INTRODUCTION TO AEROSPACE SYSTEMS I

AED201

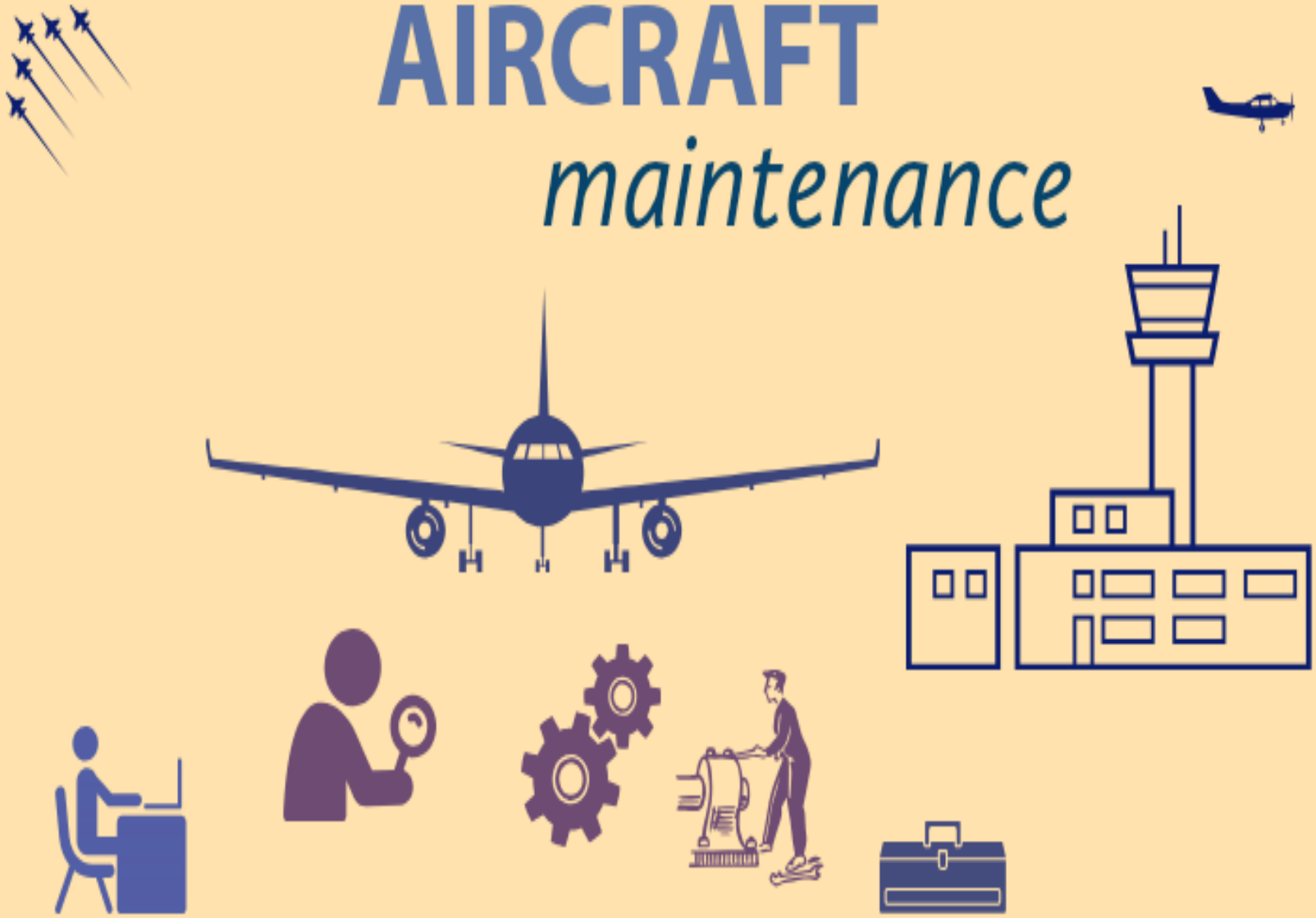
TOKAN ABASHE

ASSISTANT LECTURER

AEROSPACE ENGINEERING DEPARTMENT

AIRCRAFT

maintenance



AviationHunt.com

COURSE OUTLINE

- Overview of the Aerospace Engineering Industry
- Differing job roles for Aerospace maintenance staff
- Training opportunities and job progression
- License examination & qualification
- airworthiness regulation
- Aircraft Maintenance
- Safety culture

