AIRCFRAFT MAINTENANCE ENGINEERING

(R15A2125)

(CORE ELECTIVE – IV)

COURSE FILE

IV B. Tech ANE - I Semester

(2018-2019)

Prepared By

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Department of Aeronautical Engineering

MALLA REDDY COLLEGE OF ENGINEERING & TECHNOLOGY

(Autonomous Institution – UGC, Govt. of India)

Affiliated to JNTU, Hyderabad, Approved by AICTE - Accredited by NBA & NAAC – 'A' Grade - ISO 9001:2015 Certified)
Maisammaguda, Dhulapally (Post Via. Kompally), Secunderabad – 500100, Telangana State, India.

MRCET VISION

- To become a model institution in the fields of Engineering, Technology and Management.
- To have a perfect synchronization of the ideologies of MRCET with challenging demands of International Pioneering Organizations.

MRCET MISSION

- To establish a pedestal for the integral innovation, team spirit, originality and competence in the students, expose them to face the global challenges and become pioneers of Indian vision of modern society

MRCET QUALITY POLICY.

- To pursue continual improvement of teaching learning process of Undergraduate and Post Graduate programs in Engineering & Management vigorously.
- To provide state of art infrastructure and expertise to impart the quality education

PROGRAM OUTCOMES
(PO's)

Engineering Graduates will be able to:

1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design / development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multi disciplinary environments.
12. **Life- long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

DEPARTMENT OF AERONAUTICAL ENGINEERING

VISION

Department of Aeronautical Engineering aims to be indispensable source in Aeronautical Engineering which has a zeal to provide the value driven platform for the students to acquire knowledge and empower themselves to shoulder higher responsibility in building a strong nation.

MISSION

The primary mission of the department is to promote engineering education and research. To strive consistently to provide quality education, keeping in pace with time and technology. Department passions to integrate the intellectual, spiritual, ethical and social development of the students for shaping them into dynamic engineers.

QUALITY POLICY STATEMENT

Impart up-to-date knowledge to the students in Aeronautical area to make them quality engineers. Make the students experience the applications on quality equipment and tools. Provide systems, resources and training opportunities to achieve continuous improvement. Maintain global standards in education, training and services.

PROGRAM EDUCATIONAL OBJECTIVES – Aeronautical Engineering

1. **PEO1 (PROFESSIONALISM & CITIZENSHIP):** To create and sustain a community of learning in which students acquire knowledge and learn to apply it professionally with due consideration for ethical, ecological and economic issues.
2. **PEO2 (TECHNICAL ACCOMPLISHMENTS):** To provide knowledge based services to satisfy the needs of society and the industry by providing hands on experience in various technologies in core field.
3. **PEO3 (INVENTION, INNOVATION AND CREATIVITY):** To make the students to design, experiment, analyze, and interpret in the core field with the help of other multi disciplinary concepts wherever applicable.
4. **PEO4 (PROFESSIONAL DEVELOPMENT):** To educate the students to disseminate research findings with good soft skills and become a successful entrepreneur.
5. **PEO5 (HUMAN RESOURCE DEVELOPMENT):** To graduate the students in building national capabilities in technology, education and research

PROGRAM SPECIFIC OUTCOMES – Aeronautical Engineering

1. To mould students to become a professional with all necessary skills, personality and sound knowledge in basic and advance technological areas.
2. To promote understanding of concepts and develop ability in design manufacture and maintenance of aircraft, aerospace vehicles and associated equipment and develop application capability of the concepts sciences to engineering design and processes.
3. Understanding the current scenario in the field of aeronautics and acquire ability to apply knowledge of engineering, science and mathematics to design and conduct experiments in the field of Aeronautical Engineering.
4. To develop leadership skills in our students necessary to shape the social, intellectual, business and technical worlds.

MALLA REDDY COLLEGE OF ENGINEERING & TECHNOLOGY

IV Year B. Tech, ANE-I Sem

L	T/P/D	C
4	-/-/-	3

(R15A2125) AIRCRAFT MAINTENANCE ENGINEERING
(CORE ELECTIVE - IV)

Objectives:

- To introduce the knowledge of the maintenance and repair procedures followed for overhaul of aero engines.
- To impart the standards of FAA for documentation.

UNIT – I

NECESAITY & DEVELOPMENT OF MAINTENANCE PROGRAMS

Definition of maintenance, role of the engineer, role of the mechanic, two types of maintenance, reliability, establishing a maintenance program. Goals and objectives of maintenance. Maintenance steering group(MSG) Approach, process – Oriented maintenance, task- oriented maintenance, current MSG process – MSG – 3, maintenance program documents.

UNIT – II

AVIATION CERTIFICATION REQUIREMENTS AND DOCUMENTATION FOR MAINTENANCE & ENGINEERING

Aircraft certification, delivery inspection, operator certification, certification of personnel, aviation industry interaction; types of documentation. Manufacturer`s documentation, regulatory documentation. Airline generated documentation. ATA document standards. Objectives of a maintenance program, outline of aviation maintenance program, summary of FAA requirements, additional maintenance program requirements; organization of maintenance and engineering, organization structure, M&E organization chart, general groupings, managerial level functions- technical services, aircraft maintence, overhaul shops, material.

UNIT – III

TECHNICAL SERVICES

Engineering: makeup of engineering, mechanics and engineers, engineering department functions, engineering order preparation; production planning & control – forecasting, production planning, production control , Organization of PP&C; technical publications- functions of technical publications, airline libraries, control of publications,; Technical Training-organization, training for aviation maintenance, airframe manufacturer`s training courses,

UNIT – IV

MAINTENANCE AND MATERIAL SUPPORT

Line maintenance(on – aircraft), functions that control maintenance, MCC responsibilities, general line maintenance operations, aircraft logbook, ramp and terminal operations, maintenance crew requirement, morning meeting; Hangar Maintenance (on-aircraft)-organization of hangar maintenance, problem areas in hangar maintenance, maintenance support shops, ground support equipment, typical C – check: Shop data collection; Material support –organization and function of material. Material directorate, M&E support functions

UNIT – V

OVERSIGHT FUNCTIONS, ART & SCIENCE OF TROUBLE SHOOTING

Quality Assurance , quality audits, ISO 9000 quality standard, technical records, Quality control-quality control organization, FAA and JAA QC inspector qualifications. Basic inspection policies,; Reliability – definition and types of reliability, elements of a reliability program, Maintenance safety – safety regulations, maintenance safety program, general safety rules, accident and injury reporting . Human factors in maintenance, Trouble shooting, knowledge of malfunctions, Basic concepts of trouble shooting.

Text Books:

1. Kinnison, H.A , Aviation Maintenance Manageent, Mc Graw – Hill – 2004.
2. Mc Kinley, J.L. Bent, R.D ., Maintenance and Repair of Aerospace Vehicles, Northrop Institute of Technology, Mc Graw Hill, 1967.

Reference Books:

1. Friend, C.H., Aircraft maintence Management . Longman, 1992.
2. Kroes, M., Watkins. W., and Delp. F. Aircraft Maintenance and Repair, Tata Mc Graw – Hill. 2010

Outcomes:

- Ability to maintain and repair the areo engines.
- Ability to prepare aircraft maintenance manuals.
- Ability to know the standards of quality, FAA

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(UGC- AUTONOMOUS –Govt. OF INDIA)
IV-B.TECH – I SEMESTER AERONAUTICAL ENGINEERING
AIRCRAFT MAINTENANCE ENGINEERING (R15A2125)

Model Paper-I

MAXIMUM MARKS: 75

PART A **Max Marks: 25**

i. All questions in this section are compulsory
ii. Answer in TWO to FOUR sentences.
1.
a) Define Maintenance (3)
b) Mention two types of maintenance (2)
c) Define type certificate (3)
d) Give a summary of FAA requirements (2)
e) Draw a neat of organizational chart for technical services (3)
f) Explain in brief about “A” check planning (2)
g) What is meant by line maintenance (3)
h) Write contents of Airframe log book (2)
i) What are the types of reliability (2)
j) Define Quality Assurance (3)

PART B **Max Marks: 50**

a. Answer only one question among the two questions in choice.
b. Each question answer (irrespective of the bits) carries 10M.

2. Explain failure rate pattern with a neat sketch [10]

OR

3. Explain maintenance steering group (MSG) approach in steps in aircraft maintenance management with the help of line diagram [10]

4. Explain Manager level Functions of aircraft maintenance [10]

OR

5. Explain about additional maintenance program requirements [10]

6. Explain about organization of PP&C [10]

OR

7. Explain functions of engineering department in tech service. [10]

8. explain about the functions that control maintenance and MCC responsibilities [10]

OR

9. What are the problem areas of hangar maintenance? Brief about operation of overhaul shops [10]

10. Explain about ground support equipment (GSE) in hangar maintenance of aircraft [10]

OR

11. Explain about basic inspection policies in aircraft management [10]

MALLAREDDY COLLEGE OF ENGINEERING AND TECHNOLOGY
(UGC- AUTONOMOUS –Govt. OF INDIA)
IVB.TECH – I SEMESTER AERONAUTICAL ENGINEERING
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Model Paper-II

MAXIMUM MARKS: 75

PART A **Max Marks: 25**

i. All questions in this section are compulsory
ii. Answer in TWO to FOUR sentences.

a) Outline any two maintenance objectives (2)
b) Define OC activity (3)
c) Write ant two FAA requirements (2)
d) Mention any maintenance tasks for aircraft systems (3)
e) Write any two differences of Engineer & Mechanics in their role (2)
f) State any two functions of MCC (3)
g) Mention contents of engine log book (2)
h) Differentiate between line & hangar maintenance (3)
i) Define Quality Control (3)
j) Define quality audits (2)

PART B **Max Marks: 50**

a. Answer only one question among the two questions in choice.
b. Each question answer (irrespective of the bits) carries 10M.

2. List out differences between intra flight (TRS) & last flight servicing [10]

OR

3. Explain maintenance program documents [10]

4. Explain task oriented maintenance approach [10]

OR

5. Explain about the types of aviation certificate with neat sketches [10]

6. Explain about production control & feedback for planning [10]

OR

7. Explain about multiple checks in production planning [10]

8. What are the functions of material directorate [10]

OR

9. Discuss about fault isolation and fault report manual [10]

10. What are the elements of reliability program? Explain in brief about safety regulation [10]

OR

11. Explain about maintenance safety program, general safety rules [10]

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IVB.TECH – I SEMESTER AERONAUTICAL ENGINEERING
AIRCRAFT MAINTENANCE ENGINEERING (R15A2125)

Model Paper-III

MAXIMUM MARKS: 75

PART A **Max Marks: 25**

i. All questions in this section are compulsory
ii. Answer in TWO to FOUR sentences.

1.
a) Write goals of maintenance (3)
b) Define Condition monitoring process (2)
c) Define task cards (3)
d) Explain the outline of aviation maintenance program (3)
e) State two functions of technical service directorate (2)
f) Define controlled documents (2)
g) State line station activity (3)
h) Write any two functions of material directorate. (2)
i) What are general safety rules (3)
j) Explain about ramp operations (2)

PART B **Max Marks: 50**

a. Answer only one question among the two questions in choice.
b. Each question answer (irrespective of the bits) carries 10M.

2. Explain role of an engineer of aircraft maintenance. [10]

OR

3. Explain role of mechanic in aircraft maintenance and MSG approach [10]

4. Explain steps in detail about airline generated documentation .[10]

OR

5. Explain in detail about functions of technical publications [10]

6. Explain about the airframe manufacturers training course and airline maintenance training [10]

OR

7. Explain about requirement of Quality Assurance .[10]

8. Explain about makeup of line maintenance .[10]

OR

9. Write functions of MCC .[10]

10. What are the elements of reliability program? Explain in brief about safety regulation .[10]

OR

11. Write short notes on .[10]
    a) FAA and JAA QC inspector
    b) general safety rules
    .

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AIRCRAFT MAINTENANCE ENGINEERING (R15A2125)

Model Paper-IV

MAXIMUM MARKS: 75

PART A **Max Marks: 25**

i. All questions in this section are compulsory
ii. Answer in TWO to FOUR sentences.

1.

a) Define reliability (2)
b) Write goals of maintenance (3)
c) Draw a neat sketch of M&E organization chart (2)
d) What is aircraft maintenance (3)
e) Define engineering order (2)
f) Draw organization chart of technical services directorate (3)
g) Define Quality control (2)
h) What do you understand by Ground service equipments (3)
i) Define elements of reliability program (2)
j) Define nondestructive test and inspection (3)

PART B **Max Marks: 50**

a. Answer only one question among the two questions in choice.
b. Each question answer (irrespective of the bits) carries 10M.

1. Explain about establishing a maintenance program. [10]

OR

2. Explain MSG-3 level –I analysis failure category approach [10]
3. Explain the managerial functions of overhaul shops directorate. [10]

OR

4. Explain about overhaul shop operations [10]

OR

5. Explain the role of Production planning & control in maintenance Management [10]

6. Explain technical training organization [10]

7. Explain about makeup of line maintenance. [10]

OR

8. Explain about Maintenance Control Center responsibilities. [10]

9. Explain about requirement of Quality assurance. [10]

OR

10. Write short notes on [10]
    a)Statistical reliability
    b)Dispatch reliability.

MALLAREDDY COLLEGE OF ENGINEERING AND TECHNOLOGY
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IVB.TECH – I SEMESTER AERONAUTICAL ENGINEERING
AIRCRAFT MAINTENANCE ENGINEERING (R15A2125)

Model Paper-V

MAXIMUM MARKS: 75

PART A **Max Marks: 25**

i. All questions in this section are compulsory
ii. Answer in TWO to FOUR sentences.

1.
a) Define redesign (2)
b) State two failure pattern (3)
c) Define HT activity (2)
d) Define Zonal maintenance task (3)
e) Define engineering order (2)
f) Draw organization chart of technical services directorate (3)
g) Define management and DOM (2)
h) Explain ramp and terminal operations (3)
i) Define quality assurance (2)
j) State any two QC inspector qualifications (3)

PART B **Max Marks: 50**

a. Answer only one question among the two questions in choice.
b. Each question answer (irrespective of the bits) carries 10M.

2. Explain goals & objectives of maintenance [10]

OR

3. Discuss concept of reliability and redesign in context of maintenance [10]

4. Explain maintenance task for airframe systems in task oriented maintenance [10]

OR

5. Explain ‘A’ check and ‘C’ check planning in aircraft hangar maintenance [10]

6. Explain manager level functions in technical services directorate and outline of aviation maintenance program [10]

OR

7. Explain about maintenance planning document [10]

8. Explain about hangar maintenance activity – A typical “C” check up [10]

OR

9. Explain about overhaul non-routine parts, parts availability & saga of parts robbing [10]

10. Explain about organization structure &TPPM [10]

OR

11. Explain about ISO-9000 quality standards in aircraft maintenance management [10]

MALLAREDDY COLLEGE OF ENGINEERING AND TECHNOLOGY
DEPARTMENT OF AERONAUTICAL ENGINEERING
SESSION PLAN

SUB: AIRCRAFT MAINTENANCE ENGINEERING **IV YEAR – I SEMESTER**

UNIT – NO	TOPIC	NO OF CLASSES REQUIRED
UNIT – I	**NECESAITY & DEVELOPMENT OF MAINTENANCE PROGRAMS** Definition of maintenance, role of the engineer ,role of the mechanic	2
	,two types of maintenance, reliability, establishing a maintenance program	2
	Goals and objectives of maintenance. Maintenance steering group(MSG) Approach, process	2
	maintenance, task- oriented maintenance, current MSG process	2
	MSG – 3, maintenance program documents.	1
UNIT – II	**AVIATION CERTIFICATION REQUIREMENTS AND DOCUMENTATION FOR MAINTENANCE & ENGINEERING** Aircraft certification, delivery inspection,	1
	operator certification, certification of personnel, aviation industry interaction; types of documentation	2
	Manufacturer`s documentation, regulatory documentation. Airline generated documentation.	2
	ATA document standards. Objectives of a maintenance program, outline of aviation maintenance program, summary of FAA requirements, additional maintenance program requirements;	3
	organization of maintenance and engineering, organization structure, M&E organization chart, general groupings	2
	managerial level functions- technical services, aircraft maintenance, overhaul shops, material.	2
UNIT - III	**TECHNICAL SERVICES** Engineering: makeup of engineering, mechanics and engineers,	2
	engineering department functions, engineering order preparation;	2
	production planning & control – forecasting, production planning, production control , Organization of PP&C;	3
	technical publications- functions of technical publications, airline libraries, control of publications	2
	Technical Training-organization, training for aviation maintenance,	

	airframe manufacturer`s training courses,	2
UNIT –IV	**MAINTENANCE AND MATERIAL SUPPORT** Line maintenance(on – aircraft), functions that control maintenance	2
	MCC responsibilities, general line maintenance operations, aircraft logbook, ramp and terminal operations	2
	maintenance crew requirement, morning meeting; Hangar Maintenance (on-aircraft)-organization of hangar maintenance,	2
	problem areas in hangar maintenance, maintenance support shops, ground support equipment, typical C – check: Shop data collection;	3
	; Material support –organization and function of material. Material directorate, M&E support functions	2
UNIT – V	**OVERSIGHT FUNCTIONS, ART & SCIENCE OF TROUBLE SHOOTING** Quality Assurance , quality audits, ISO 9000 quality standard, technical records	2
	Quality control-quality control organization, FAA and JAA QC inspector qualifications. Basic inspection policies	3
	Reliability – definition and types of reliability, elements of a reliability program,	2
	Maintenance safety – safety regulations, maintenance safety program, general safety rules, accident and injury reporting .	3
	Human factors in maintenance, Trouble shooting	1
	Knowledge of malfunctions, Basic concepts of trouble shooting.	2
	TOTAL NUMBER OF CLASSES	**56**

Text Books:

1. Kinnison, H.A , Aviation Maintenance Manageent, Mc Graw – Hill – 2004.
2. Mc Kinley, J.L. Bent, R.D ., Maintenance and Repair of Aerospace Vehicles, Northrop Institute of Technology, Mc Graw Hill, 1967.

UNIT – I

NECESAITY & DEVELOPMENT OF MAINTENANCE PROGRAMS

Definition of maintenance

- We have talked about maintenance and how the approach to maintenance has evolved over the years; but just what is it that we mean when we use the term maintenance? Definition of maintenance by Lindley R. Higgins, defining maintenance as art, science, and philosophy. In this text, however, we will address the subject in less poetic and more practical terms.

Typical airline definition of maintenance

- This definition was taken from the text of a "typical" airline's technical policies and procedures manual (TPPM).
- **Maintenance** is defined as "those actions required for restoring or maintaining an item in a serviceable condition, including servicing, repair, modification, overhaul, inspection, and determination of condition."
- This is not incorrect. However, it merely describes what maintenance people do; it is not descriptive of the intent or the result of maintenance activity.

FAA definition of maintenance

- In the Federal Aviation Regulations, FAR part 1, maintenance is defined as "… inspection, overhaul, repair, preservation, and replacement of parts". Again, this describes what maintenance people do, but it is not a definitive description of what maintenance is intended to accomplish
- "The maintenance of an aircraft provides assurance of flight safety reliability, and airworthiness."The aircraft maintenance department is responsible for accomplishing all

maintenance tasks as per the aircraft manufacturer and the company's requirements .The goal is a safe, reliable, and airworthy aircraft.

- The aircraft maintenance department provides maintenance and preventive maintenance to ensure reliability, which translates into aircraft availability. These functions do not preclude a random failure or degradation of any part or system, but routine maintenance and checks will keep from happening and keep the aircraft in good flying condition.

Role of the engineer

- The design of systems or components is not only limited by the imperfections of the physical world (i.e., the "natural frequency" of the system) it is also limited by a number of other constraints which we could refer to as "man – made entropy."
- A design engineer may be limited from making the perfect design by the technology or the state of the art within any facet of the design effort. He or she may be limited by ability or technique or, more often than not, the designer may be limited by economics: i.e., there just is not enough money to build that nearly perfect system that is on the drawing board or in the designer's mind. Although the designer is limited by many factors, in the tradition of good engineering practice, the designer is obliged to build the best system possible within the constraints given.
- Another common situation in design occurs when the designer has produced what he or she believes is the optimum system when the boss, who is responsible for budget asks, "How much will it cost to build this?" The designer has meticulously calculated that these widgets can be mass produced for $1200 each."Great," says the boss."Now redesign it so we can build it for under a thousand dollars." That means redesign, usually with reduced tolerances, cheaper, materials, and, unfortunately, more entropy. More entropy sometimes translates into more maintenance required .The design engineer's primary concern, then, is to minimize (not eliminate) the entropy of the system he or she is designing while staying within the required constraints.

