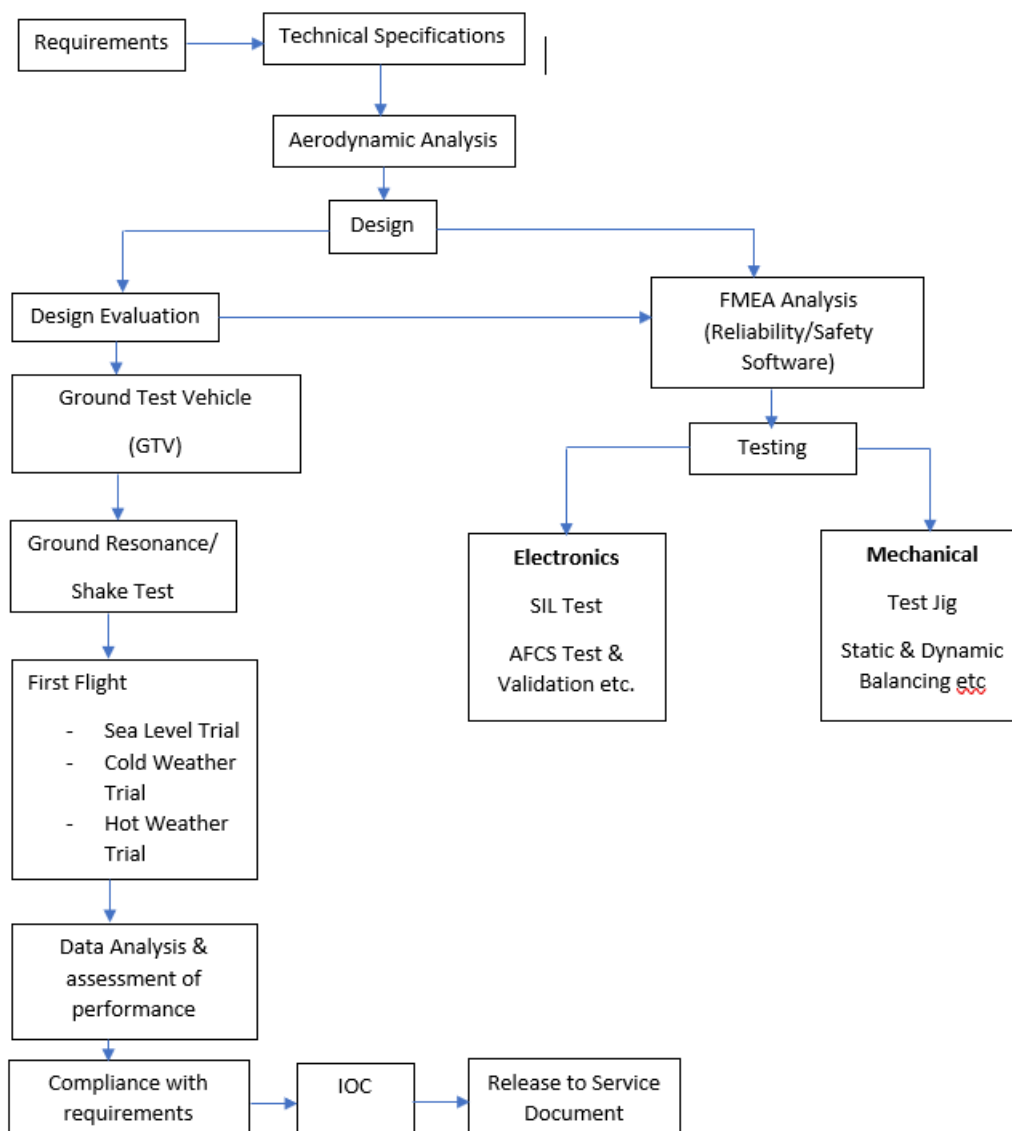
This day, we got a very informative session regarding the functioning and roles of RCMA – Helicopters & CEMILAC (Centre for Military Airworthiness & Certification). Right from the intital requirements till testing phases of the aircrafts, RCMA-Helicopters plays a major role in certification and release of the aircraft signifying it in airworthy (fit to fly) condition.

Some of the major divisions of CEMILAC are :

1. RCMA Aircraft
2. RCMA Helicopters
3. RCMA Engines etc.

Right from the Advanced Light Helicopter's first flight from 2001 till the recent certifications of Light Utility Helicopter (LUH), RCMA – Helicopters have been involved and played a very significant role. The four major indigeneous designs that have been certified by RCMA Aircrafts and RCMA Helicopters are Light Combat Aircraft (LCA), Advanced Light Helicopter (ALH), Light Combat Helicopter (LCH) and Light Utility Helicopter (LUH). The other organization responsible for the quality is Director General of Aeronautical Quality Assurance (DGAQA).

*The following chart describes the processes involved in designing and certification*



## **Conclusion**

We learnt about three different classes of helicopters (i.e. Advanced Light Helicopter (ALH), Light Combat Helicopter (LCH) & Light Utility Helicopter (LUH)). Right from the manufacturing of a single blade till the integrating of helicopter, the entire process was quite noteworthy and interesting to know. My entire experience here would be giving a different shape to my career from both technical and organizational perspective. We also got to meet the people who were very humble and eager to help us to learn. We also saw the team of the finest engineers of India, brainstorming their mind for solving a variety of problems. Each and Every second here was a lesson to be learnt and implement in day-to-day life. I also got to know about the practical applications of the theoretical studies that I did in my curriculum. Right from the Bernoulli's Equation till the Bending Moment Diagrams have been used here for designing and calculation purposes for the helicopters. It was a memorable experience ever.

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