COURSE OBJECTIVES

- To enable students understand the basic principles of aircraft maintenance
- To understand basic maintenance tasks
- To understand the classifications of aircraft maintenance checks
- Knowledge of manuals in use in aircraft maintenance

INTRODUCTION

AIRCRAFT MAINTENANCE -is the performance of tasks on an aircraft ***engine, propeller, or associated part*** required to ensure the **continuing airworthiness** of an aircraft, it is performed on both civil and military aircrafts.

MODIFICATION – Modification means, A change to the type design of an aircraft, engine, or propeller.

REPAIR – Repair means, The restoration of an aircraft, engine, propeller, or associated part to an airworthy condition, in accordance with the appropriate airworthiness requirements, after it has been damaged or subjected to wear.

Airlines and commercial operators of large turbine powered aircraft follow **CONTINIOUS INSPECTION PROGRAM APPROVED BY NATIONAL AUTHORITIES OF THAT OPERATOR** .

Under the national authorities oversight each Operator prepares a **CONTINIOUS AIRWORTHINESS MAINTENANNCE PROGRAM** this includes

- Routine Inspection
- Detailed Inspection(referred to as CHECKS)

A and B are lighter checks

C and D are heavier checks

REQUIREMENTS AND PURPOSE OF MAINTENANCE

REQUIREMENTS

All aircraft owners/operators are mandated to comply with the following **at least 21 calendar days** prior to the commencement of any scheduled base maintenance.

1.Formally notify the ***Authority*** of the upcoming base maintenance, ***detailing the type and level of maintenance***, ***the facility & location where the maintenance is to be accomplished and its estimated date of completion.***

2.Submit to the authority the ***work scope*** of the maintenance/Inspection in accordance with the aircraft approved maintenance programme or schedule .

3.Apply to the authority for the issue/renewal of the certificate of airworthiness to be carried out at the facility where the maintenance will be accomplished.

PURPOSE OF AIRCRAFT MAINTENANCE

The essential purpose of Aircraft Maintenance is to either return a **defective system or component** to ***serviceability*** or to maintain the ***aircraft system***, component or structure in an airworthy condition.

2. Regular maintenance will ensure that the aircraft is serviceable for the time it flies.

3. Regular maintenance helps to ***extend*** the life of the aircraft , a well-executed inspection and maintenance process includes thorough check-ups of the vital aircraft parts with the addition of necessary fluids to avoid friction.

4. Proper Maintenance improves safety for the aircraft , Therefore, ***MRO (Maintenance, Repair, and Overhaul / Operation)*** is crucial for the safety of humans and aircraft as well.

5. Aircraft maintenance improves **PERFORMANCE AND STABILITY** for the aircraft

Holistic maintenance includes ***calibration management*** too. It means changing the old part and installing a new advanced part so that it can increase the performance.

CALIBRATION :The application of specifically known and accurately measured input to ensure that an item will produce a specifically known output which is accurately measured.

Generally Calibration Should be performed

a. Initial purchase unless it comes with calibration certificate

b. After repair

c. Periodic Calibration

d. Whenever accuracy is in doubt

CATEGORIES OF AIRCRAFT MAINTENANCE

Continuous inspection and ***Maintenance*** are mandatory in the aviation industry as established by the ***civil aviation authority*** .

1.**LINE MAINTENANCE :-**

This type of maintenance is the *most routine*. Sometimes called

- **post-flight maintenance,**
- **pre-flight service check or**
- **overnight checks**

this is the most typical maintenance service performed on aircraft. Line checks **require minimal tools** and are usually done at ***the airport gate under the "open sky."***

Typically it is carried out every 24- 48 hours and a weekly check every 7-8 days

There may be other **out of phase maintenance** carried out (OOP) if need be.