Typical duties

- Carries out assignments of daily aircraft maintenance and overhaul programs.
- Checks condition of aircraft and engine, make repairs, replacements and adjustments, in accordance with approved maintenance procedures .May direct the work of a number of Air Mechanics and Trades Helpers. May be required to fly with aircraft as flight engineer performs other related duties as assigned.
- Through knowledge of aircraft maintenance procedures and inspection systems knowledge of aircraft materials and parts and the regulations governing their acceptance for registered aircraft and the process of quarantine action. Knowledge of safety precautions and fire prevention. Ability to select and record data necessary to substantiate airworthiness. Proficiency in the use of measuring instruments and test equipments.

Duties of an Aircraft Maintenance Engineer

- There are various duties of an aircraft maintenance engineer which needs to be followed diligently.

- ✓ Before an aircraft flies it has to be checked by an aircraft maintenance engineer that the aircraft is fit to fly or not.
- ✓ The aircraft cannot fly without the permission and a certificate from aircraft maintenance engineer.
- ✓ The maintenance engineer certifies and issue the airworthiness certificate for flying the aircraft

➢ Role of the mechanic

- The mechanic (aircraft maintenance technician (AMT), repairer, or maintainer), on the other hand, has a different problem .Let us, once again, refer to the field of thermodynamics.
- One important point to understand is that entropy not only exists in every system, but that the entropy of a system is always increasing. That means that the designed –in level of perfection (imperfection?) will not be permanent. Some components or systems will deteriorate from use, and some will deteriorate from lack of use (time or environment related).Misuse by an operator or user may also cause some premature deterioration or degradation of the system or even outright damage. This deterioration or degradation of the system represents an increase in the total entropy of the system. Therefore, while the engineer's job is to minimize the entropy of a system during design, the mechanic's job is to combat the natural, continual increase in the entropy of the system during its operational life time.
- To summarize, it is the engineer's responsibility to design the system with as high degree of perfection (low entropy) as possible within reasonable limits.
- The mechanic's responsibility is to remove and replace parts, troubleshoot systems, isolate faults in systems by following the fault isolation manual (FIM).

- Employees in the trade of aircraft maintenance engineering (mechanical) maintain, inspect and undertake fault diagnosis of aircraft engine systems and airframe components on fixed and rotary wing aircraft.

They

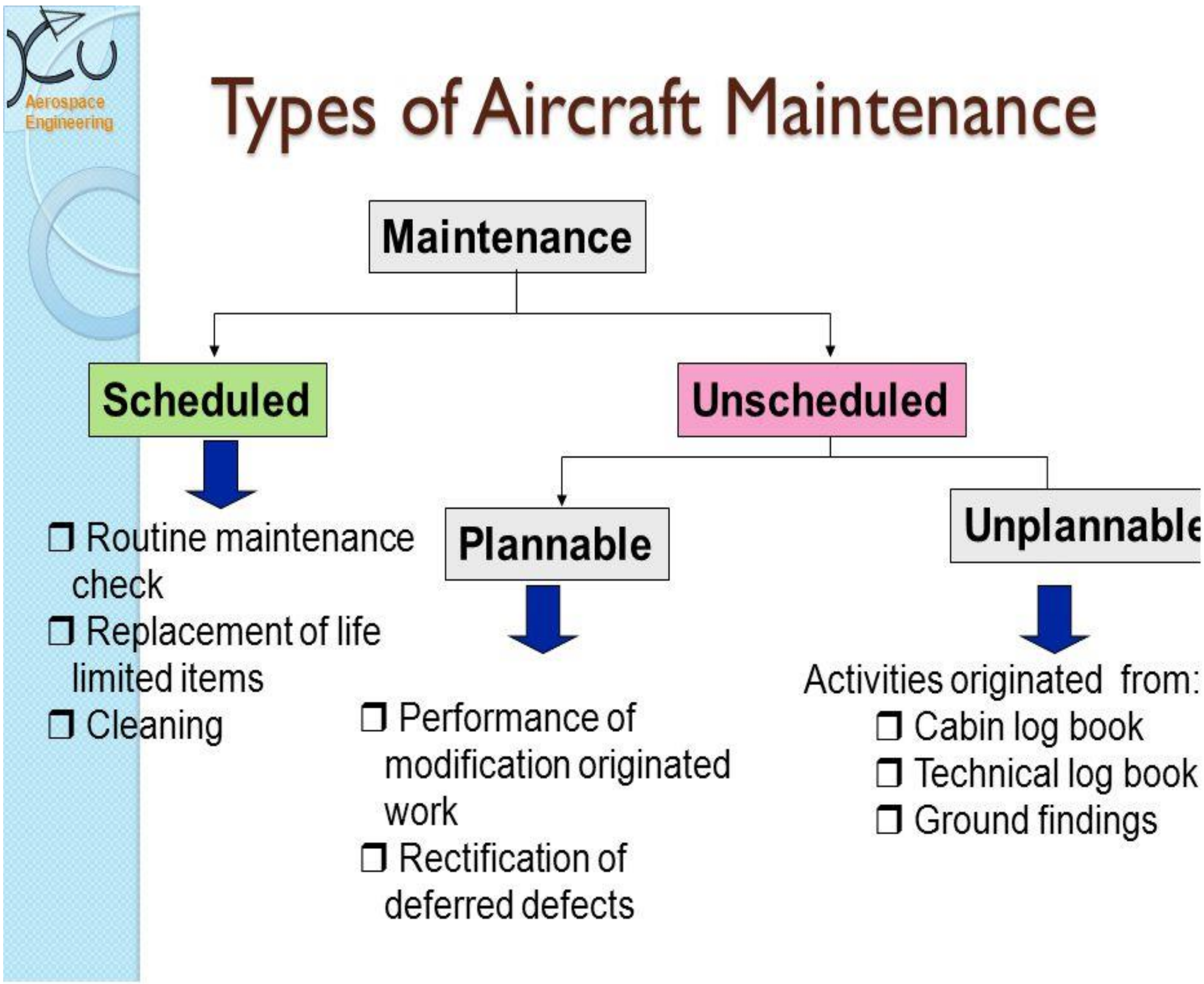
- Remove and install engine systems and airframe components on aircraft
- Inspect engine systems and airframe components on aircraft
- Test and diagnose problems with engine systems and airframe components on aircraft
- Aircraft engine systems and airframe components include landing gear, wheels and brakes, aircraft pressurization systems, aircraft pneumatic and hydraulic systems, aircraft flight control systems, aircraft environmental control systems, aircraft fire detection and prevention systems, aircraft ice and rain protection systems and their components.
- Civil aviation maintenance organizations operating under relevant civil aviation safety authority airworthiness regulatory systems , including major airlines , regional airlines, general aviation , third party aircraft maintenance organizations and component maintenance organizations , and
- Defense force aviation maintenance organizations operating within the relevant airworthiness regulatory systems, including defense force organizations and civilian contractors maintaining defense force aircraft and aircraft components.

➢ Mechanics, Technicians, Maintainers, Engineers

- The terminology used by the world's airlines to identify maintenance personnel varies. The terms mechanic, technician, and maintainer are often used to identify those who perform the scheduled and unscheduled maintenance tasks of the unit's aircraft.
- In some organizations, however, these same people are called engineers, while in others; the term engineer is reserved for those personnel who have college degrees in one of the engineering fields. These people usually perform duties quite different from those of the line, hangar, and shop maintenance people.

➢ Types of maintenance

Two types of maintenance



- Fig -1 is a graph showing the level of perfection of a typical system .One hundred percent perfection is at the very top of the y-axis. The x- axis depicts time.
- There are no numbers on the scales on either axis since actual values have no meaning in these theoretical discussions .The left end of the curve shows the level of perfection attained by the designers of our real world system. Note that the curve begins to turn downward with time. This

is a representation of the natural increase in entropy of the system- the natural deterioration of the system- over time. When the system deteriorates to some lower (arbitrarily set) level of performance, we perform some corrective action: adjusting, tweaking, servicing, or some other form of maintenance to restore the system to its designed – in level of perfection. That is, we reduce the entropy to its original level. This is called preventive maintenance and is usually performed at regular intervals. This is done to prevent deterioration of the system to an unusable level and to keep it in operational condition. It is sometimes referred to as scheduled maintenance. This scheduled could be daily, every flight, every 200 flight hours, or every 100 cycles (a cycle is a takeoff and a landing).

Scheduled maintenance

- Scheduled maintenance consists of all the individual maintenance tasks performed according to the maintenance time limitations, also called a maintenance schedule .Your scheduled maintenance activities should include procedural instructions for the maintenance tasks and procedures for recording the results of the inspections, checks , tests and other maintenance .Your procedures should also provide for time – related activities such as recurring Ads , certification maintenance requirements (CMR) , and life – limited parts retirement.

- Fig -2 shows the system restored to its normal level (curves a and b).There are times, of course, when the system deteriorates rather rapidly in service to a low level of perfection (curve c). At other times the system breaks down completely (curve d).In these cases, the maintenance actions necessary to restore the system are more definitive, often requiring extensive testing, troubleshooting, adjusting, and very often, the replacement, restoration, or complete overhaul of parts or subsystems. Since these breakdowns occur at various, unpredictable intervals, the maintenance actions employed to correct the problem are referred to as unscheduled maintenance.

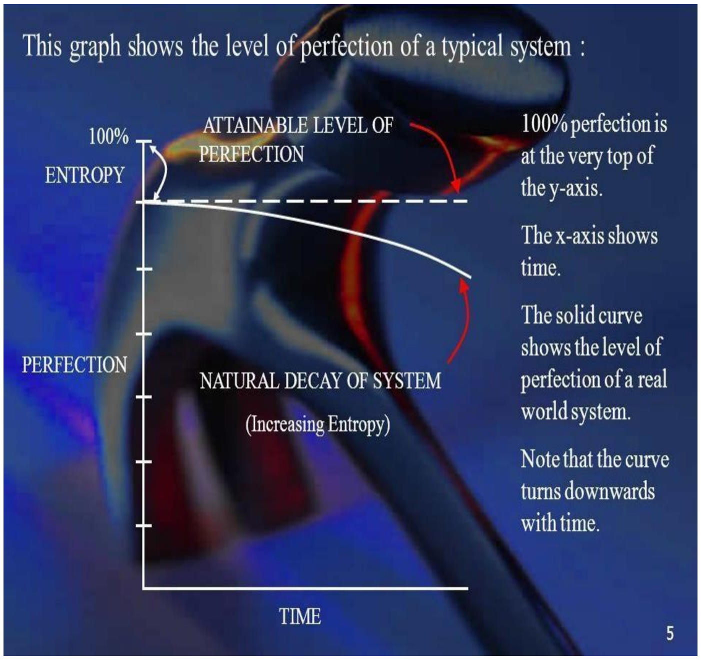


Fig -1 -The difference between theory and practice

Unscheduled maintenance

Unscheduled maintenance includes procedures, instructions and standards for maintenance that occurs on an unscheduled or unforeseen basis. A need for unscheduled maintenance may result from scheduled maintenance tasks, pilot's reports, or unforeseen events, such as high – load events, hard or overweight landings, tail strikes, ground damage, lightning strikes, or an engine over – temperature. In your maintenance manual, you should include instructions and standards for accomplishing and recording unscheduled maintenance.

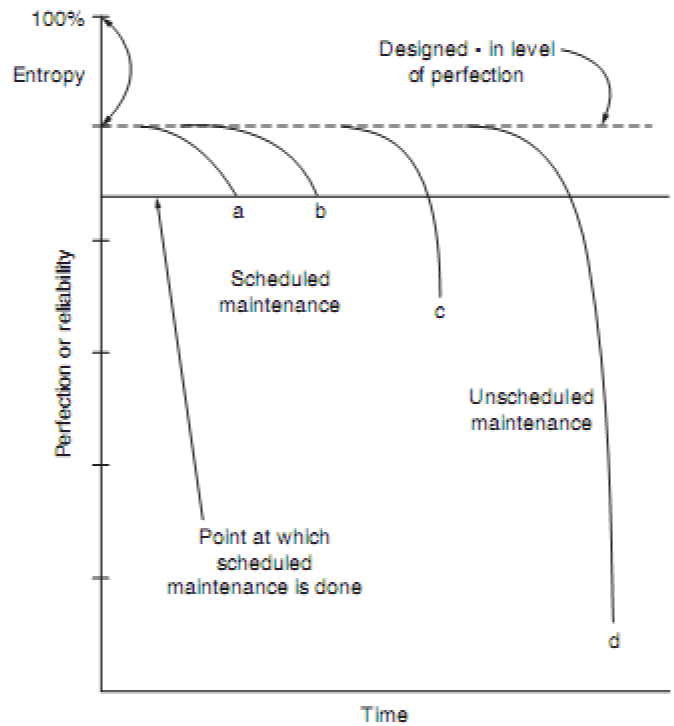


Fig – 2 - Restoration of system perfection

➢ Reliability

- The level of perfection we have been talking about can also be referred to as the reliability of the system. The designed - in level of perfection is known as the inherent reliability of that system .This is as good as the system gets during real world operation. No amount of maintenance can increase system reliability any higher than this inherent level. However , it is desirable for the operator to maintain this level of reliability (or this level of perfection) at all times, we will discuss reliability and maintenance in more detail .But there is one more important point to cover – redesign of the equipment.

➢ Redesign

Fig-3- shows the original curve of our theoretical system, Curve A. The dashed line shows the system's original level of perfection. Our system however, has now been redesigned to a higher level of perfection: that is, a higher level of reliability with a corresponding decrease in total entropy. During this redesign, new components , new materials , or new techniques may have been used to reduce the natural entropy of the system .In some cases , a reduction in man- Made entropy may result because the designer applied tighter tolerances, attained improved design skills, or changed the design philosophy.

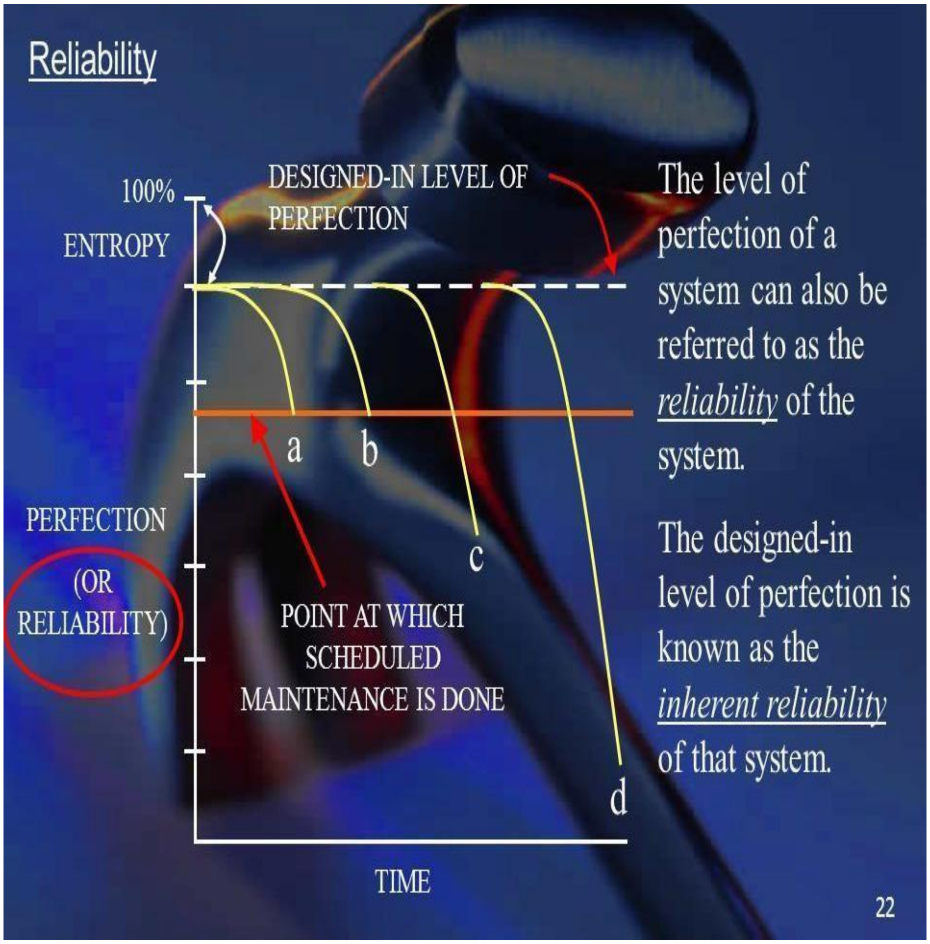


Fig -3 – Effects of redesign on system reliability

- Although the designers have reduced the entropy of the system, the system will still deteriorate. It is quite possible that the rate of deterioration will change from the original design depending upon numerous factors; thus, the slope of the curve may increase , decrease , or stay the same .Whichever is the case, the maintenance requirements of the system could be affected in some way.
- If the decay is steeper, as in (B) in fig -3, the point at which preventive maintenance needs to be performed might occur sooner, and the interval between subsequent actions would be shorter. The result is that maintenance will be needed more often. In this case, the inherent reliability is increased, but more maintenance is required to maintain that level of reliability (level of perfection), unless the performance characteristics of the system have been improved, this redesign may not be acceptable. A decision must be made to determine if the performance improvement justifies more maintenance and thus an increase in maintenance costs.
- Conversely if the decay rate is the same as before, as shown in curve C of fig-3, or less steep, as shown in curve D, then the maintenance interval would be increased and the overall amount of preventive maintenance might be reduced. The question to be considered then is this; does the

reduction of maintenance justify the cost of the redesign? This question, of course, is a matter for the designers to ponder, not the maintenance people.

- One of the major factors in redesign is cost .Fig – 4 shows the graphs of two familiar and opposing relationships. The upper curve is logarithmic. It represents the increasing perfection attained with more sophisticated design efforts. The closer we get to perfection (top of the illustration) the harder it is to make a substantial increase. (We will never get 100 percent).The lower curve depicts the cost of those ongoing efforts to improve the system. This, unfortunately, is an exponential curve. The more we try to approach perfection, the more it is going to cost us. It is obvious, then, that the designers are limited in their goal of perfection, not just by entropy but also by costs .The combination of these two limitations is basically responsible for our profession of maintenance.

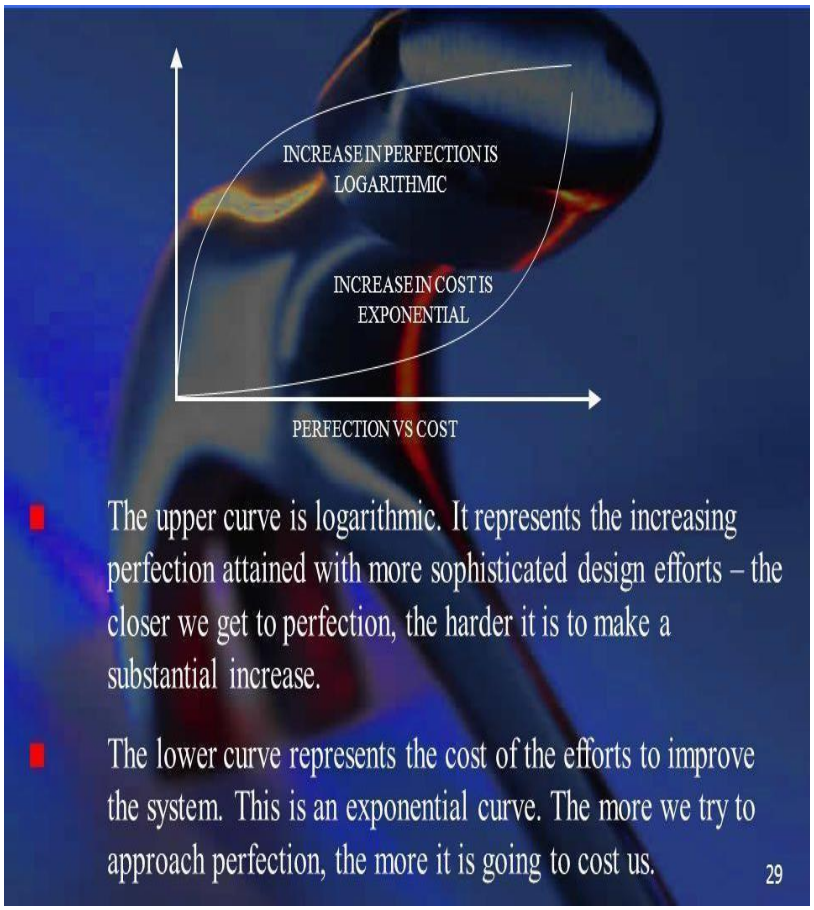


Fig – 4 – perfection Vs cost

➢ Failure Rate Patterns

- Maintenance, of course, is not as simple as one might conclude from the above discussion of entropy. There is one important fact that must be acknowledged not all systems or components fail at the same rate nor do they all exhibit the same pattern of wear out and failure .As you might except, the nature of the maintenance performed on these components and systems is related to those failure rates and failure patterns.

- United Airlines did some studies on lifetime failure rates and found six basic patterns.
- These are shown in table in below .The vertical axes show failure rates and the horizontal axes indicate time.
- No values are shown on the scales since these are not really important to the discussion.

- Curve A shows when is commonly referred to as the “bath tub” curve, for obvious reasons .This failure rate pattern exhibits a high rate of failure during the early portion of the component’s life, known as infant mortality. This is one of the bugaboos of engineering. Some components exhibit early failures for several reasons; poor design, improper parts, or incorrect usage .Once the bugs are works out and the equipment settles into its pattern, the failure rate levels off or rises only slightly overt time. That is, until the later stages of the component’s life .The rapid rise shown in curve A near the end of its life is an indication of wear out. The physical limit of the component’s materials has been reached.

- Curve B exhibits no infant mortality but shows a level , or slightly rising failure rate characteristic throughout the component’s life until a definite wear – out period is exhibited toward the end.

- Curve C depicts components with a slightly increasing failure rate with no infant mortality and no discernible wear – out period, but at some point, it becomes unusable.

- Curve D shows a low failure rate when new (or just out of the shop), which rises to some steady level and holds throughout most of the component’s life.

- Curve E is an ideal component no infant mortality and no wear –out period just steady (or slightly rising) failure rate throughout its life.

- Curve F Shows components with an infant mortality followed by a level or slightly rising failure rate and no wear – out period.

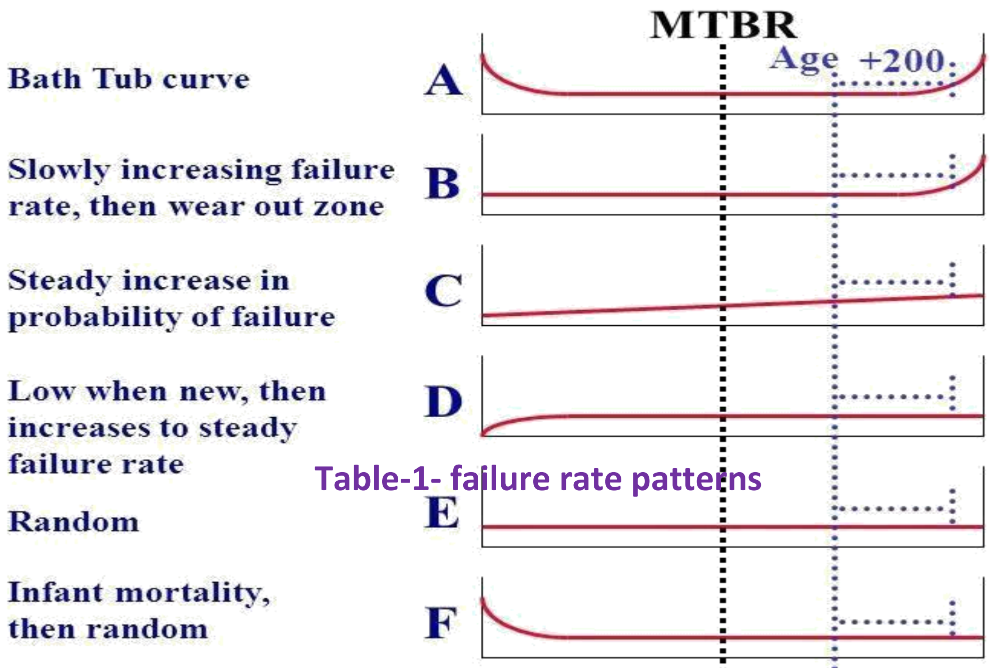


Table-1- failure rate patterns

- The other 89 percent (depicted by curves D,E, and F of table) would require some other approach. The implication of this variation is that the components with definite life limits and /or wear out periods will benefit from scheduled maintenance. They will not all come due for maintenance or replacement at the same time, however, but they can be scheduled; and the required maintenance activity can be spread out over the available time, thus avoiding peaks and valleys in the workload. The other 89 percent, unfortunately, will have to be operated to failure before replacement or repair is done. This, being unpredictable, would result in the need for maintenance at odd times and at various intervals; i.e., unscheduled maintenance.

- These characteristics of failure make it necessary to approach maintenance in a systematic manner, to reduce peak periods of unscheduled maintenance .the industry has taken this into consideration and has employed several techniques in the design and manufacturing of aircraft and systems to accommodate the problem.

Other maintenance considerations

- The aviation industry has developed three management techniques for addressing the in service interruptions created by the items that must be operated to failure before maintenance can be done .These are equipment redundancy , line replaceable units, and minimum aircraft dispatch requirements

- The concept of redundancy of certain components or systems is quite common in engineering design of systems where a high reliability is desirable. In the case of redundant units- usually called primary and backup units-if one unit fails, the other is available to take over the function .For example, in aviation most commercial jets have two high – frequency (HF) radios. Only one is needed for communications, but the second one is there for backup in case the first one fails.

- A unique feature of redundant units also affects the maintenance requirements .If both primary and back –up units are instrumented such that the flight crew is aware of any malfunction, no prior maintenance check is required to indicate that incapability. On the other hand, if neither system is so instrumented, maintenance personnel would need to perform some check on both primary and backup systems to determine serviceability.

- Another common concept used in aviation is the line replaceable unit (LRU) .An LRU is a component or system that has been designed in such a manner that the parts that most commonly fail can be quickly removed and replaced on the vehicle. This allows the vehicle to be returned to scheduled service without undue delay for maintenance .The failed part, then, can either be discarded or repaired in the shop as necessary without further delaying the flight.

- The third concept for minimizing delays for maintenance in aviation is known as the minimum equipment list (MEL).This list allows a vehicle to be dispatched into service with certain items inoperative provided that the loss of function does not affect the safety and operation of the flight .These items are carefully determined by the manufacturer and sanctioned by the regulatory authority during the early stages of vehicle design and test. The manufacturer issues a master minimum equipment list (MMEL) which includes all equipment and accessories available for the aircraft model. The airline then tailors the document to its own configuration to produce the MEL .Many of these MEL items are associated with redundant systems. The concept of the MEL allows deferral of maintenance without upsetting the mission requirements .The maintenance , however , must be performed within certain prescribed periods , commonly 1,3,10,or,30 days , depending on the operational requirements for the system.

- The items are identified in the MMEL , by flight crew personnel during the later stages of new aircraft development .Thus flight personnel determine what systems they can safely fly the mission without or in a degraded condition.

- These flight crew personnel also determine how long (1, 3, 10,or 30 days) they can tolerate this condition. Although this is determined in general terms prior to delivering the airplane, the flight crew on board makes the final decision based on actual conditions at the time of dispatch. The pilot in command (PIC) can, based on existing circumstances, decide not to dispatch until repairs are made or can elect to defer maintenance per the airline's MEL. Maintenance must abide by that decision.

- Associated with the MEL, is a dispatch deviation guide (DDG) that contains instructions for the line maintenance crew when the deviation requires some maintenance action that is not necessarily obvious to the mechanic. A DDG is published by the airplane manufacturer to instruct the mechanic on these deviations.

- The DDG contains such information as tying up cables and capping connectors from removed units, opening and placarding circuit breakers to prevent inadvertent power – up of certain equipment during flight, and any other maintenance action that needs to be taken for precautionary reasons.

- Similar to the MEL is a configuration deviation list (CDL). This list provides information on dispatch of the airplane in the event that certain panels are missing or when other configuration differences not affecting safety are noted. The nonessential equipment and furnishing (NEF) items list contains the most commonly deferred items that do not affect airworthiness or safety of the flight of the aircraft .This is also a part of the MEL system.

- Although failures on these complex aircraft can occur at random and can come at inopportune time; these three management actions – redundancy of design, line replaceable units, and minimum dispatch requirements – can help to smooth out the workload and reduce service interruptions.

Establishing a maintenance program

- Although there has been a considerable amount of improvement in the quality and reliability of components and systems, as well as in materials and procedures, over the 100 – year life of aviation, we still have not reached total perfection. Aviation equipment, no matter how good or how reliable, still needs attention from time to time.
- Scheduled maintenance and servicing are needed to ensure the designed – in level of perfection (reliability).Due to the nature of the real world , some of these components and systems will , sooner or later , deteriorate beyond a tolerable level or will fail completely .In other instances , users , operators , or even maintenance people who interface with these components and systems can misuse or even abuse the equipment to the extent of damage or deterioration that will require the need for some sort of maintenance action.
- We have seen that components and systems fail in different ways and at different rates .This results in a requirement for unscheduled maintenance that is somewhat erratic and uncertain. There are often waves of work and no – work periods that need to be managed to smooth out the workload and stabilize the manpower requirements.
- Those components exhibiting life limits or measurable wear – out characteristics can be part of a systematic, scheduled maintenance program. Design redundancy, line replaceable units, and minimum dispatch requirements have been established as management efforts to smooth out maintenance workload. But these are numerous components and systems on an aircraft that do not lend themselves to such adjustments for convenience. Occasionally, inspections and /or modifications of equipment are dictated - within specified time limits – by aviation regulators as well as by manufacturers. It is necessary, then, that the maintenance and engineering organization of an airline be prepared to address the maintenance of aircraft and aircraft systems with a well – thought –out and well executed program.

- The program discussed herein has been created over the years by concentrated and integrated efforts by pilots, airlines, maintenance people, manufacturers, component and system suppliers, regulatory authorities, and professional and business organizations within the aviation industry. Not every airline will need to be organized and operated in the same manner or style, but the programs and activities discussed in this text will apply to all operators.

Goals and objectives of maintenance

  - A goal is a point in time or space where you want to be; a level of accomplishment you want to achieve.

  - An objective is the action or activity you employ in order to help you achieve a specific goal.

  - In other words, a goal is where you want to be; an objective is how you plan to get there.

- The maintenance programs currently in use in commercial aviation were developed by the industry using two basic approaches: the process – oriented approach and the task – oriented approach. The differences in these two methods are twofold
- (a)The attitude toward maintenance actions and
- (b) The manner in which maintenance actions are determined and assigned to components and systems.
- Although the commercial aviation industry has recently gone to the task oriented approach for the most recent airplane models, there are many older airplanes still in service whose maintenance programs were developed by the process – oriented approach.

- In recent years, McDonnell-Douglas and Boeing have developed new task – oriented maintenance programs for some of these older model aircraft .the operator can purchase these new programs from the manufacturer.

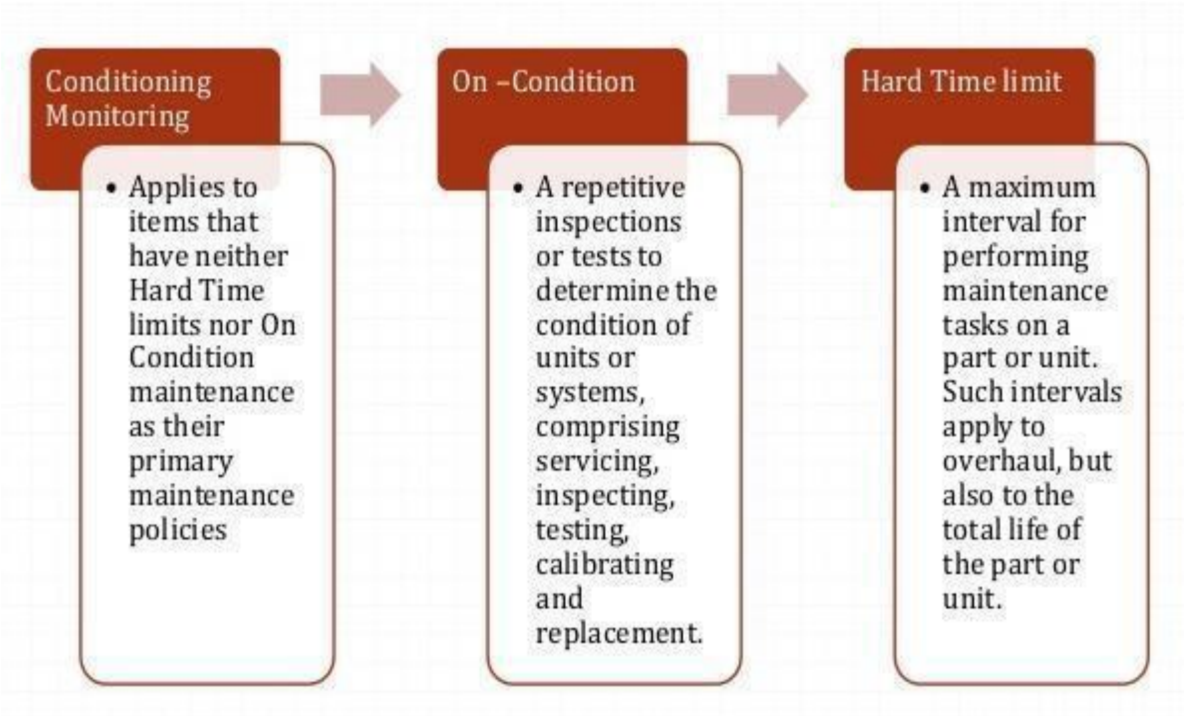
- The process-oriented approach to maintenance uses three primary maintenance processes to accomplish the scheduled maintenance actions. These processes are called hard time (HT), on-condition (OC), and condition monitoring (CM).

- The hard time and on-condition processes are used for components or systems that, respectively, have definite life limits or detectable wear-out periods

- . These are the items in categories A, B, and C discussed above and illustrated in Table I.

- The condition monitoring process is used to monitor systems and components that cannot utilize either the HT or OC processes. These CM items are operated to failure, and failure rates are tracked to aid in failure prediction or failure prevention efforts. These are the "operate to failure" items in categories D, E, and F of Table I.

- The task oriented approach to maintenance uses predetermined maintenance tasks to avoid in service failures .Equipments redundancies are sometimes used to allow in-service failures to occur without adversely affecting safety and operation. A reliability program is usually employed (similar to, but more elaborate than, the CM process) for those components or systems whose failure rates are not predictable and for those that have no scheduled maintenance tasks.
- Both of these maintenance philosophies—the process oriented and the task oriented—are discussed in general below along with the basic method of generating the program. How the maintenance tasks and task intervals are determined will be discussed in detail.



- Maintenance must ensure that the flight department has vehicles available to carry out the flight schedule, and this schedule should be met with all required maintenance completed. Therefore, the goals of an airline maintenance program can be stated as follows:
- To deliver airworthy vehicles to the flight department in time to meet the flight schedule
- To deliver these vehicles with all necessary maintenance actions com-pleted or properly deferred

- The objectives of an airline in-service maintenance program are as follows:

1) To ensure the realization of the inherent safety and reliability levels of the equipment
2) To restore safety and reliability to their inherent levels when deterioration has occurred

3) To obtain the information necessary for adjustment and optimization of the maintenance program when these inherent levels are not met

4) To obtain the information necessary for design improvement of those items whose inherent reliability proves inadequate
5) To accomplish these objectives at a minimum total cost, including the costs of maintenance and the cost of residual failures

Maintenance steering group (MSG) Approach

- The Boeing Company started the modern approach to maintenance program development in 1968 with the Boeing 747 airplane, then the largest commercial airplane. It was the start of a new era in aviation, the era of the jumbo jets, and the company felt that this new era should begin with a more sophisticated approach to maintenance program development. They organized teams of representatives from the Boeing Company's design and maintenance program groups along with representatives from the suppliers and the airlines who were interested in buying the airplane. The FAA was also included to ensure that regulatory requirements were properly addressed.

- The process used involved six industry working groups (IWGs):
- (a) Structures; (b) mechanical systems; (c) engine and auxiliary power plant (APU); (d) electrical and avionics systems; (e) flight controls and hydraulics; and (f) zonal.
- Each group addressed their specific systems in the same way to develop an adequate initial maintenance program. Armed with information on system operation, maintenance significant items (MSIs) and their associated functions, failure modes, failure effects, and failure causes, the group analyzed each item using a logic tree to determine requirements.
- This approach to maintenance program development was called a "bottom-up" approach because it looked at the components as the most likely causes of equipment malfunction. The purpose of the analysis was to determine which of three processes would be required to repair the item and return it to service. The three processes were identified as HT, OC, and CM as defined above.
- This maintenance steering group (MSG) approach to maintenance program development was so successful on the 747 that it was modified slightly for use with other aircraft. The specific references to the 747 airplane were removed, and the new generalized process could be used on all aircraft. It was renamed MSG-2 and applied to the development of maintenance programs for the Lockheed L-1011 and the McDonnell-Douglas DC-10 airplanes. Other slight modifications were made to the process in 1972 by European manufacturers, and the resulting procedure used in Europe became known as EMSG.
- The MSG-2 process was slightly different for the three maintenance areas studied:
- (*a*) systems and components;
- (*b*) structures; and
- (*c*) Engines.
- Table 2 summarizes the steps for each:

Step number for			
System/comp	Structure	Engine	Analysis activity
1		1	Identify the systems and their significant items
	1		Identify significant structural items
2			Identify their functions, failure modes, and failure reliability
	2		Identify failure modes and failure effects
		2	Identify their functions, failure modes, and failure effects
3		3	Define scheduled maintenance tasks having potential effectiveness relative to the control of operational reliability
	3		Assess the potential effectiveness of scheduled inspections of structure
4		4	Assess the desirability of scheduling those tasks having potential effectiveness
	4		Assess the desirability of those inspections of structure which do have potential effectiveness
	5		Determine that initial sampling thresholds were appropriate

TABLE -2 -MSG-2 Process Steps

- Step 1, identify the maintenance or structure items requiring analysis.
- Step 2; identify the functions and failure modes associated with the item and the effect of a failure.
- Step 3; identify those tasks which may have potential effectiveness.
- Step 4, assess the applicability of those tasks and select those deemed necessary.
- Step 5, for structures only, evaluate initial sampling thresholds.
- The process flow diagram in the MSG-2 document is too complex to repeat here, especially since the MSG-2 process is no longer used. It is important, however, to understand how the maintenance processes were assigned to the tasks selected.
- Figure 2 is a simplified diagram of that process. Briefly, if failure of the unit is safety related (block 1) and there is maintenance check available to detect a reduction in failure resistance (block 4), then the item in question is identified as on-condition. If no such check is available, then the item is classified as hard time. The student can follow the logic of Fig. 2 for the other conditions.

- Once the maintenance action was determined, it was necessary to define how often such maintenance should be done. Available data on failure rates, removal rates, etc. of the item were then used to determine how often the maintenance should be performed.