LINE MAINTENENACE ACTIVITIES

- Landing gear checks, check for leaks
- Engine Oil level checks
- Check the hydraulics system to see if they need to be replenished
- The tire pressure also need to be checked to see if its good
- The pilots technical log book also need to be checked for any documented reports.
- The engineer will also check the cockpit to see if the fuel pumps have been switched off and if batteries have been disconnected

2. A - CHECKS

The A check is performed *approximately every*

400-600 flight hours or every 200–300 cycles*(take off and landing is considered an aircraft "cycle")* or every 10 weeks depending on aircraft type.

A check maintenance is typically done at **a hangar and can take a minimum of 20-60 man working hours Depending on the services needed. (B737 takes 6-24hrs)**

Sometimes, this maintenance is done ***overnight*** as to not interrupt the schedule that airlines keep.

The frequency of this check varies by

- ***Aircraft type***
- ***The flight cycle count,***
- ***The number of hours flown since the last check.***

MAINTENANCE WORK DURING A-CHECKS OFTEN COVERS

1. General visual inspection of the interior and hull for evidence of damage, deformation, corrosion, missing parts.

2. Check of crews oxygen system pressure

3.Operational checks of emergency lights

4. Lubricate nose gear retract actuator

5. Check parking break accumulator pressure

6. Perform bite of flap/Slat electronic unit

3. B CHECKS

B checks are often completed during the A check phase, as airlines and operators have merged A and B Checks. For airlines and operators to efficiently maintain, repair, and overhaul an aircraft, some B check tasks have been absorbed into A check phases.

Aviation maintenance professionals perform B **maintenance checks approximately every 6-8 months.**

It needs about 120-150 man hours, depending on the aircraft, and can be completed **within 2–3 days at an airport hangar**.

***B Check* is mostly routine maintenance** but expanded to include a more thorough inspection and maintenance of some engine components, aircraft part replacements.

Newer models such as the Boeing B737-700 through -900, A319, A320, ATR42-300, and many more have never required a B Check separate from what was incorporated into A Checks.

OLDER B- CHECKS PROCEDURE

B Checks were performed every 6 to 8 months or 400 to 900 flight hours. Single aisle planes required 120 to 150 man hours but twin aisle planes could take 300 man hours. Most were done at an airport hangars rather than at maintenance facilities. Compared to the lighter A check, the more extensive B Check includes

- Torque tests and flight control tests.
- Inspecting the wheel well hydraulic tubing for corrosion, and fluid leakage.
- Checking alignment and torqueing of the nose landing gear spot light.
- Check up lock and down lock proximity sensors
- Check wheel well door linkages, springs, stop cables, drive rods, and hinges.

4. C- CHECKS

C and D checks typically fall under "**heavy maintenance**," and are much more extensive than the B check.

It is performed every **20-24** Months or a specific amount of flight hours as defined by the manufacturer

This check puts the aircraft out of service , it requires more man power , large space it generally requires **1-2 Weeks** to carry out and an effort of **6,000 man hours** , it can take more time if there is shortage of components and. Manpower.

EXAMPLES OF C- CHECK ITEMS

- Visually check flight compartment escape ropes for condition and security
- Check operation of DC bus tie control unit
- Visually check the condition of entry door seals
- Operationally check flap asymmetry system
- Pressure decay check APU fuel line shroud
- Inspect engine inlet TAI ducting for cracks
- Operationally check RAT deployment and system

5. D CHECKS

The D check, sometimes known as a **"heavy maintenance visit"** (HMV),is by far the most comprehensive and demanding check for an airplane. **This check occurs approximately *every 6-10 years***. It is a check that more or less takes the entire airplane apart for inspection and overhaul.

Even the paint need to be completely removed for complete inspection of the fuselage metal skin.