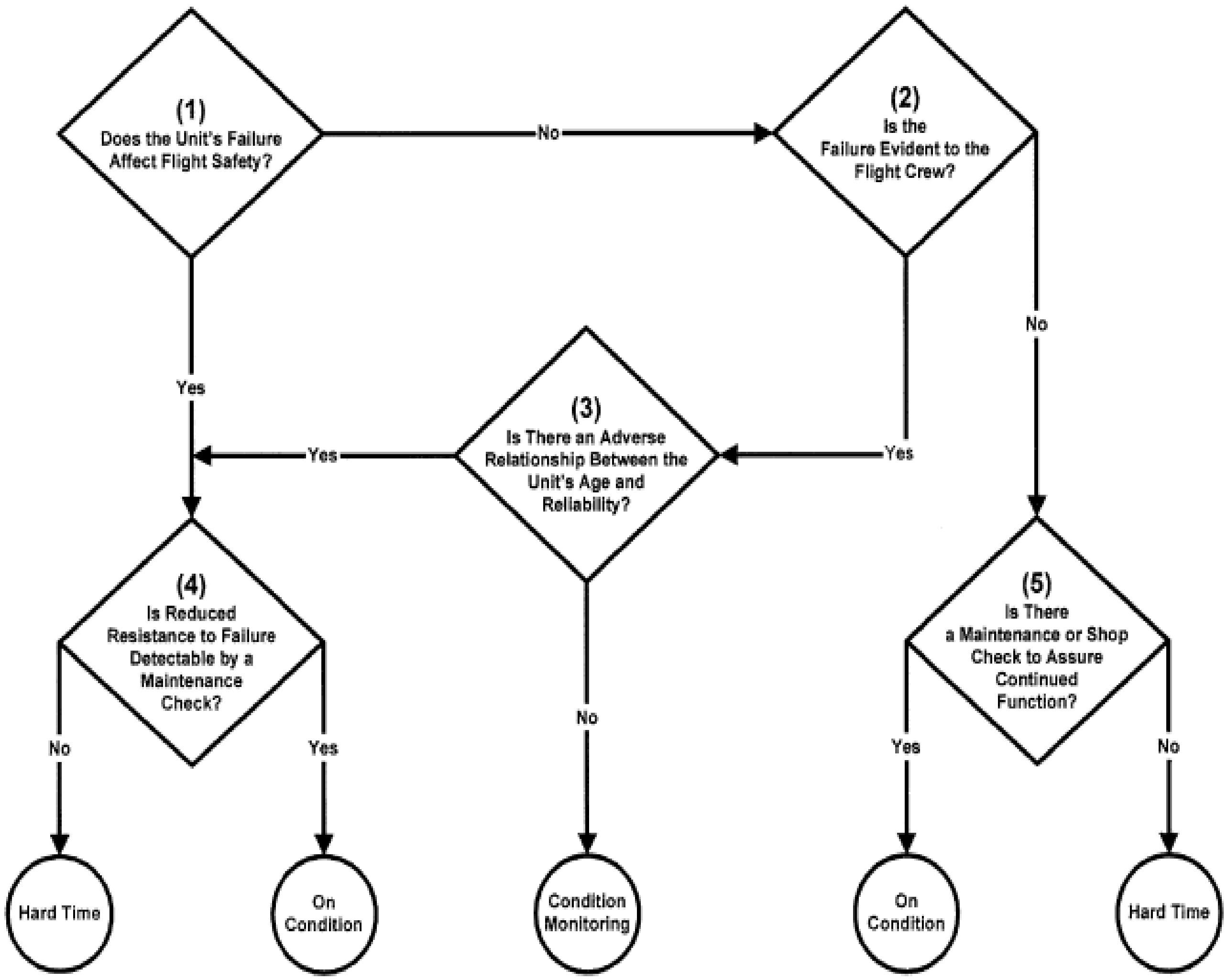
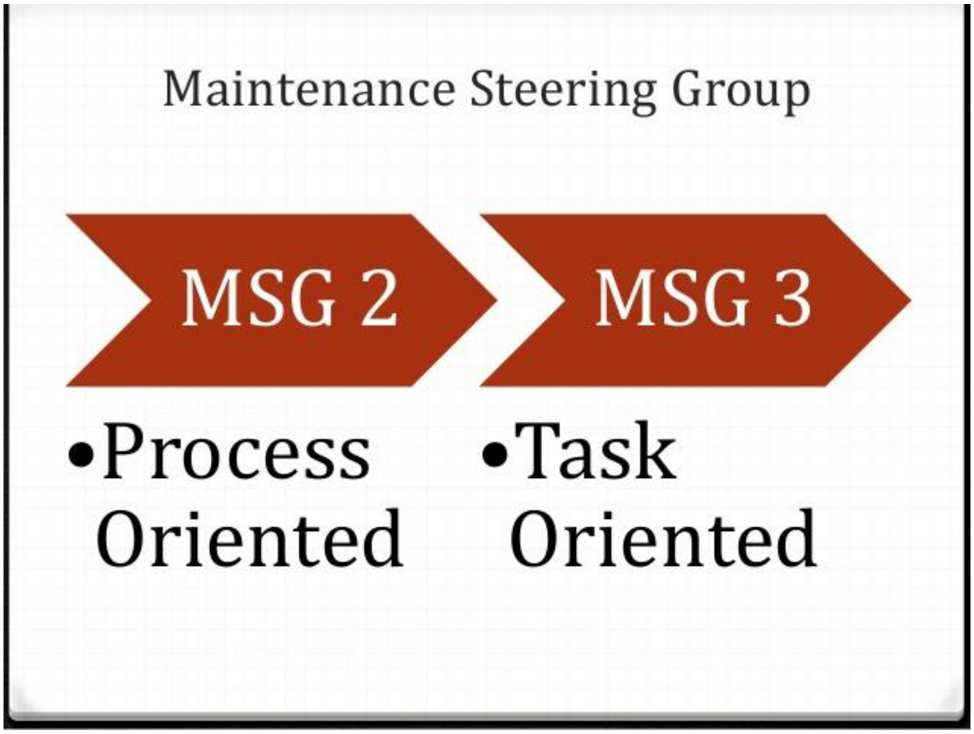


Figure -4-Simplified MSG-2 flow chart.



➢ Process – Oriented maintenance

- Process-oriented maintenance programs are developed for aviation using decision logic procedures developed by the Air Transport Association of America (ATA). The MSG-2 process is a bottom-up approach whereby each unit (system, component, or appliance) on the aircraft is analyzed and assigned to one of the primary maintenance processes, HT, OC, or CM.

- In general, hard time means the removal of an item at a predetermined interval, usually specified in either so many flight hours or so many flight cycles. In some cases the hard time interval may be in calendar time. On-condition means that the item will be checked at specified intervals (in hours, cycles, or calendar time) to determine its remaining serviceability. Condition monitoring involves the monitoring of failure rates, removal rates, etc. to facilitate maintenance planning. Let us look at each process in more detail.

The hard time (HT) process

- Hard time is a failure preventive process which requires that the item be removed from the vehicle and either completely overhauled, partially overhauled (restored), or discarded before exceeding the specified interval. The hard time interval may be specified by calendar time, by engine or airplane check interval (engine change, "C" check, etc.), by landing or operating cycles, by flight hours, by block hours, by specified flights (over water, terminating, etc.), or in conjunction with another process (OC for instance).
- When HT is specified, the component will be removed from the vehicle and overhauled, restored, or discarded, whichever is appropriate. This will be done before the component has exceeded the specified time interval. The component overhaul or restoration will restore the component to a

condition that will give reasonable assurance of satisfactory operation until the next scheduled removal.

- Ideally, hard time would be applied to a component that always fails at *X* hours of operation. This component would then be replaced at the last scheduled maintenance period prior to the accumulation of *X* hours; thus, the operator would get maximum hours out of the component and the component would never fail in service (ideally).
- Hard time is also applied to items having a direct adverse effect on safety and items subject to reliability degradation with age but having no possible maintenance check for that condition.
- As an example, structural inspection, landing gear overhaul, and replacement of life-limited engine parts are all controlled by hard time. Frequently, mechanical linkages and actuators, hydraulic pumps and motors, electric motors and generators, and similar items subject to a definite wear-out cycle will also be identified as hard time. For items having clearly defined wear-out periods, hard time is probably the most economical process. However, these items can also be OC or CM, depending on the operator, as long as they are not safety related.

The on-condition (OC) process

- On-condition is a failure preventive process that requires that the item be periodically inspected or tested against some appropriate physical standard (wear or deterioration limits) to determine whether or not the item can continue in service.
- After failing an OC check, the component must be overhauled or restored to the extent of at least replacing out-of-tolerance parts. Overhaul or repair must restore the unit to a condition that will give reasonable assurance of satisfactory operation for at least one additional OC check interval. If the item cannot be overhauled or restored, or if it cannot be restored to a condition where it can operate one more OC check period, then it should be discarded.
- On-condition must be restricted to components, equipment, or systems on which a determination of continued airworthiness may be made by measurements, tests, or other means without doing a tear-down inspection. These on-condition checks are to be performed within the time limits (intervals) prescribed for each OC check.
- The periodically scheduled OC checks must constitute meaningful determination of suitability for continued operation for another scheduled OC check interval. If the check performed provides enough information regarding the condition and failure resistance of the item to give reasonable assurance of its continued airworthiness during the next check period, the item is properly categorized as on-condition.
- If the check constitutes merely a maintenance task—servicing, adjustment, or a go/no-go determination—and is not making a meaningful disclosure of actual condition, the item is, in fact, operating as a condition monitored item. It should be classified as CM and not OC.
- In some cases, it could even be classified as HT. A simple operational check is *not* an acceptable requisite for the on-condition process. On-condition checks must measure or evaluate the wear and/or deterioration condition of the item.

- The on-condition process also encompasses periodic collection of data that will reveal the physical condition of a component, system, or engine. Through analysis and evaluation, OC data must be able to ascertain continued airworthiness and/or deterioration of failure resistance and imminence of failure. On-condition data must be directed to an individual component, system, or engine (by serial number). It is a priori (before the fact) failure data that can be used to measure decreasing life expectancy and/or predict failure imminence.
- Examples of OC checks are as follows: (*a*) tire tread and brake linings, (*b*) scheduled bore scope inspections of engines, (*c*) engine oil analysis, and (*d*) in-flight engine performance analysis (i.e., engine condition monitoring or ECM). In each of the above stated cases, one can measure degradation and determine, from established norms, how much life or serviceability remains.

- Two points to remember about the on-condition process:
  (a) if a satisfactory on-condition check can be accomplished to ensure serviceability with reasonable probability until the next OC check, or if evaluation of the OC data collected will predict failure imminence, then the OC process will achieve close to maximum life on components and engines; and
  (b) on-condition applicability is limited by the requirement for a satisfactory condition measurement or pertinent failure predicting data.

- Examples of components susceptible to the on-condition process are as follows
  1. **Brake wear indicator pins**: Compare brake wear condition against a specified standard or limit. Brake wear will vary considerably among operators due to operational conditions and crew habits, but the wear indicator pin OC check will help attain near maximum usage out of each set of brakes.

  2. **Control cables**: Measure these for diameter, tension, and broken strands.

  3. **Linkages, control rods, pulleys, rollers tracks, jack screws, etc.**: Measure these for wear, end or side play, or backlash.

The condition monitoring (CM) process

- The condition monitoring process is applied when neither the hard time nor the on-condition process can be applied.
- The CM process involves the monitoring of the failure rates, removals, etc. of individual components or systems that do not have a definite lifetime or a noticeable wear-out period. Condition monitoring is not a failure preventive process as are HT and OC. There are no maintenance tasks suitable for evaluating the life expectancy of the CM item and there is no requirement to replace the item before it fails. Neither time nor condition standards can be used to control CM items because these components do not have such attributes. Therefore, CM components are operated until failure occurs and replacement of CM items is an unscheduled maintenance action.

- Since CM items are operated to failure, the ATA states that these items must comply with the following conditions:

    1. A CM item has no direct, adverse effect on safety when it fails; i.e., the air-craft continues to fly to a safe landing. Generally, CM items have only this indirect, non adverse effect on safety due to system redundancy.
    2. A CM item must not have any hidden function (i.e., a malfunction that is not evident to the crew) whose failure may have a direct adverse effect on safety. However, if there is a hidden function and the availability or operation of that hidden function is verified by a scheduled operational test or other non measurement test made by the flight crew or maintenance crew, CM can still be used.
    3. A CM item must be included in the operator's condition monitoring or reliability program; i.e., there must be some sort of data collection and analysis for those items for maintenance to get a better understanding of the nature of failure for those components or systems.

- In addition to the above ATA stipulations, CM items usually have no adverse relationship between age and reliability (i.e., no predictable life expectancy). They exhibit a random failure pattern.

- The most appropriate application of the condition monitoring process is to complex systems, such as avionics and electronics components, and to any other components or systems for which there is no way to predict failures. Typical components and systems suitable for CM include navigation and communications equipment, lights, instruments, and other items where test or replacement will not predict approaching failure nor result in improved life expectancy. In aviation, CM is frequently applied to components where failure has no serious effect on safety or air-worthiness, due to redundancy, and to items not affecting airworthiness at all, such as coffee makers, lavatories, passenger entertainment systems, etc.
- Condition monitoring systems consist of data collection and data analysis procedures that will portray information upon which judgments relative to the safe condition of the vehicle can be made.
- Condition monitoring, which is primarily a data collection and analysis pro-gram, can also be used on HT and OC components for verifying or adjusting the HT and OC intervals.
- For example, if a hard time item is removed just prior to its expiration date and overhaul activities reveal that little or nothing needs to be done to restore the component, then perhaps the HT interval can be extended. Likewise, if OC checks reveal little or no maintenance requirement or that the lifetime of the component is longer than originally expected, the OC check interval can be changed.
- However, without the collection of data over a period of time (several HT periods or OC intervals), there would not be any solid justification to change the intervals. By the same token, CM data collection may indicate that the HT or OC intervals need to be shortened for some components. The CM pro-gram also provides data to indicate whether or not components are being monitored under the most appropriate process.

Task- oriented maintenance

- Task-oriented maintenance programs are created for aviation using decision logic procedures developed by the Air Transport Association of America. The process called MSG-3 is a modification of and an improvement on the MSG-2 approach.

- The MSG-3 technique is a top-down consequence of failure approach whereby failure analysis is conducted at the highest management level of air-plane systems instead of the component level as in MSG-2. The MSG-3 logic is **used** to identify suitable scheduled maintenance tasks to prevent failures and to maintain the inherent level of reliability of the system. There are three categories of tasks developed by the MSG-3 approach:
    1. Airframe system tasks
    2. Structural item tasks
    3. Zonal tasks

Maintenance tasks for airframe systems

-

- Under the MSG-3 approach, eight maintenance tasks have been defined for airframe systems. These tasks are assigned in accordance with the decision analysis results and the specific requirements of the system, component, etc. under consideration. These eight tasks are listed and defined below:

1. Lubrication. An act of replenishing oil, grease, or other substances that maintains the inherent design capabilities by reducing friction and/or conducting away heat.

2. Servicing. An act of attending to basic needs of components and/or systems for the purpose of maintaining the inherent design capabilities.

3. Inspection. An examination of an item and comparison against a specific standard.

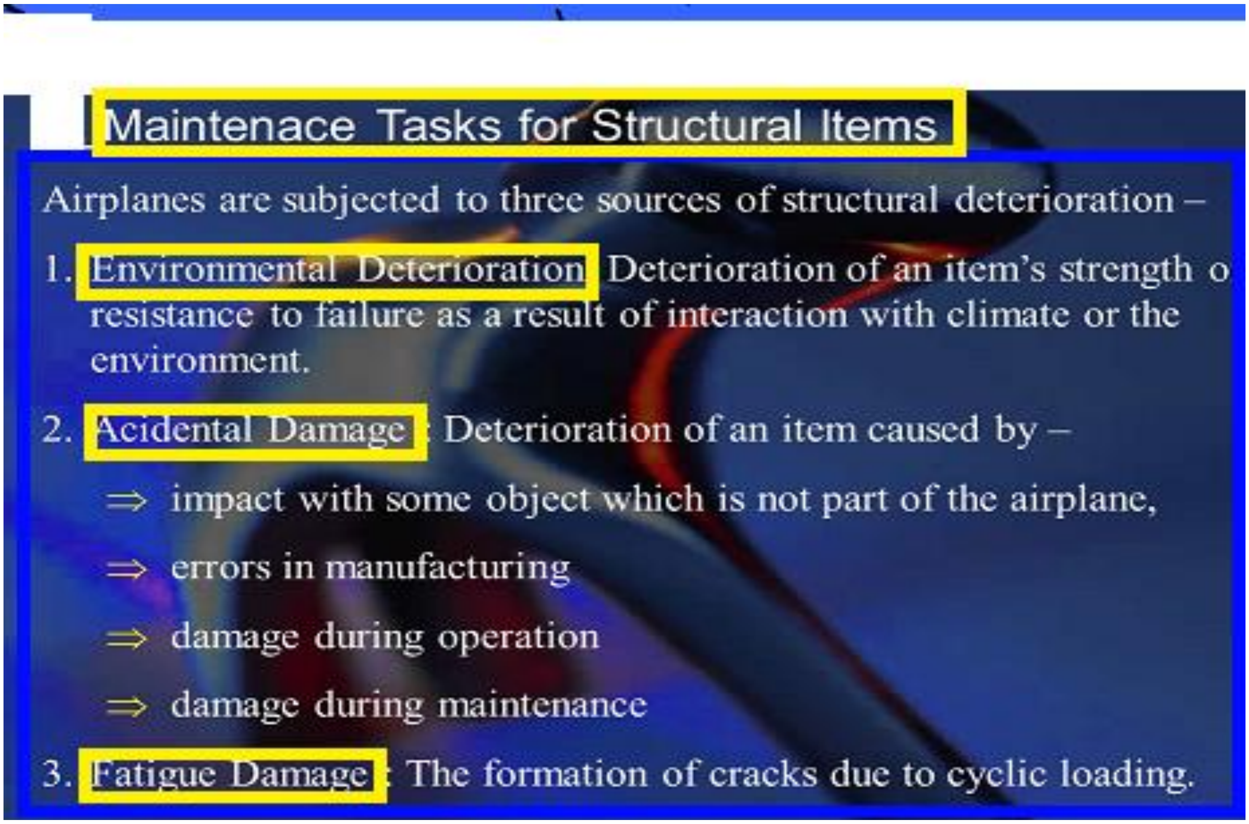
4. Functional check. Aquantitative check to determine if each function of an item performs within specified limits. This check may require use of additional equipment.
5. Operational check. A task to determine if an item is fulfilling its intended pur-pose. This is a failure-finding task and does not require quantitative tolerances or any equipment other than the item itself.

6. Visual check. An observation to determine if an item is fulfilling its intended pur-pose. This is a failure-finding task and does not require quantitative tolerances.

7. Restoration. That work necessary to return the item to a specific standard. Restoration may vary from cleaning the unit or replacing a single part up to and including a complete overhaul.

8. Discard. The removal from service of any item at a specified life limit.

Maintenance tasks for structural items



- Airplanes are subjected to three sources of structural deterioration as discussed below.

1. Environmental deterioration. The physical deterioration of an item's strength or resistance to failure as a result of chemical interaction with its climate or environment. Environmental deteriorations may be time dependent
2. Accidental damage. The physical deterioration of an item caused by contact or impact with an object or influence that is not a part of the airplane, or damage as a result of human error that occurred during manufacture, operation of the vehicle, or performance of maintenance.
3. Fatigue damage. The initiation of a crack or cracks due to cyclic loading and subsequent propagation of such cracks

- Inspection of airplane structures to determine if deterioration due to the above has occurred requires varying degrees of detail. The MSG-3 process defines three types of structural inspection techniques as follows:

  1. General visual inspection. A visual examination that will detect obvious, unsatisfactory conditions or discrepancies. This type of inspection may require removal of fillets or opening or removal of access doors or panels. Work stands and ladders may be required to facilitate access to some components.

2. Detailed inspection. An intensive visual inspection of a specified detail, assembly, or installation. It is a search for evidence of irregularity using adequate lighting and, where necessary, inspection aids, such as mirrors, hand lenses, etc. Surface cleaning and detailed access procedures may also be required.
3. Special detailed inspection. An intensive examination of a specific location. It is similar to the detailed inspection but with the addition of special techniques. This examination may require such techniques as nondestructive inspections (NDIs): dye penetrant, high-powered magnification, magnetic particle, eddy current, etc.

Zonal maintenance tasks

- The zonal maintenance program ensures that all systems, wiring, mechanical controls, components, and the installation contained within the specified zone on the aircraft receive adequate surveillance to determine the security of installation and general condition. The logical process is normally used by type certificate (TC) and supplement type certificate (STC) holder for developing their maintenance and inspection for zonal maintenance by using MSG-3 logic to develop a series of inspections, and a numerical reference is assigned to each zone when it is analyzed. Due to aging aircraft, the FAA has established specific damage tolerance criteria based on inspection of an aircraft operator's continued airworthiness program. The AC 120-93 provides for detailed damage tolerance inspection (DTI) for repair and alterations that affect fatigue-critical structure of the aircraft. The DTI process includes the area to be inspected, the inspection methods and techniques, and the inspection procedures.

- The program packages a number for general visual inspection tasks, generated against the item in the system's maintenance program, into one or more zonal surveillance tasks. Zonal maintenance and inspection level techniques are performed in two types as in the following list.
    1. General visual inspection
    2. Detailed visual inspection

➢ The Current MSG Process—MSG-3

- The MSG-2 process was modified in 1980 in a document released by the Air Transport Association of America.
- The document states "MSG-3 did not constitute a fundamental departure from the previous version, but was built upon the existing framework of MSG-2 which had been validated by 10 years of reliable aircraft operation using the maintenance programs based thereon."
- The MSG-3 program adjusted the decision logic to provide a more straight-forward and linear progression through the logic.
- The MSG-3 process is a top-down approach or consequence of failure approach. In other words, how does the failure affect the operation? It does not matter whether a system, subsystem, or component fails or deteriorates. What matters is how the failure affects the aircraft operation. The failure is assigned one of two basic categories: safety and economic. Figure 5 is a simplified diagram of the first step in the MSG-3 logic process.

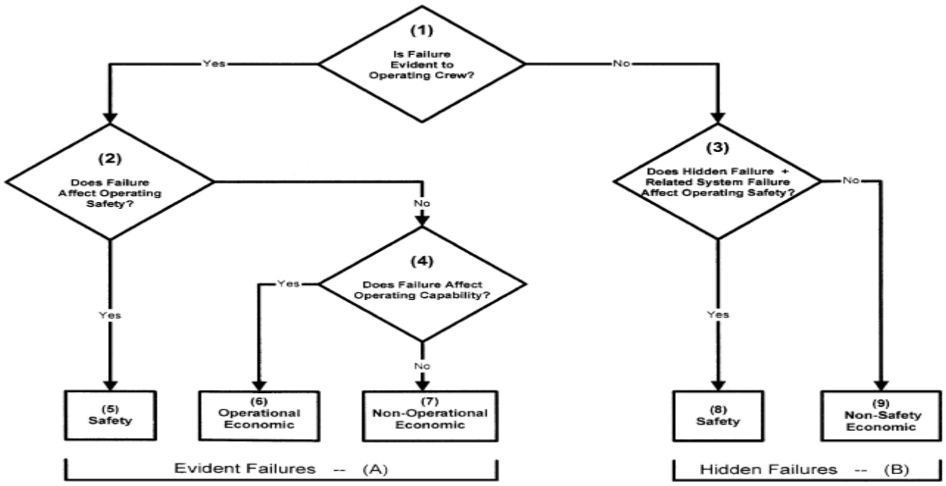


Fig – 5- MSG-3—level I analysis—failure categories

- The maintenance tasks resulting from the MSG-3 approach may include hard time, on-condition, and condition monitoring tasks similar to those of MSG-2, but they are not referred to by those terms.
- The MSG-3 approach is more flexible in developing the overall maintenance program.
- The flow chart of Fig. 5 is used to determine if the failure is evident to the flight crew or hidden from them (level I analysis). Those failures that are evident are further separated into safety related and operationally related with the latter split into those that are of economic significance and those that are not. These types are numbered 5, 6, and 7. The significance of these categories will be addressed later. Those failures that are determined to be hidden from the crew are divided into safety related and non safety related items. These are designated as categories 8 and 9.
- Figures 6 and 7 (level II analysis) are used to determine the maintenance tasks required to accommodate the functional failure. Although the questions are similar, there is a slight difference in the way evident and hidden failures are addressed. Note that some of the flow lines in Figs. 2-3 and 2-4 are identified as Cat 5 or Cat 8 only. This requires some explanation.

- The first question in each chart, regarding lubrication or servicing, must be asked for all functional failures (categories 5 through 9). Regardless of the answer to this question (Yes or No), the analyst must ask the next question. For categories 6 and 7 in Fig. 6 and category 9 in Fig. 7, the questions are asked in sequence until a Yes answer is obtained. At that point the analysis stops. For categories 5 and 8 (safety related), however, all questions must be answered regardless of
- the Yes or No response to any of them.
- The last block of Figs 6 and 7 also requires some explanation. These flow charts are used for the development of a maintenance program for a new aircraft or derivative. If progression through the chart ends up in this block for categories 6, 7, and 9, then a redesign on the equipment involved may be considered by the design engineers. However, if the item is safety related—categories 5 or 8—then a redesign is mandatory. Once the initial maintenance program is developed, the airline mechanics will use that program.

- The MSG-3 process can be best understood through a step-by-step explanation of what the working groups would do for a given analysis. Each working group will receive information about the systems and components within their respective groups:
- (*a*) the theory of operation; (*b*) a description of the operation of each mode (if there is more than one mode); (*c*) the failure modes of each operational mode; and (*d*) any data available (actual or estimated) on the failure rates, removal rates, etc. [such as mean time between failures (MTBF) and mean time between unscheduled removals (MTBUR) for repairable parts; and mean time to removal (MTTR) for non repairable parts].

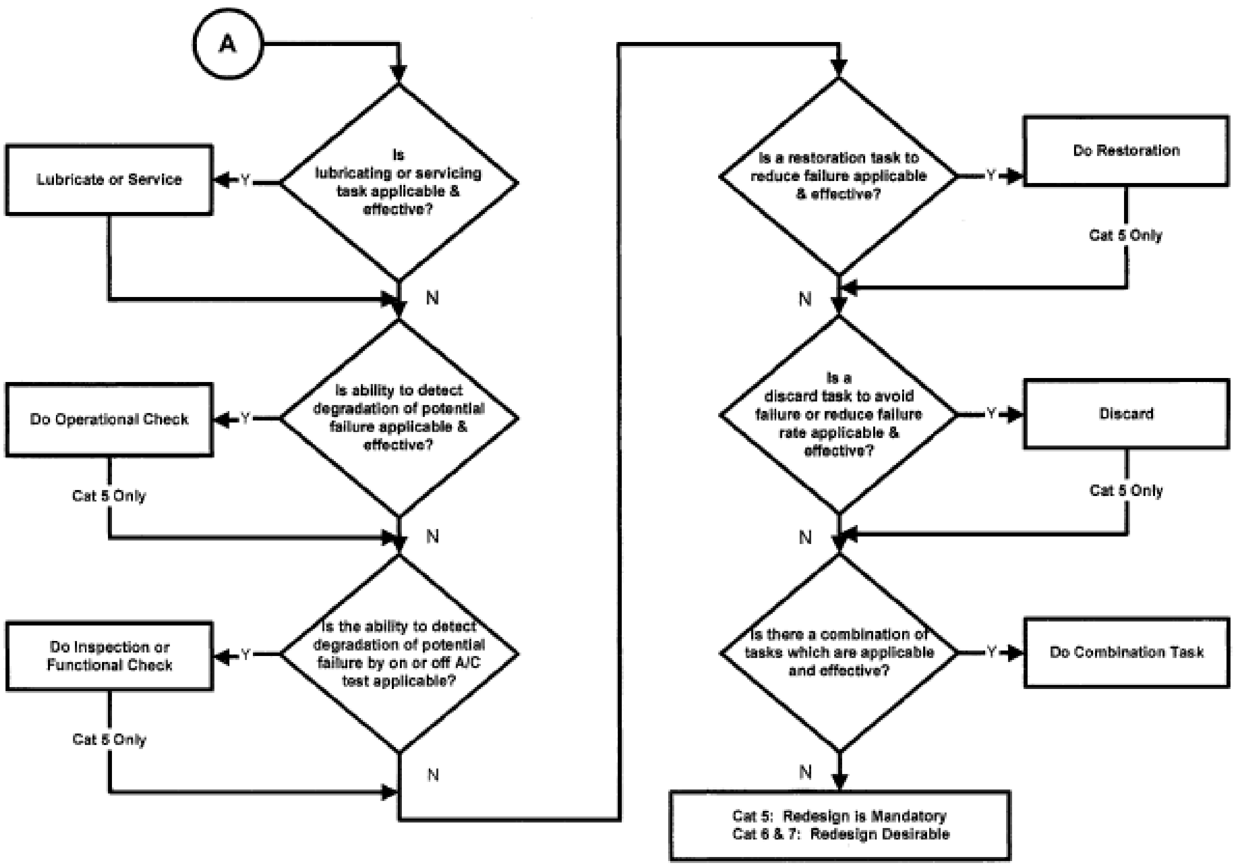


Fig – 6 - MSG-3—level II analysis—evident failures

- If the system is the same as, or similar to, that used on an existing model aircraft , the group members only need refresher training on the operation and on the failure modes. If the equipment is new, or has been extensively modified for the new model aircraft, the learning process may take a little more time. The airframe manufacturer is responsible for providing this training to the working groups. The manufacturer is also responsible for furnishing any available performance and failure rate data to the working groups.

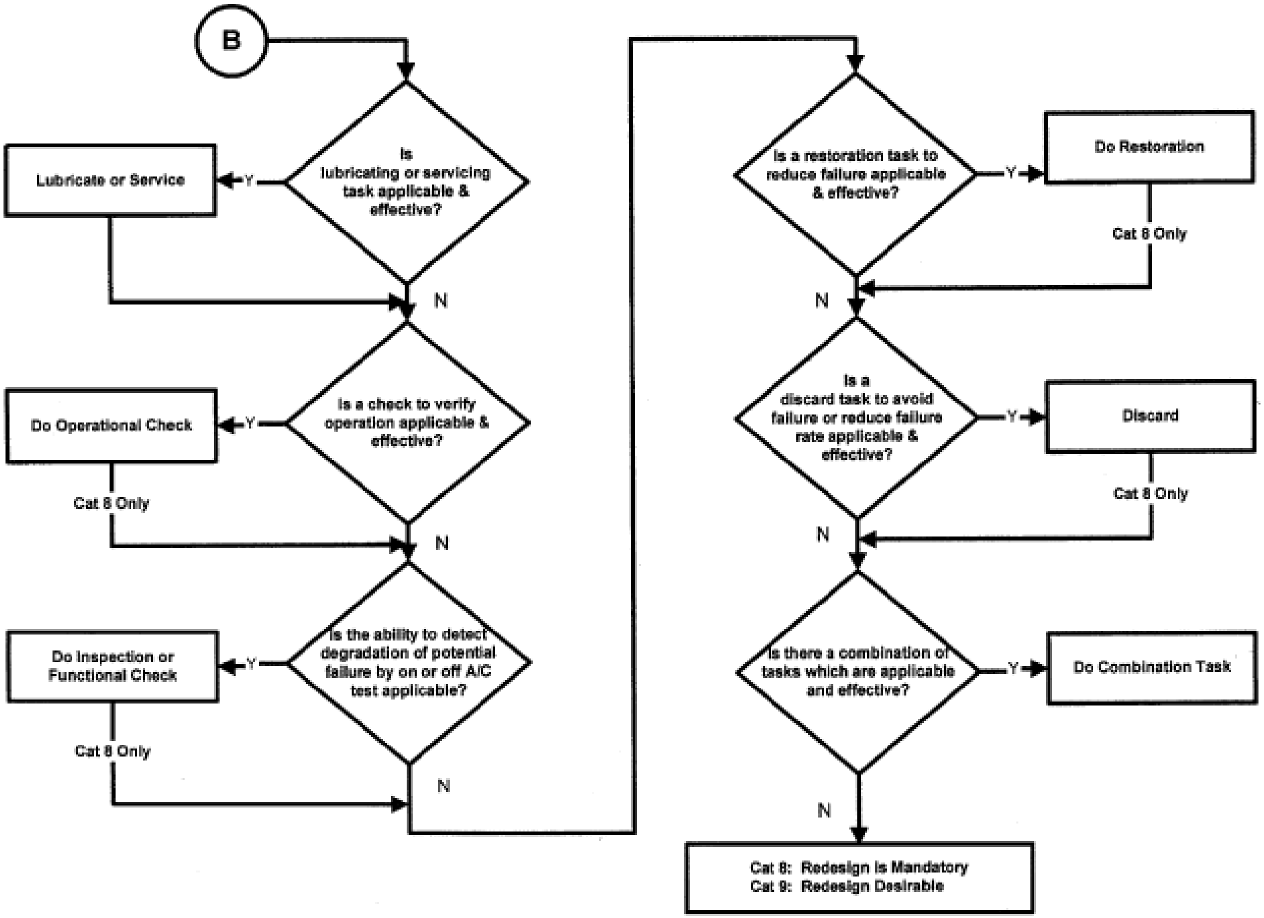


Fig – 7 - MSG-3—level II analysis—hidden failures

➢ Maintenance program documents

- The result of the MSG-3 analysis constitutes the original maintenance program for the new model aircraft and the program that is to be used by a new opera-tor of that model. The tasks selected in the MSG process are published by the airframe manufacturer in an FAA approved document called the Maintenance Review Board Report (MRBR). This report contains the initial scheduled maintenance program for U.S. certificated operators. It is used by those operators to establish their own FAA approved maintenance program as identified by their operations specifications.
- The MRBR includes the systems and power plant maintenance program, the structural inspection program, and the zonal inspection program. It also contains aircraft zone diagrams, a glossary, and a list of abbreviations and acronyms.
- In addition to the MRBR, the manufacturer publishes its own document for maintenance planning.
- At Boeing, this document is called the maintenance planning data (MPD) document. McDonnell-Douglas called it the on aircraft maintenance planning (OAMP) document.

- At Airbus Industries, it is called the maintenance planning document (MPD). We will use the acronym MPD/OAMP to refer to all such documents.
- These documents contain all the maintenance task information from the MRBR plus additional tasks suggested by the air-frame manufacturer.
- The MPD/OAMP also sorts the tasks in various ways to aid in planning. This document often groups by letter check and by hours, cycles, and calendar time.
- These manufacturer's documents also contain diagrams showing the location and numbering of access doors and panels, aircraft dimensions, and other information to aid the development of maintenance programs and the planning of maintenance checks. The latter includes man-hour requirements for each task. These are only estimates of the time required to do the actual work prescribed. They do not include the time required to open and close doors or panels, position work stands, to analyze or troubleshoot problems, or to correct any discrepancies found during conduct of the task. These estimated times must be altered by the operator to accommodate the actual task requirements when planning any given check activity.

Maintenance Intervals Defined

- The maintenance work interval depends on the aircraft manufacturer with the cooperation of the airline's operator discretion.
- Various maintenance checks have been named and defined in the MSG-3 process and are to be considered standard.
- However, many airlines have defined their own named intervals, but as long as the integrity is maintained of the original maintenance required task or an approved FAA deviation.
- Aircraft maintenance checks are normally driven by total air time (TAT), the number of hours an aircraft has flown, and total landing cycles (CYC), which translates into each time aircraft lands it generates one cycle. Under FAA oversight, airlines and aircraft operators must prepare a continuous airworthiness maintenance program (CAMP) under their operations specification.
- The CAMP program outlines routine and detailed inspection.
- Airlines and aircraft operators and airworthiness authorities commonly refer to these types of inspections as checks. These checks are known as A, B, C, D checks
- The following are the examples of standard intervals:

Daily checks

- Daily checks consist of the oil level check. The oil level on the aircraft engine must be checked between 15 and 30 minutes after engine shutdown to obtain an accurate reading. This means that the oil level cannot be checked and replenished prior to the first flight of the day. It can only be done soon after landing. (If one must check the oil level prior to first departure, the engine must be run for 2 minutes or more to warm up the oil. Fifteen minutes after shutting down, the oil level can be checked. This is not a normal procedure, but it is necessary in some cases.)

- The daily checks also include any time-deferred maintenance items, such as an aircraft engine being on oil watch. ETOPS-type aircraft also receive a pre-departure service check, which is also part of the daily checks.

48-hour checks

- A 48-hour check, for most aircraft models, replaces what used to be called a daily check.
- The 48-hour check is performed every 48 hours depending on airline operations specifications. This check may include tasks that are more detailed than the daily checks;
- For example, items such as wheel and brake inspection, replenishment of fluids such as engine oil and hydraulic, auxiliary power unit oil replenishment and inspection, general visual inspection of the fuselage, wings, interior, and flight deck.

Hourly limit checks

- Certain checks determined by the MSG analysis have maintenance tasks assigned by the number of hours the unit or system has been operating: 100, 200, 250 hours, etc.
- This approach is used for engines, airplane flight controls, and numerous other systems that are operating on a continual basis during the flight or on the ground.

Operating cycle limit checks

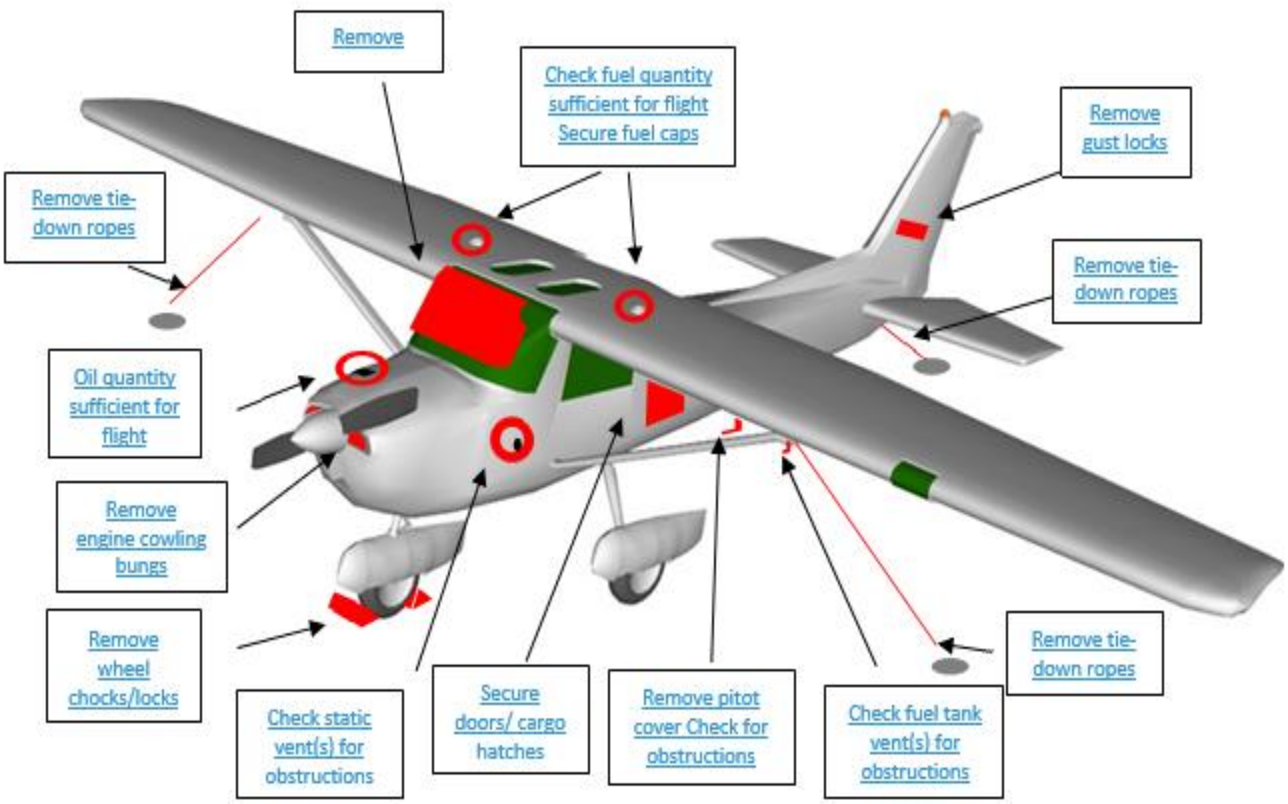
- Other airplane systems are maintained on a schedule determined by the number of operating cycles they have endured.
- For example, landing gear is used only during takeoffs and landings, and the number of those operations will vary with the flight schedule. Airframe structures, power plant/engine components, such as LP and HP impellors and HP turbine blades and some other components are also subject to cyclic stresses and will have numerous tasks in this category.

Letter checks

- Until the development of the Boeing 777, all aircraft utilizing the MSG-3 processes for maintenance program development had various letter checks identified in the maintenance program.
- These checks were identified as A, B, C, and D checks. The Boeing 777, using a modified MSG-3 process (called MSG-3, Revision 2) eliminated the letter checks. Every task that was not on the transit check was identified by hours or cycles only, and these tasks were not grouped into letter checks as was done for previous model aircraft.
- This produced an optimum maintenance program in that it allowed maintenance to be done at the most appropriate time for the equipment or system. For the operator, it makes the program more adaptable to their needs. Some operators, however, still schedule this maintenance in blocks at specific time or cycle intervals.