Such a check can generally take up to **50,000 man-hours**, **and 2 months to complete** depending on the number of technicians involved. It also requires the most space of all maintenance checks and by far the **most expensive**.

On average, a commercial aircraft undergoes 2 or 3 D checks before being retired.

The airplane is stripped back to its Aluminum shell, all critical parts need to be checked ***(typically an B747-400 has around 6 million components)***

Each day the engineers commit to doing a particular section of the airplane(cabin on a particular day, wings on a particular day etc.)

The first thing to do is to test the 18 wheeled landing gear

The seats are dismantled, checked and retrofitted if need be

Critical safety equipment are tested such as the chute

The cabin floor panels must be removed

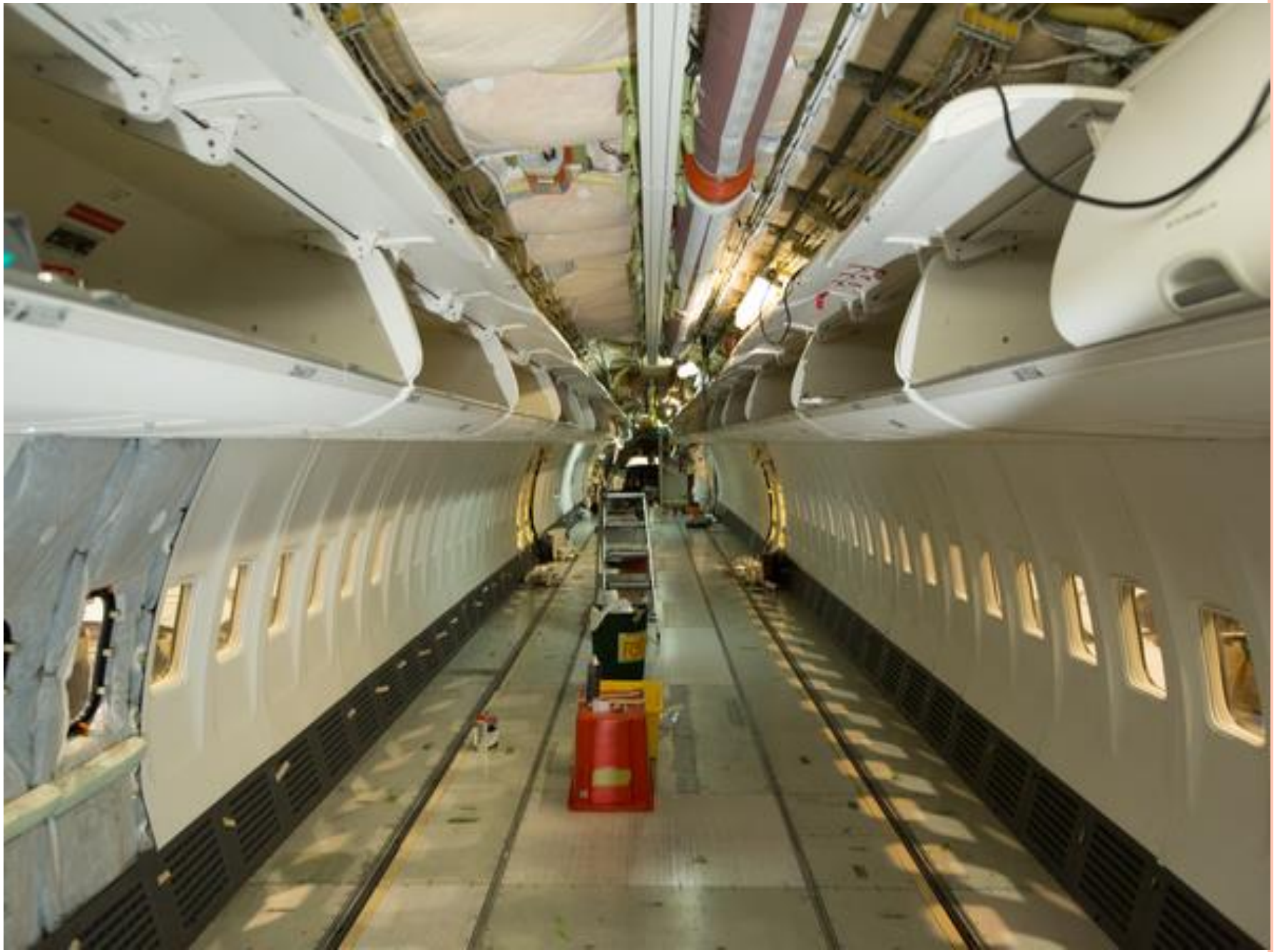
The window protectors and blinds must be taken out, this is done to inspect every inch of the frame for any defects