Changing Basic Maintenance Intervals

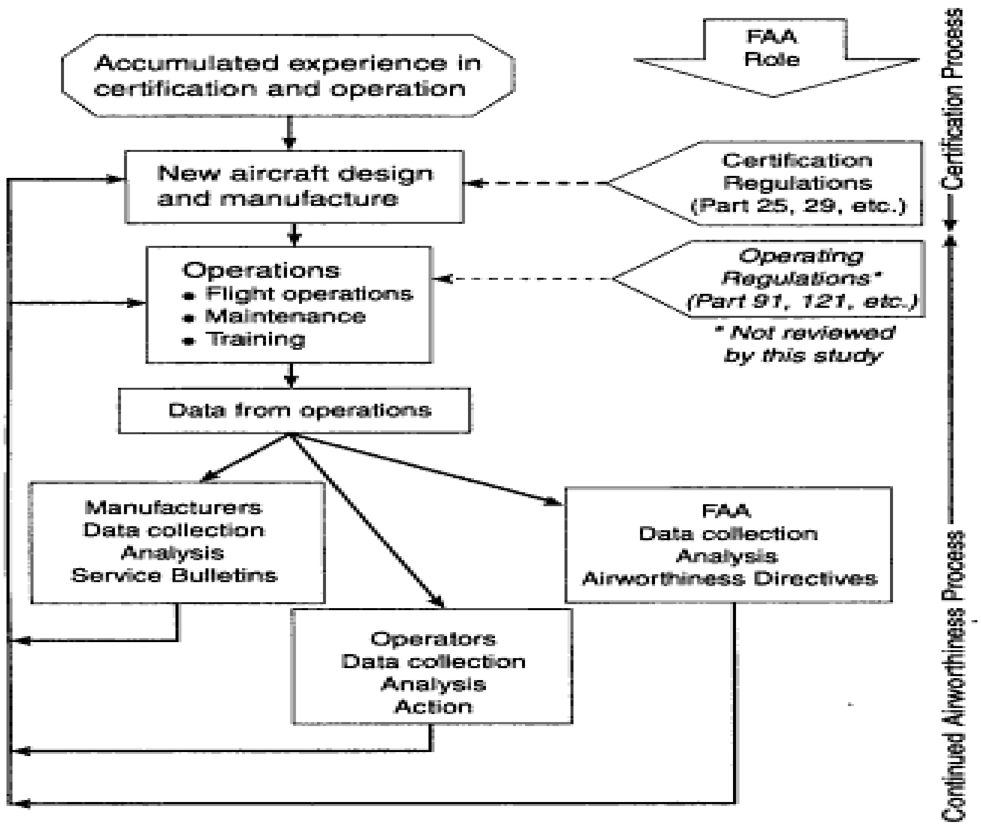
- Operational conditions will often require that an operator change the basic maintenance program to better address the organizational needs and to accommodate the fifth objective of a maintenance program.
- For example, operation in hot humid climates may require that corrosion control tasks be performed more often than the MRB report indicates while operating the same vehicles in a dry, desert climate may reduce the needed frequency for these tasks. In the latter situation, however, items sensitive to sand and dust will need increased attention in the maintenance program
- It is expected that an operator will change the original maintenance intervals for certain tasks or for entire letter checks whenever in-service experience dictates. However, to do this, the operator must have proof that a change is warranted. The accepted proof for such maintenance interval changes is in the form of data collected through the operator's condition monitoring program or reliability program. As aircraft get older, task intervals for certain items may have to be shortened while others may be lengthened. Maintenance is a dynamic process.



UNIT – II
AVIATION CERTIFICATION REQUIREMENTS AND DOCUMENTATION FOR MAINTENANCE & ENGINEERING

➢ Aircraft certification

- There are three certificates necessary for full certification of the airplane. These documents—the type certificate, the production certificate, and the airworthiness certificate—certify, respectively, the aircraft design, the manufacturing process, and the aircraft itself.



Type certificate (FAA form 8110.9)

- To begin with, each aircraft designed and built for commercial as well as private operation must have an approved type certificate (TC). This certificate is applied for by the designers of the vehicle once the basic design has been deter-mined. The TC defines the vehicle, engines and/or propellers, and the various instruments, systems, and equipment that make up the model.
- If more than one engine type (i.e., derivatives of existing engines or engines from different manufacturers) is offered for the same vehicle, the TC must cover the characteristics and limitations of all of them. The same is true on other equipment, systems, and accessories. The TC also defines the capabilities and limitations of the vehicle, such as passenger and cargo carrying limits, altitude limits, fuel capacity, and top speed as well as cruising speed.
- All of these parameters combined, which define the airframe/engine combination, must be identified on a data sheet attached to the certificate. The aircraft/engine combination is designed to exacting safety and airworthiness standards set by the FAA, and this design must be proven to the FAA by means of inspections and test flights. A final FAA proving flight is conducted before the TC is awarded.
- The TC is applied for early in the design stages but is not awarded until the aircraft is actually built, tested in flight, and proven to meet the standards of safety and airworthiness.
- For example, the Boeing Company applied for the TC for the 757-200 airplane in 1978; it was awarded by the FAA's Aircraft Certification Office (ACO) in 1982.

- A sample of the TC is shown in Fig-1.
- This is the first page showing the air-planes covered.
- Additional information concerning the design is given in the data sheets (not shown) attached to the TC.
- The TC remains in effect until superseded revoked, or a termination date is established by the FAA. Figure -2 shows an STC.

The United States of America

Department of Transportation

Federal Aviation Administration

①

Type Certificate

②

Number _______ ③

This certificate issued to ④ certifies that the type design for the following product with the operating limitations and conditions therefor as specified in the Federal Aviation Regulations and the Type Certificate Data Sheet, meets the airworthiness requirements of Part ⑤ of the Federal Aviation Regulations.

⑥

This certificate, and the Type Certificate Data Sheet which is a part hereof, shall remain in effect until surrendered, suspended, revoked, or a termination date is otherwise established by the Administrator of the Federal Aviation Administration.

Date of application: ⑦

Date of issuance: ⑧

By Direction of the Administrator

(Signature)____________________________

⑨

(Title) ________________________________

This certificate may be transferred if endorsed as provided on the reverse hereof.

Any alteration of this certificate and/or the Type Certificate Data Sheet is punishable by a fine not exceeding $1,000, or imprisonment not exceeding 3 years, or both.

FAA FORM 8110-9 (2-82)(Representation)

Fig-I- FAA type certificate (sample)

(1) Type of product (airplane, engine, propeller); (2) "IMPORT" if applicable; (3) TC number as assigned; (4) applicant's name; (5) applicable Federal Aviation Regulation; (6) product type designation: "Airplane Model 120." Additional models if applicable; (7) date of original application; (8) date TC is issued. When later models are added, retain original date and add new date; (9) signature of manager, FAA accountable directorate.

United States of America

Department of Transportation–Federal Aviation Administration

Supplemental Type Certificate

Number

This certificate, issued to

certifies that the change in the type design for the following product with the limitations and conditions therefor as specified hereon meets the airworthiness requirements of Part of the Regulations.

Original Product-Type Certificate Number:

Make:

Model:

Description of Type Design Change:

Limitations and Conditions:

This certificate and the supporting data which is the basis for approval shall remain in affect until surrendered, suspended, revoked, or termination date is otherwise established by the administrator of the Federal Aviation Administration.

Date of application: Date reissued:

Date of issuance: Date amended:

By Direction of the Administrator

____
(Signature)

____
(Title)

Any alteration of this certificate is punishable by a fine not exceeding $1,000, or imprisonment not exceeding 3 years, or both.

This certificate may be transferred in accordance with FAR 21.47.

FAA FORM 8110-2 (10-68)(Representation)

Fig- 2- FAA supplemental type certificate (sample)

Production certificate (FAA form 8120-4)

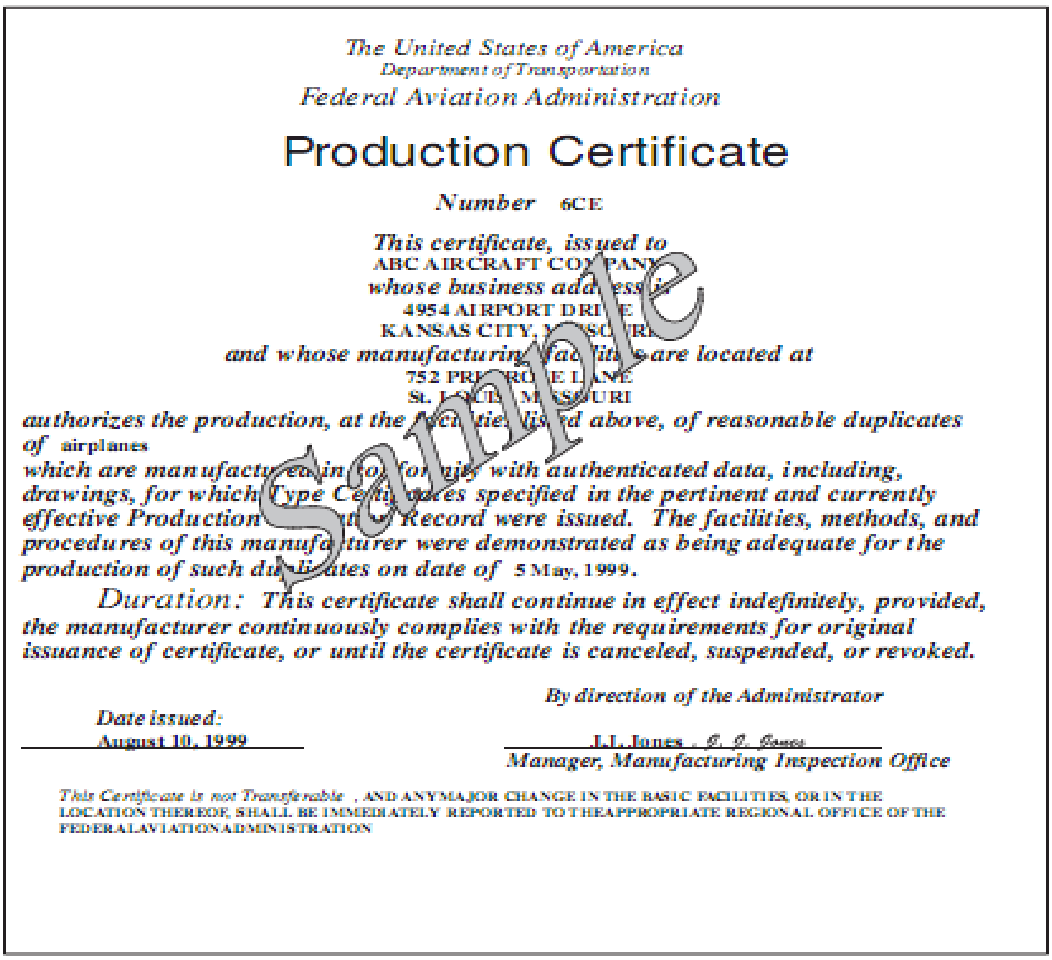
- Once the TC is awarded, the manufacturer applies for the production certificate (PC) by submitting application form 8110.12 to the FAA's Manufacturing Inspection District Office (MIDO).
- The production certificate is awarded after the FAA is satisfied with the quality control system that also consists of necessary manufacturing and production facilities, effective quality system for compliance as per requirements of 14 CFR part 21, and approved design data of each unit(aircraft) built to the TC standards.
- In other industries, it is possible to build a hand-made prototype of a product which often differs from the mass-produced units. This is then used to demonstrate the unit's capabilities.
- This is not the case in aviation. Each copy of the aircraft must be built to the type certificate standards.
- A manufacturer usually gets one production certificate.
- Each subsequent air-craft manufactured by that company will be added to the original PC by the FAA.
- Figure -3 shows the first page of a typical production certificate
- A production certificate may have a production limitation record (PLR), shown in Fig. - 4, which lists all the TCs and STCs issued to that manufacturer as well as any limitations. The PC is effective for as long as the manufacturer complies with the requirements of the original issuance. For new technology, or for derivative or new aircraft, the FAA may conduct additional inspections of the manufacturer's facilities and processes if it deems that to be necessary. The FAA may cancel, suspend, supersede, or revoke the PC for just cause at any time.

Airworthiness certificate (FAA form 8100-2)

- The third certificate, the airworthiness certificate (AC), is awarded by the FAA's MIDO to each aircraft produced by a manufacturer. This certificate confirms that the aircraft to which it is awarded has been inspected and found to conform with its type certificate and to be in airworthy condition.
- This airworthiness certificate is applied for by the manufacturer and awarded by the FAA after the aircraft has passed all inspections and a successful flight test—when the aircraft "rolls out the door"—just prior to delivery to the customer. The airworthiness certificate contains the aircraft's unique serial (tail) number.
- The standard AC remains in effect as long as the following conditions are met: (*a*) the aircraft meets its type design; (*b*) the aircraft is in a condition for safe operation; (*c*) all applicable airworthiness directives (ADs) have been incorporated; and (*d*) maintenance and alterations are performed in accordance with applicable FARs. The FAA can cancel, suspend, supersede, or revoke the AC if, in its opinion, any of the above have been violated.
- Figure-5 shows a typical airworthiness certificate.
- FAA rules require that this certificate be prominently displayed in the aircraft. In passenger airliners, it is usually posted by the main entry door. Look for it the next time you board a commercial aircraft. If you do not see it, ask a crew member where it is.

- The FAA form 8100-2 is also allowed for the following categories of vehicles, including normal, utility, acrobatic, transport, and special classes. Special air-worthiness certificate FAA Form 8130-7 is not used for commercial aircraft/ airline use.
- The FAA authorization is required to operate any type of aerial vehicle in U.S. airspace. The following are the examples of categories

- Primary. Aircraft flown for pleasure and personal use
- Restricted. Agriculture, forest, and wildlife, surveying, patrolling, weather use
- Light-Sport. Light sport aircraft, ultra light vehicle use
- Experimental. R&D, air racing, crew training, unmanned aircraft system use


The United States of America
Department of Transportation
Federal Aviation Administration

Production Certificate

Number 6CE

This certificate, issued to
ABC AIRCRAFT COMPANY
whose business address is
4954 AIRPORT DRIVE
KANSAS CITY, MISSOURI
and whose manufacturing facilities are located at
752 PRIMROSE LANE
St. LOUIS, MISSOURI
authorizes the production, at the facilities listed above, of reasonable duplicates of airplanes
which are manufactured in conformity with authenticated data, including drawings, for which Type Certificates specified in the pertinent and currently effective Production Limitation Record were issued. The facilities, methods, and procedures of this manufacturer were demonstrated as being adequate for the production of such duplicates on date of 5 May, 1999.

Duration: This certificate shall continue in effect indefinitely, provided, the manufacturer continuously complies with the requirements for original issuance of certificate, or until the certificate is canceled, suspended, or revoked.

By direction of the Administrator

Date issued:
August 10, 1999

J.J. Jones , J. J. Jones
Manager, Manufacturing Inspection Office

This Certificate is not Transferable , AND ANY MAJOR CHANGE IN THE BASIC FACILITIES, OR IN THE LOCATION THEREOF, SHALL BE IMMEDIATELY REPORTED TO THE APPROPRIATE REGIONAL OFFICE OF THE FEDERAL AVIATION ADMINISTRATION

Sample

Fig – 3 - FAA production certificate (sample).

The United States of America
Department of Transportation
Federal Aviation Administration

Production Limitation Record

The holder of
Production Certificate No. 6CE
may receive the benefits incidental to the
possession of such certificate with respect to

AIRCRAFT
(OR AIRCRAFT PROPELLER,
AIRCRAFT ENGINE AS APPLICABLE)

manufactured in accordance with the data forming the
basis for the following Type Certificate(s) No.

Type Certificate	Model	Date Production Authorized
A 920CE	[illegible] 2[illegible]47R	August 10, 1978
A 9CE	[illegible] 258D	August 10, 1978
STC 492CE	[illegible]awing List HC-B2YK-6	August 10, 1978

(Note: Any number of columns may be used provided the material is neat and legible. Additional PLRs may be used when necessary. Additional PLRs shall be numbered "1 of 2," "2 of 2," as appropriate to the number of pages involved.)

LIMITATIONS:

(if any)

August 10, 1999
Date of issuance

By Direction of the Administrator
J. J. Jones
J. J. Jones
Manager, Manufacturing Inspection District Office

FAA FORM 8120-3 (7-67)

Fig – 4 - FAA production limitation record (sample).

UNITED STATES OF AMERICA
DEPARTMENT OF TRANSPORTATION FEDERAL AVIATION ADMINISTRATION

STANDARD AIRWORTHINESS CERTIFICATE

1 NATIONALITY AND REGISTRATION MARKS	2 MANUFACTURER AND MODEL	3 AIRCRAFT SERIAL NUMBER	4 CATEGORY
N12345	Boeing 747-400	197142	Transport

5 AUTHORITY AND BASIS FOR ISSUE
This airworthiness certificate is issued pursuant to the Federal Aviation Act of 1958 and certifies that as of the date of issuance, the aircraft to which issued has been inspected and found to conform to the type certificate, therefor, to be in condition for safe operation, and has been shown to meet the requirements of the applicable comprehensive and detailed airworthiness code as provided by Annex 8 to the Convention on International Civil Aviation, except as noted herein:

EXEMPTION NO. 1013A FAR 25.471(b): Allows lateral displacement of C.G. from airplane centerline.

6. TERMS AND CONDITIONS
Unless sooner surrendered, suspended, revoked, or a termination date is otherwise established by the Administrator, this airworthiness certificate is effective as long as the maintenance, preventive maintenance, and alterations are performed in accordance with Parts 21, 43, and 91 of the Federal Aviation Regulations, as appropriate, and the aircraft is registered in the United States.

DATE OF ISSUANCE	FAA REPRESENTATIVE	DESIGNATION NUMBER
11/29/92	John Q. Publican John Q. Publican	DMIR ANM 1234

Any alteration, reproduction, or misuse of this certificate may be punishable by a fine not exceeding $1,000, or imprisonment not exceeding 3 years, or both. THIS CERTIFICATE MUST BE DISPLAYED IN THE AIRCRAFT IN ACCORDANCE WITH APPLICABLE FEDERAL AVIATION REGULATIONS.

FAA Form 8100-2

Figure 4-5 FAA airworthiness certificate (sample).

Fig – 5 - FAA airworthiness certificate (sample)

➢ Delivery Inspection

- Prior to delivery to a customer, the aircraft usually undergoes an inspection by that customer to ensure that the vehicle has been built to the customer's specifications and requirements.
- This includes basic design, options, and customer-furnished equipment (if any), down to the shape, color, and positioning of the airline logo.
- This inspection by the operator may be cursory or detailed and often includes a test flight by their own flight and cabin crews. Any discrepancies found should be corrected by the manufacturer before delivery is taken. Commercial carriers will often fly the aircraft "around the flag pole" at the builder's delivery center to perform this checkout. Some may take the aircraft on a

"shakedown flight" from the delivery center to the carrier's home base. Once the customer accepts the aircraft from the manufacturer, that customer is fully responsible for maintaining the unit in airworthy condition in accordance with its own maintenance program and regulatory authority rules.

Operator Certification

- An operator cannot just buy an aircraft and enter into commercial service simply by getting a license and petitioning the market for customers. In aviation, for a prospective operator to enter the business, he or she must meet the requirements of both the Department of Commerce, with respect to the business aspects of airline operation, and the Department of Transportation (DOT), primarily the FAA, with respect to the technical aspects. In short, the prospective operator must provide the necessary information to ensure that he or she understands the business of commercial aviation; understands the operational and maintenance aspects of commercial aviation operation; and has the necessary people, facilities, and processes in place needed to carry out that business.
- The secretary of the DOT issues a "certificate of public convenience and necessity" authorizing the recipient to enter into commercial transportation. The secretary determines that the applicant is "fit, willing, and able" to perform the service.
- An operating certificate (OC) is then issued by the Flight Standards District Office (FSDO) of the FAA to the airline company. This certificate authorizes the carrier to operate scheduled air transportation service under the Federal Aviation Act of 1958 as amended. The operating certificate is not transferable to another operator.
- The OC remains in effect indefinitely unless it is surrendered by the operator, superseded by another certificate, or revoked by the FAA. The OC states, in part, that the airline is authorized to operate in accordance with the Federal Aviation Act and its rules and regulations, and "the terms, conditions, and limitations contained in the operations specification."
- In part, the Federal Aviation Act of 1958 requires the airline to develop an operations specifications document (Ops Specs) for each type of aircraft to be operated in commercial service.
- The Ops Specs is a parent document; i.e., in addition to specific information listed in the document, it may identify other airline documents, by reference, that fully describes certain airline operations that apply to the model.
- The Ops Specs outlines such operational activities as (*a*) the type of service to be offered, passenger, cargo, or combination; (*b*) the type of aircraft to be used; (*c*) the routes to be flown; (*d*) the airports and alternate airports that will be used; (*e*) the navigation and communications facilities to be utilized on each route; (*f*) the way points used in navigation; and (*g*) the takeoff and approach routes, including any alternate approach routes, at each airport.
- The Ops Specs must also identify the maintenance and inspection program applicable to the model, including the scheduled and unscheduled maintenance programs; the inspection program; and the engine and equipment repair pro-gram (off-aircraft maintenance).