The wings are also inspected for damage

The engines are brought down to examine the fixtures holding them(pylon, 8 bolts hold the engine)

The engine blades are removed, the surface is examined for any damage

The fuel tanks go through inspections for any fuel **leaks(centre fuel tank, and 7 other tanks)**



D check is the most expensive of all aircraft check categories , most airlines plan for D checks years in advance .

Boeing 747 and Airbus A380's are retiring sooner than scheduled because of cost of carrying out D checks.

ACTUAL COST OF D CHECK

- B737- 1M USD
- B777-200ER- 4M USD
- B777-300ER- 4.5M USD
- B747-400- 6M USD

FLIGHT HOURS MAINTENANACE INTERVALS

MODEL	A CHECK	C CHECK	D CHECK
AIRBUS A320 FAMILY	750 (or 750 cycles or 4 months)	7,500 (or 5,000 cycles or 24 months)	6/12 years
ATR 42/ATR 72	750	5,000	2/4/8 years
Boeing 747-400/747-8	600/1,000	7,500/10,000	6 years (systems) 8/8/6 years (most structures and zonal)
Bombardier Dash 8	800	8,000	

Examples of Facilities in the world that can carry out heavy maintenance are

- Air India(have approval for all 4 checks)
- Jet airways can perform A and B Checks (Contracts A330 C and D Checks to air India)
- Lufthansa Technik
- British Airways Engineering
- Singapore Airlines

DOCUMENTS USED FOR AIRCRAFT MAINTENENACE

As part of CONTINUED AIRWORTHINESS the following documents are used to maintain the airworthiness of aircraft.

- AMM (Aircraft Maintenance Manual)
- IPC (Illustrated parts catalog)
- TSM (Trouble Shooting Manual)
- SRM (Structure Repair Manual)
- AWM (Aircraft Wiring Manual)
- ASM (Aircraft Schematic Manual)
- CMM (Component Maintenance Manual)

1. AMM (Aircraft Maintenance Manual) -

The formal document which details the way in which all maintenance tasks carried out on an aircraft shall be accomplished. This includes items such as **lubrication system ,functional checks** and **servicing of the airplane** but usually excludes structural repairs and modifications.

2. IPC (Illustrated parts catalog)

A key reference document specific to aircraft type which describes in comprehensive detail every component.

3. TSM (Trouble Shooting Manual)

provides maintenance personnel with a quick, direct approach to troubleshooting and corrective actions. They include, maintenance and support information with systems information and component locations.

4. SRM (Structure Repair Manual)

Contains the procedures for making good minor structural repair for any damage sustained by an aircraft . *If appropriate procedures for the damage found are not contained in the SRM then a specific Repair Scheme needs to be obtained from the aircraft manufacturer*.

5. AWM (Aircraft Wiring Manual)

Contains the aircraft wiring diagrams and systems, this makes it easy for the avionics engineers to trace faults and carry out repairs.

6. ASM (Aircraft Schematic Manual)

Aircraft Schematic manual are simple diagrams that illustrate the major components and function of a system such as hydraulics or fuel, etc. This is used for training or general reference. Some schematic will have detailed information that will help the mechanic to diagnose a problem or repair it.

7. CMM (Component Maintenance Manual)

A formal document which details the way in which aircraft maintenance tasks on the specified component shall be accomplished. The maintenance tasks contained in these manuals do include procedures for restoring a structural component to a serviceable state and re-working and refinishing procedures are often provided .

MAINTENANCE PROCESSES

Aircraft maintenance tasks can be classified as follows

- ***Hard Time (HT)***
- ***On Condition (OC)***
- ***Conditioned Monitoring (CM)***

1.<u>Hard-time</u>: A primary maintenance process under which an item must be removed from service at or before a ***scheduled specified time.***

- Airframe checks
- Landing gear overhaul (beechcraft1900-10,000 cycles 5 years)
- Engines
- Extinguishers-Lavatory fire extinguishing systems,
  Portable fire extinguishing systems,
  Engine and APU fire extinguishing systems
  Cargo compartment fire extinguishing systems
- Survival kits(compass, whistle, water proof matches)

All these are controlled by flight hours, cycles or calendar time. A hard time component has a limited life in the aircraft.

2. **On-Condition Monitoring (OCM):** Is a preventive primary maintenance process that requires a system, component, or appliance to be inspected periodically or checked against some physical standard to determine if it can continue service . ***The standard ensures that the unit is removed from service before failure. Examples*** tire thread

3. Condition Monitoring(CM) is a process for systems, components, or appliances that have neither ***HT nor OC maintenance as their primary maintenance process***. It is accomplished by appropriate means available to an operator for finding and solving problem areas. The user must control the reliability of systems or equipment based on knowledge gained by analysis of failures or other indications of deterioration.

HUMAN FACTORS IN AIRCRAFT MAINTENANCE

A Definition of Human Factors - A discipline that discovers and applies information about **human behavior**, **abilities**, **limitations** and other characteristics to the design of **tools**, **machines**, **systems**, **tasks**, **jobs**, and **environments** for productive, safe, comfortable and effective human use.

Human error is cited as a major causal factor in most aviation mishaps, **5%- 20%** that involve maintenance **error**, **75%-80% involve human error**

In summary human factors covers three areas of influence on people at work:

1.<u>The organization</u> : The organization plays a key role in human factors, areas such as

Poor work planning, leading to high work pressure

Lack of safety systems and barriers

Management based one way communication

Deficient Coordination and responsibilities

Inadequate responses to previous incidents

2. **<u>Job Factors</u>** : job factors such as missing or unclear instructions, poorly maintained equipment, high work load ,noisy and unpleasant working conditions

3. **<u>Individual Factors</u>** : Factors such as low skill and competence level , tired staff, bored or disheartened staff, individual medical problems, can influence the output of an employee.

Importance of human factors

- Human factors is important because it helps make work more efficient, effective and safe.
- Organizations that address human factors will ensure the machines and equipment are easy and safe to use for their workers.
- Applying human factors allows plant/equipment and procedures to be designed with the user in mind, taking account of human capabilities and limitations so people work in harmony with technology.
- Applying human factors aims to get the best out of human capabilities by taking account of their weaknesses and strengths when designing equipment/technology and processes.

Over the past several decades, safer and more reliable designs have been responsible for much of the progress made in reducing the accident rate and increasing efficiency. **Improvements in engines, systems, and structures** have all contributed to this achievement.

Aircraft Manufacturing firms today use

- Customer input.
- Appropriate degree of automation.
- Crew interaction capability.
- Communication, Navigation and Surveillance/Air Traffic Management improvements.

Chief mechanic participation.

The appointment of a chief mechanic grew out of the recognition that the maintenance community contributes significantly to the success of airline operations in both safety and on-time performance.

Computer-based maintainability design tools.

Beginning with the 777 program, Boeing stopped building full-scale airplane mockups, which in the past helped determine whether a mechanic could reach an airplane part for removal and reinstallation. Now, using a computer-aided three-dimensional interactive application (CATIA), Boeing makes this type of determination using a human model to know if certain areas are accessible to the maintenance engineer during maintenance.