- Other aspects of maintenance, such as the quality assurance and reliability programs, will also be defined. If any portion of the aircraft or systems maintenance is performed by a third party, that agreement must also be addressed in the Ops Specs.
- The operations specifications document is a detailed document and is put together by the principal maintenance inspector (PMI) assigned to the airline by the FAA and by the airline personnel. It is tailored to each operation.

➢ Certification of Personnel

- The minimum requirements for airline operations under part 121 state that the airline must have sufficient full-time qualified management and technical personnel to ensure a high degree of safety in its operations.
- The basic personnel requirements are a director of safety; a director of operations, a director of maintenance, a chief pilot, and a chief inspector. This is only a suggestion, how-ever. The FAA goes on to say that they may approve any other number of positions and any other titles as long as the operator can show that it can perform the operation safely. The people in such positions must have the necessary "training, experience, and expertise" for conducting the business of aviation and must be knowledgeable of the regulatory and airline policies and procedures as they relate to their specific jobs. The airline identifies the "duties, responsibilities, and authority" of these management personnel.

Aviation Maintenance Certifications

- Training begins with someone who is interested in becoming an aircraft maintenance technician. This normally starts in high school. Some high schools have contracts with aviation maintenance training schools that allow student to take classes and graduate with Airframe and Power Plant (A&P) licenses concurrent with their high school graduation.
- Federal Aviation Regulation 119.65 (a), (b).
- Federal Aviation Regulation 119.65 (c), (d).
- Federal Aviation Regulation 119.65 (e).

- The aviation maintenance training schools must train all individuals and certify them in accordance with FAA regulations. To earn an A&P license, aviation schools must fulfill three requirements, which are the bare minimum, prior to taking the FAA's A&P exam. The Avionics/FCC license course is optional.
- General aviation course
- Airframe course
- Power plant course
- Avionics/FCC license course

➢ Aviation Industry Interaction

- The aviation industry is made up of aircraft manufacturers; manufacturers and vendors of parts, systems, and accessories for the aircraft; airline operators; third-party maintenance organizations; trade associations, such as the Air Transport Association of America (ATA) and the International Air Transport Association (IATA); flight crew, cabin crew, and mechanics' unions; and regula-tory authorities.

- This integrated group of professionals is constantly working together to develop and improve aviation both technically and operationally. This is somewhat unique compared to other transport modes. This continuous quality improvement (CQI) concept was in effect in the commercial aviation field long before it became standard procedure in other industries.

Documentation for Maintenance

- The documentation for maintenance is required by the FAA.
- Advisory Circular AC 120-16E, Air Carrier Maintenance Programs, refers to the air carrier maintenance manual system, maintenance record/documentation keeping system, and various other requirements.
- The aircraft documentation system can be defined as "cradle to grave." When the aircraft is built, the documentation starts, and throughout its service life the documentation is gathered in the form of maintenance performed log pages, Engineering Order (EOs), Airworthiness Directive (ADs), Service Bulletins (SBs), Fleet Campaign Directives (FCDs), records of any minor or major repairs, and phase checks.
- When an aircraft is sold, decommissioned, and retired, all the paperwork must follow the aircraft.
- The main focus of this topic is to understand documentation that identifies an aircraft, its systems, and the necessary work to repair and maintain them.
- Some of the documents will be customized for the operator by the aircraft manufacture vendor to the manufacturer, while others will be generic.
- Most of these documents have standard revision cycles, and changes are distributed on a regular basis by the airframe manufacturer.
- Controlled documents are used in operation and /or maintenance of the aircraft in accordance with the FAA regulations.
- These types of documents have limited distribution within the airline and require regular revision with a list of revisions and active and rescinded page numbers.
- The operator is required to use only up-to-date documents. The written information is provided by the airframe manufacturer and the manufacturer of the systems and equipment installed on the aircraft.
- The documents provided by the regulatory authority and the documentation written by the airline itself detail the individual maintenance processes.
- We will be discussing the following documentation:

1) Manufacturer's documentation
2) Regulatory documentation
3) Airline-generated documentation
4) ATA document standard

➢ Manufacturer's Documentation

- Table below indicates the documents provided to an operator by the airframe manufacturer for the maintenance of the aircraft.
- The form and content of the documents sometimes varies from one manufacturer to another. The table identifies, basically, the type of information the airframe manufacturer makes available to its customers.
- Some of the documents can be customized for the airline or operator to only include configuration and equipment. These are called customized documents by the manufacturer and are noted at the bottom of Table below.

- **Manufacturer's Documentation**

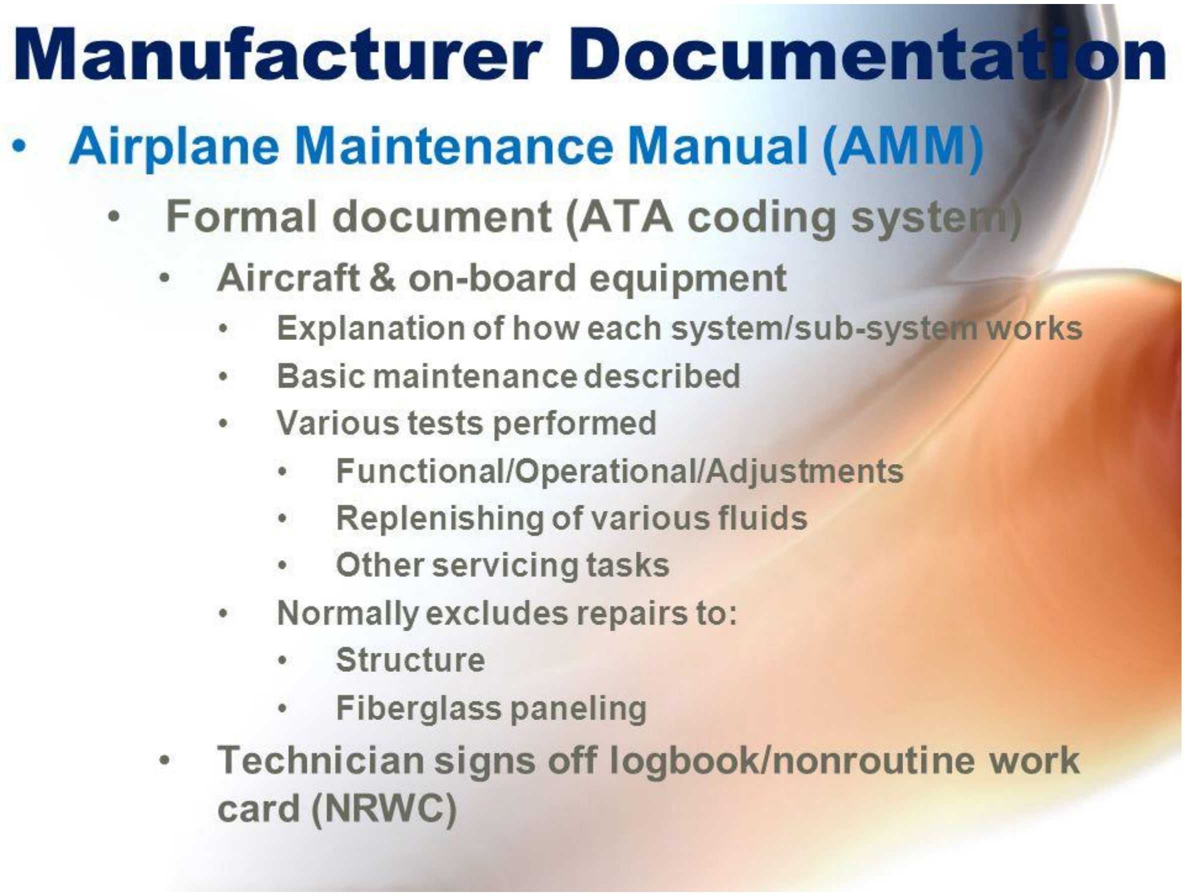
Title	Abbreviation
Airplane maintenance manual*	AMM
Component location manual	CLM
Component maintenance manual	CMM
Vendor manuals	VM
Fault isolation manual*	FIM
Illustrated parts catalog†	IPC
Storage and recovery document‡	SRD
Structural repair manual	SRM
Maintenance planning data document	MPD
Schematic diagram manual*	SDM
Wiring diagram manual*	WDM
Master minimum equipment list	MMEL
Dispatch deviation guide	DDG
Configuration deviation list	CDL
Task cards*	TC
Service bulletins	SBs
Service letters	SLs

*Customized to contain customer configuration.
†Customized on request.
‡Information may be included in AMM for recent model aircraft.

- Other maintenance documents that normally accompany aircraft manufacturer documents are the vendor documents.
- These documents contain engine manufacturer, flight crew seats, passenger seats, aircraft galley manuals, and other suppliers' component repair manuals.

Airplane maintenance manual

- The airplane maintenance manual (AMM) is a formal document containing all the basic information on the operation and maintenance of the aircraft and its on-board equipment. It starts with an explanation of how each system and sub-system works (detailing description and operation) and describes such basic maintenance and serving actions as removal and installation of LRUs and various tests performed on the system and equipment, such as functional test, operational check, adjustments, the replenishing of various fluids, and other servicing tasks.
- The AMM normally excludes any type of repair which may include structures or fiberglass paneling. The AMM uses the ATA coding system. Upon completion of a discrepancy or maintenance task, a technician signs off the log book or non routine work card (NRWC) using the AMM reference associated with the ATA chapter and subchapter system.



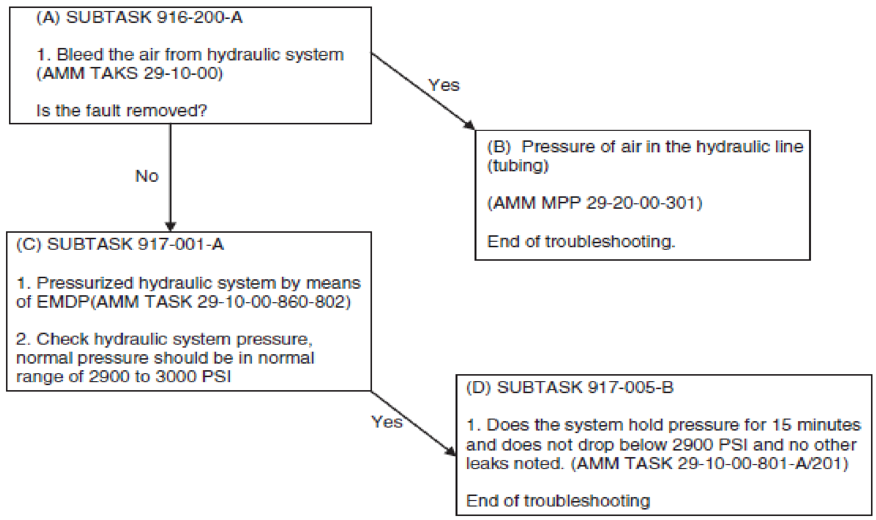
Component and vendor manuals

- Any component built by the airframe manufacturer will be accompanied by a component maintenance manual (CMM) written by the manufacturer.
- Normally, the aircraft manufacturers make the aircraft, while other systems, such as engines, landing gears, flight crew seats, and passenger seats, are purchased from outside vendors, but when the aircraft manufacturer sells the aircraft, the other vendors' CMMs accompany these items, in case parts need to be repaired or replaced.
- The CMM shows the breakdown of all components that make a complete part. The components installed on the aircraft are chosen by the airlines and are installed during or after the aircraft is completed.

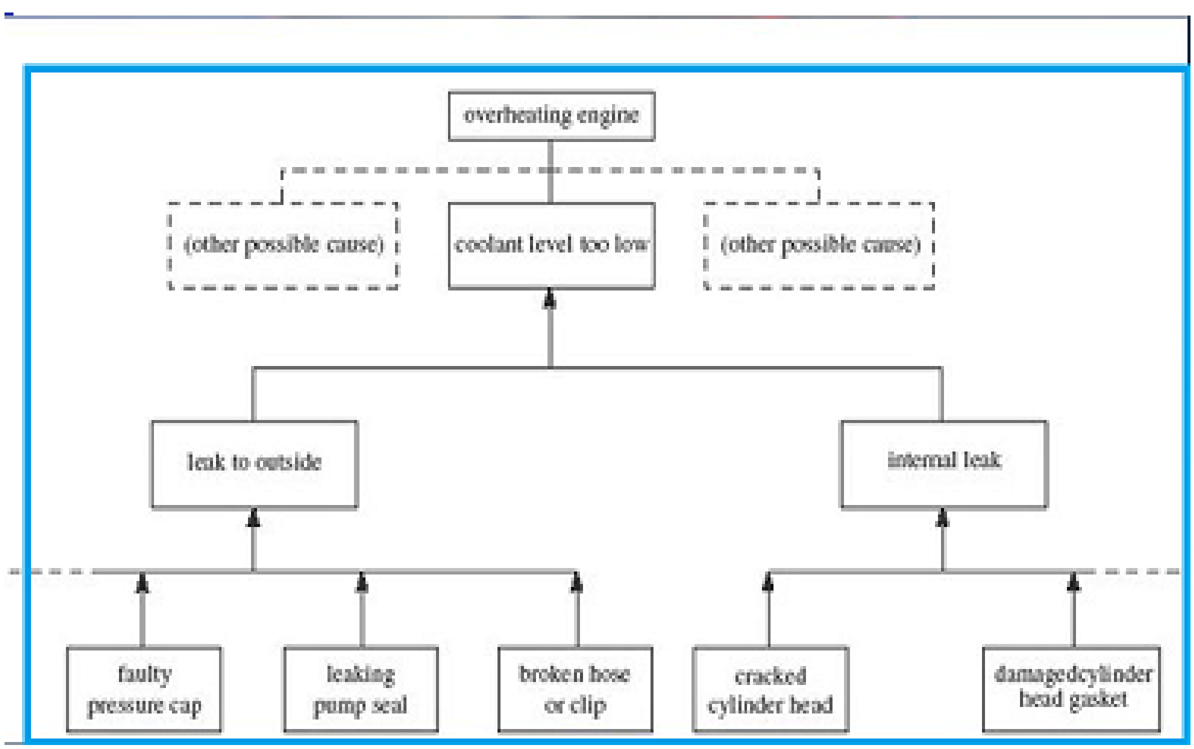
Fault isolation manual (FIM)

- The FIM contains a set of fault isolation trees provided by the aircraft manufacturer to help troubleshoot, isolate the section where the fault occurred, and identify and pinpoint problems related to various systems and components on the aircraft.

- The aircraft faults system normally shows the fault occurrence at the flight deck on the engine-indicating and crew-alerting system (EICAS) message screen. The EICAS shows faults in a yellow/amber color, which alerts the flight crew that a fault has occurred.
-



Example of FIM



- The FIM is a block diagram that provides a reference to AMM tasks and sub-tasks. At the end of each task, it will ask, “Is the fault removed?” The AMT must follow the subsequent arrows indicating Yes or No to further troubleshoot. If no further maintenance is required, the discrepancy has been resolved and no further action needs to be taken. The flow diagram is designed to locate many but not all problems within the various systems.

Component location manual (CLM)

- The CLM provides the location of all the major equipment items of the aircraft. Normally, AMTs know how to locate a component when replacing it, but the CLM is a great tool for finding the part number of the component and its location as well.
- The CLM works with four different sections within the manufacturer’s manual system: (1) ATA coding system, (2) fin number system, (3) illustrated parts catalog (IPC) system, and (4) item location figures.
- The ATA system is used to find or locate the item with the ATA chapters.
- The fin number works with the illustrated parts catalog (IPC) system with item location in an alphanumeric system. This is a great tool for helping avionics technicians to find relays and other hidden items; just type in the fin number and part name, and the number and manual reference is displayed.
- The fourth item is the location figure, where each zone of the aircraft is highlighted upon selection. This presents an overview of the entire zone, including the components’ pictures and part num-bers with their respective locations.

Illustrated parts catalog (IPC)

- The IPC is produced by the airframe manufacturer and includes list and location diagrams of all parts used on the aircraft. This includes all parts for all systems and is usually not customized to the airline’s configuration. However, when the aircraft is customized it will show parts by figure, part number, and item number with aircraft applicability.
- Every aircraft is given a serial number, along with an aircraft registration number, which is used in the IPC for affectivity reason when searching for a part by using the ATA chapters.
- The IPC shows assemblies, subassemblies, alternate part numbers, and part inter-changeability along with any modifications if performed on parts by the service bulletin, the IPC will show these parts as pre- or post modification.

Storage and recovery document (SRD)

- The SRD contains information needed to address maintenance and servicing of aircraft that are to be out of service and stored for long periods of time.
- This includes the procedures for draining certain fluids, moving the aircraft so that tires will not go flat, and protecting components from the weather. In the older model aircraft, this document was produced separately by the airframe manufacturer.
- For more recently manufactured aircraft, this information is included in the applicable AMM.

Structural repair manual (SRM)

- The SRM is an airframe-specific manual that provides the aircraft operator with information regarding aircraft skin and other specific tolerances and procedures in the event of minor structural damage.

- The SRM gives the acceptable dimensions and limits of damage to the aircraft structure so the
- operator knows when the damage should be fixed.
- For example, when an aircraft incurs damage such as a dent, usually the dent is measured in by its depth and in relation to its surrounding area to make sure there is no damage to the ribs area and to check for any evidence of a crack. The operator then looks into the SRM for the area where the dent is located on the aircraft to see if it will be a minor or a major repair. The SRM provides the damage tolerance which will determine if the aircraft can fly with a minor dent that can be repaired later. The SRM will also indicate the number of hours the aircraft can fly with the dent.
- There are some damages beyond SRM limits, and the maintenance department will have to contact engineering in order for specific repair schemes to be issued. If the damages are beyond SRM limits, the airline engineering department is in contact with the aircraft manufacturer's engineers. The repair is usually done by using an engineering order (EO) that will guide the aircraft maintenance department and inspection department on how to repair and sign off, bringing the aircraft back to an airworthy condition.

Maintenance planning data document (MPD)

- This document (called the on aircraft maintenance program by McDonnell-Douglas) provides the airline operator with a list of maintenance and servicing tasks to be performed on the aircraft.
- It contains all items of the MRB report along with other information.
- Some of these tasks are identified as certification maintenance requirements (CMRs) and are required by the FAA in order to maintain certification of the aircraft.
- All other tasks, which were developed by the MSG process, are included along with other tasks recommended by the manufacturer.
- The tasks are divided into various groupings for older aircraft models—daily, transit, letter checks, hourly limits, and cycle limits—and are used for planning purposes by the airline.
- Later models do not group the tasks by letter checks, only by hours, cycles, and calendar time.

Schematic diagram manual (SDM)

- The SDM contains schematic diagrams of electrical, electronic, and hydraulic systems on the aircraft, as well as logic diagrams for applicable systems. The diagrams in the AMM and other manuals are usually simplified diagrams to aid in describing the system and assist in troubleshooting.
- The schematic manual, however, contains the detailed information and identifies wiring harnesses, connectors, and interfacing equipment.

Wiring diagram manual (WDM)

- The WDM is an essential tool for troubleshooting.
- The WDM provides information on the wiring runs for all systems and components containing such elements.
- Due to the complexity of the modern aircraft and its electrical system, such control devices as gauges and sensors provide and relay information to the flight deck in a complicated network of wiring runs like a network system.
- The WDM shows the wire routing from the aircraft's nose to tail and from other sections to different connectors, on-board sensors, and control devices. Normally wires that are routed in bundles from the airframe side of the aircraft are also shown in the WDM.

- The wiring harness is a type of wiring bundle as well, but when referring to the wiring harness, we usually are referring to the power side of the air-craft. The wiring harness normally is connected to a fire wall, which is a connection point from the engine wire harness to the aircraft airframe system
- Aircraft wires are normally made from standard copper, and in some cases they are coated with different alloys to prevent corrosion. Due to the large amount of current required for carrying
- longer distances, aluminum wire is frequently used. Normally it is insulated by a fiberglass braid.
- Aircraft wire is measured in the American Wire Gauge (AWG) system, which has been in use since the late 1850s. In the AWG system, the largest number represents the smallest wire. The following is an example of the AWG system found in the WDM:

***** K15B-25 *****

K → Alphabet letter—System in which a wire is being used

15 → Two-digit number—Individual wire number

B → Alphabet letter—Wire segment/section of wire power source

25 → Two-digit number—Wire size (AWG size)

Master minimum equipment list (MMEL)

- The MMEL is issued by the airframe manufacturer and developed by the manufacturer's flight engineering group. Prior to issuing the MMEL, the aircraft manufacturer submits a proposed master minimum equipment list (PMMEL) to the type certificate office of the aircraft manufacturing country (in the United States, FAA Flight Operation Evaluation Board). Once it is approved by the authority it becomes an MMEL.
- The MMEL is used to identify the equipment that may be degraded or inoperative at the dispatch time of the aircraft. These are the systems that the flight crew, under certain circumstances, may agree to accept at dispatch in degraded or inoperative condition, provided the system is fixed within the prescribed time limit set by the MMEL.

Dispatch deviation guide (DDG)

- Some of the MMEL items that are inoperative or degraded at dispatch require maintenance action prior to the deferral and dispatch. This may be the need to pull and placard certain circuit breakers, disconnect power, tie up loose cables for removed equipment, and various other actions to secure the aircraft and the system against inadvertent operation. The instructions necessary for these actions are provided in the DDG. This guide is written by the manufacturer's AMM staff and is coordinated with the MMEL.

Configuration deviation list (CDL)

- The CDL is similar to the DDG but involves configuration of the aircraft rather than the aircraft's system and equipment.
- The CDL identifies any external part of an aircraft's panels, gear doors, flap hinge fairings, cargo doors, and all door indication and warning systems.
- These items could have been inoperative, cracked, broken, or missing. Normally, these items are discovered during the line checks or at pre- or post flight checks of the day. The CDL items do not affect the airworthiness and safety of the aircraft, and scheduled flight operation can be resumed.

Nonessential equipment and furnishing (NEF) items

- The NEF contains the most commonly deferred items, such as paneling (flight deck, cabin), cup holders, missing paint off panel in flight deck or cabin area— cosmetic items which could be broken, cracked, chipped, or missing.
- NEF items are located throughout the aircraft and do not affect the safety or airworthiness of the aircraft.

Task cards (TC)

- Certain tasks in the AMM for removal/installation, testing, servicing, and similar maintenance items are extracted from the AMM and produced on separate cards or sheets so that the mechanic can perform the action without carrying the entire maintenance manual to the aircraft. These task cards can be used "as is" or they can be modified by the operator for reasons discussed in the section Airline-Generated Documentation.

Service bulletins, service letters, and maintenance tips

- Whenever the airframe manufacturer or the engine manufacturer has modifications or suggestions for improving maintenance and/or servicing, they issue appropriate paperwork to the affected airlines.
- A service bulletin (SB) is usually a modification of a system that will provide improved safety or operation of a system and includes a detailed description of the work and parts required.
- An SB is usually optional and the airline makes the choice, except in certain cases involving an FAA airworthiness directive (AD) discussed below in Regulatory Documentation.

- A service letter (SL) usually provides information to improve maintenance actions without equipment modification. The maintenance tip is a suggestion for maintenance personnel to assist in their work or improve conditions.

Regulatory Documentation

- The FAA issues numerous documents related to maintenance of aircraft and their systems. Table lists the more significant of these documents.

Title	Abbreviation
Federal aviation regulations	FARs
Advisory circulars	ACs
Airworthiness directives	ADs
Notice of proposed rule making	NPRM

Regulatory Documents

Federal aviation regulations (FARs)

- In the United States, Federal laws are collected into a document known as the code of federal regulations or CFRs.
- Those laws related to commercial aviation are under title 14 of this code, aeronautics and space, parts 1 through 200.
- The regulations relating to certification and operation of large, commercial aircraft— part 121— would be noted as 14 CFR 121. We usually refer to this as FAR part 121. we will use the FAR terminology and form since it is so common in the industry.
- These FARs address all aspects of the aviation field, including private, commercial, and experimental aircraft; airports; navigational aids; air traffic control; training of pilots, controllers, mechanics, etc.; and other related activities.

Advisory circulars (ACs)

- An advisory circular is a document issued by the FAA to provide assistance to operators on meeting the requirements of various FARs.
- These ACs are not binding as law but are merely suggestions as to how to comply with other requirements.
- An AC often states that it is “a means, but not the only means” of complying with a regulation. The FAA allows some leeway in how its regulations are met in order to achieve the desired results without trying to micromanage the operator.

Airworthiness directives (ADs)

- The airworthiness directives are substantial regulations issued by the FAA to correct an unsafe condition that exists in a product (aircraft, aircraft engine, propeller, or appliance) and a condition that is likely to exist or develop in other, similar products.
- An AD, whose incorporation is mandatory, may be issued initially by the FAA when an unsafe condition is noted or it may result from FAA action after the airframe manufacturer has issued a service bulletin (SB) relative to some noted problem.
- Incorporation of an SB is optional but, if it is made into an AD by the FAA, incorporation becomes a mandatory requirement.
- Aircraft owners or operators are required to maintain the aircraft in compliance with all ADs.
- Typically, an AD will include (*a*) a description of the unsafe condition; (*b*) the product to which the AD applies; (*c*) the corrective action required; (*d*) date of compliance; (*e*) where to get additional information; and (*f*) information on alternative methods of compliance if applicable.

Notice of proposed rulemaking (NPRM)

- The NPRM is an FAA process that indicates the intent to change or amend an existing Federal Aviation Regulation (FAR).
- This provides an advance notice and invites public comment on proposed rules, which includes holding public hearings or specific activities, rendering a decision, and issuing a new rule, directive, or requirement in the form of an FAR.

➢ Airline-Generated Documentation

- Table lists the documentation that the airline will generate in order to carry out its maintenance activities.
- Again, these documents may vary in name and actual content from one operator to another, but the information identified here must be addressed by airline documentation.

Title	Abbreviation
Operations specifications	Ops Specs
Technical policies and procedures manual	TPPM
Inspection manual	IM
Reliability program manual	RPM
Minimum equipment list	MEL
Task cards*	TC
Engineering orders†	EOs

*May be manufacturer written, customer written, or a combination.
†Issued for maintenance not identified in standard maintenance plan.

Airline-Generated Documentation

Operations specifications

- The operations specifications (Ops Specs) document has been discussed as an FAA requirement for airline certification.
- It is written by the air-line in accordance with strict FAA requirements and usually with the help of an FAA representative.
- The Ops Specs is required for each aircraft type flown by the airline.
- It is a parent document, which refers to numerous other documents to avoid duplication and details the airline's maintenance, inspection, and operations programs.

Technical policies and procedures manual (TPPM)

- The TPPM is the primary document for the airline's M&E operation and, with other documents supplied by the airframe manufacturer, serves as the FAA requirement for a maintenance manual per AC 120-16E.
- It is usually written by engineering, to ensure technical accuracy, from inputs supplied by management of the various M&E organizations.
- It should define exactly how all M&E functions and activities will be carried out. The TPPM is a detailed document and may be several volumes. Personnel in all units of M&E must be trained on the TPPM, especially those parts that relate directly to that unit's operation, so that the operation will go smoothly.

Inspection manual (IM)

- The IM may be a separate document distributed primarily to QC personnel, Contents of the IM relate to all inspection activities within M&E: (*a*) mechanic inspection tasks from the MPD/OAMP or the MRB report; (*b*) QC inspector's tasks; (*c*) special inspections (hard landings, bird strikes, etc.); (*d*) the airline's required inspection item (RII) program; and (*e*) the paperwork, forms, and reports required to carry out these functions.
- Some IMs may indicate details on the calibration of tools and test equipment, since these are QC functions, or these may be in a separate chapter of the TPPM.

Quality assurance (QA) manual

- The QA manual could be a special manual for QA auditors only, it could be part of the inspection manual, or it could be a separate chapter in the TPPM as desired.
- The QA manual defines the duties and responsibilities of the QA organization and defines the processes and procedures used in the annual quality assurance audits conducted on the M&E units, suppliers, and outside contractors. Forms used and reports are also covered along with the procedures for follow-up and enforcement of QA write-ups.

Reliability program manual

- An airline's reliability program, under FAA rules, must be approved by the regulatory authority, so it is usually published as a separate document. This document defines the reliability program in detail so that the FAA can evaluate and approve all its elements at one time.

Minimum equipment list (MEL)

- The MMEL provided by the aircraft airframe manufacturer includes all equipment and aircraft configuration information available for the model to which it applies.
- The airlines pick and choose from the MMEL system the type of MEL they would rather have due to specifications, weight variants, options installed, software and hardware upgrades, retrofit status, engines, and airframe configuration, which later in the airline's version becomes an MEL. The MEL cannot be less restrictive than the MMEL.

  MEL categories may vary from operator to operator. There are four MEL categories:

  - Category A MEL is normally 1 to 2 days, unless specified for such MEL where it could be a 1-day flight MEL, depending on the restrictions.
  - Category B MEL is normally issued for 3 consecutive calendar days.
  - Category C MELs shall be repaired within 10 days.
  - Category D MEL items must be replaced in 120 calendar days. This is a part that is normally considered for replacement.

Task cards

- The task cards produced by the airframe manufacturer are usually for one action only.
- These procedures may call for the mechanic to open panels set certain circuit breakers "in" or "out," turn other equipment "on" or "off," etc., prior to the work and to reverse these processes at the completion.
- Much of the work done at an airline during an aircraft check, however, involves the combination of several tasks to be performed by the same mechanic or crew within the same area or on the same equipment.
- To avoid unnecessary duplication of certain actions, and the unnecessary opening and closing of the same panels, etc., most airlines write their own task cards to spell out exactly what to do, using the manufacturer's cards as a guide. This eliminates the duplicated or wasted efforts.

Engineering orders (EO)

- Any maintenance work not covered in the standard maintenance plan developed by engineering from the MRB report or Ops Specs data must be made official by the issuance of an EO.
- This is official paper work, issued by engineering and approved by QA, and is usually implemented through the production planning and control (PP&C) organization. In some airlines, the document may be called simply a work order.

➢ ATA Document Standards

- Line maintenance people for most airlines, especially those doing contract maintenance for other carriers, will have the opportunity to work on a wide variety of aircraft during the course of their shift or work week. Since aircraft manufacturers are independent, they each (in the past) had their own way of doing things.
- To reduce confusion on the line, the ATA stepped in and standardized the overall format of the maintenance manuals so that all manufacturers' documents would be more compatible. ATA codes are designed to help understand different systems or system types on aircraft and their subsystems and are assigned a chapter number.
- Table below shows the chapter assignment as per ATA standard.

ATA	Subject	ATA	Subject
5	Time limits, maintenance checks	37	Vacuum
6	Dimensions and access panels	38	Water/waste
7	Lifting and shoring	45	Central maintenance system
8	Leveling and weighing	49	Airborne auxiliary power
9	Towing and taxiing	51	Standard practices and structures—general
10	Parking, mooring, storage, and return to service	52	Doors
11	Placards and markings	53	Fuselage
12	Servicing	54	Nacelles/pylons
20	Standard practices—airframe	55	Stabilizers
21	Air conditioning	56	Windows
22	Auto flight	57	Wings
23	Communications	70	Standard practices—engines
24	Electrical power	71	Power plant (package)
25	Equipment/furnishings	72	Engine (internals)
26	Fire protection	73	Engine fuel control
27	Flight controls	74	Ignition
28	Fuel	75	Air
29	Hydraulic power	76	Engine controls
30	Ice and rain protection	77	Engine indicating
31	Indicating/recording system	78	Exhaust
32	Landing gear	79	Oil
33	Lights	80	Starting
34	Navigation	82	Water injection
35	Oxygen		
36	Pneumatic	91	Charts (miscellaneous)

ATA Standard Chapter Numbers

- These ATA coding systems are uniform for all models and types of aircraft, and all aircraft manufacturers use the same coding system.
- If there are any air-craft systems that require maintenance, such as the navigation system, an A&P technician or avionics technician will know that they can find such information in ATA of the aircraft maintenance manual
- The ATA codes are further broken down into three sets of two-digit numbers followed by a three-digit number.
- This identifies the chapter, subject, section, and page block, respectively.
- Figure below shows the structure of the number.

- The first two digits (ATA Chapter) are the same for all manufacturers and are used throughout the maintenance manual system.
- The second (section) and third (subject) groups may vary from one manufacturer to another and from one model aircraft to another of the same manufacturer because of differences in the structure of the systems to which they apply.
- The last group of digits (page block) is the same for all maintenance manuals.
- The page blocks refer to specific types of information contained in the air-plane maintenance manual.

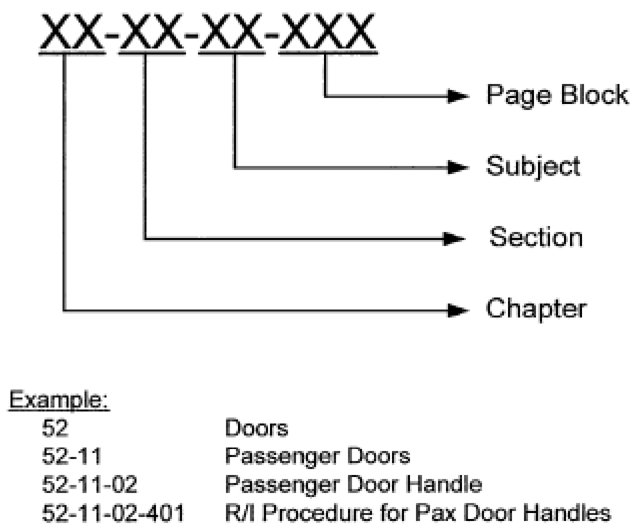


Fig - ATA format for maintenance manuals.

- The advantage of this system is quite apparent to a line maintenance mechanic who works on a Boeing 757, then a Douglas MD-80, an Airbus A320, and then a Lockheed L-1011 in the course of a single day.
- No matter what the aircraft, if a write-up concerns a hydraulic system component, the mechanic knows that any maintenance manual information he or she needs will be found in ATA.

Objectives of a maintenance program

- The five objectives of a maintenance program were discussed
- . In this topic , we will begin to outline a maintenance program that will address these five maintenance objectives.
- There are certain regulatory requirements that each airline must adhere to and certain additional necessary maintenance activities that airlines need to have in place to carry out their approved maintenance pro-gram requirements.
- The aircraft and aircraft systems are sophisticated, with miles of wires to chase, electromechanical valves, airframe systems, engines, auxiliary power units, hydraulic systems, and navigation systems, all of which require a well-trained professional technician with aircraft

systems knowledge, experience, and a keen mechanical ability to correct any kind of discrepancy according to the approved maintenance program.

- These mechanical tasks and maintenance programs require oversight and monitoring to make sure airlines and aircraft operators are carrying out them out effectively.

1. To ensure the realization of the inherent safety and reliability levels of the equipment
2. To restore safety and reliability to their inherent levels when deterioration has occurred
3. To obtain the information necessary for adjustment and optimization of the maintenance program when these inherent levels are not met
4. To obtain the information necessary for design improvement of those items whose inherent reliability proves inadequate
5. To accomplish these objectives at a minimum total cost, including the costs of maintenance and the cost of residual failures

Aviation Maintenance Program Outlined (AC 120-16E)

- The AC 120-16E is the type of information provided by the FAA to the aviation community. The FAA requires each commercial airline to have an operations specifications (Ops Specs) document authorizing maintenance program, the maintenance manuals required by FAA regulations, and their operational equip-ment as a commercial airliner. The AC requirement is under Title 14 of the Code of Federal Regulations (14 CFR), part 119, air carrier commercial operation under 14 CFR parts 121 and 135. This AC also applies to each individual employed or engaged in air carrier maintenance, preventive maintenance, or alteration of its aircraft.
- The following is an example of a maintenance AC 120-16E. It describes the scope and content of an air carrier aircraft maintenance program. It explains the background of these programs as well as the FAA regulatory requirements.

FAA AC 120-16E describes the elements listed below:

- Airworthiness responsibility
- Air carrier maintenance manual
- Air carrier maintenance organization
- Maintenance record keeping system
- Accomplishment and approval of maintenance and alterations
- Maintenance schedule
- Required inspection items (RII)
- Contract maintenance
- Personnel training
- Continuous analysis and surveillance system (CASS)

Summary of FAA Requirements

- The objectives of an airline maintenance program were stated in above as follows:

1. To ensure the realization of the inherent safety and reliability levels of the equipment
2. To restore safety and reliability to their inherent levels when deterioration has occurred
3. To obtain the information necessary for adjustment and optimization of the maintenance program when these inherent levels are not met
4. To obtain the information necessary for design improvement of those items whose inherent reliability proves inadequate
5. To accomplish these objectives at a minimum total cost, including the cost of maintenance and the cost of residual failures

- To meet these objectives, an organization must perform certain scheduled maintenance tasks (objective 1) to maintain the equipment capability.
- Unscheduled tasks are done whenever the equipment has deteriorated below acceptable standards or has completely failed (objective 2).
- Objective 3 requires that the opera-tor have some sort of data collection program in place to monitor reliability levels of the equipment and investigate problem areas to effect maintenance program improvement when applicable.
- Objective 3 can also address deficiencies in the management and administrative aspects of the maintenance program.
- Objective 4 requires that the operator initiate action to effect redesign if reliability standards cannot be met and this deficiency is not attributed to the operator's maintenance program.
- Objective 5 indicates that the maintenance program should be a direct asset to the organization in that the operator does not waste time, money, or manpower performing unnecessary or ineffective maintenance but performs only that maintenance which is necessary and performs it in a timely manner.
- To accomplish the above objectives, the programs and processes required by the FAA as described above must be put into place.
- An effective maintenance pro-gram is developed for the equipment and systems based on the best knowledge and ability of the manufacturers' and the industry's representatives. This maintenance program is then employed by the operator in an effort to maintain the equipment in top operating condition. Through the collection and analysis of performance data during actual operation, and through monitoring the effects of maintenance within the operator's own environment, the maintenance program can be tweaked and adjusted, as necessary, to optimize the entire set of processes.

- This results in an optimized maintenance program that not only satisfies objective 5 but also allows the operator to meet objectives 1, 2, 3, and 4.

Additional Maintenance Program Requirements

- In addition to the maintenance program elements described in the previous sections, there are a number of other activities needed to carry out an effective maintenance and engineering program.
- The basic structure of the organization discussed here may not be adequate for all maintenance organizations.
- Some organizations may need to expand or combine activities, out of necessity, as dictated by the size of the specific operation.
- The important thing to remember is that, regardless of the organizational arrangement, these functions are necessary to carry out an effective and efficient maintenance and engineering program. These additional activities and their implementing organizations are generally called engineering, material, planning, maintenance control, training, computing, and publications.
- We will discuss each of these in subsequent sections.

Engineering

- The primary purpose of the engineering section of the maintenance organization is to establish the initial maintenance program from the manufacturer's maintenance manual and other documents and to continually upgrade the program over time.
- Engineering will also provide technical assistance in troubleshooting equipment problems; develop workable maintenance processes and procedures when required; review manufacturer's service bulletins and other maintenance tips, changes, or suggestions; and provide engineering expertise to the company or its hired consultants in designing and modifying the maintenance facilities (i.e., hangars, shop, ramps, etc.).

Material

- The function of the material section is to provide the maintenance organization with parts and supplies necessary to carry out the maintenance activities.
- This would include the purchase and warehousing of the necessary spare parts, supplies, and tools for the maintenance activities; issuance of parts to mechanics as needed; handling of warranty claims on parts, equipment, and tools; and passing repairable components to the appropriate workshop or vendor for repair.

Planning

- The planning section is responsible for planning all of the scheduled maintenance activities, including the manpower, facilities, and supplies needed for these activities.

- Planning also collects data on the time, manpower, and facilities actually used in the performance of the maintenance to accurately readjust these requirements for use with subsequent maintenance planning activities.

Maintenance control center

- The maintenance control center (MCC), sometimes called the maintenance operations control center (MOCC), is the nerve center of the line maintenance organization; it is responsible for keeping track of all vehicles in operation.
- Vehicle location, maintenance and servicing needs and other requirements are monitored by the MCC during the operational phase of activity via telephone, radio, facsimile, and any other available means of communication.
- The MCC keeps track of the vehicles and coordinates with key units throughout the operations, maintenance, and engineering activities so that maintenance, when needed, can be coordinated and expedited to minimize delays and down time.
- The MCC locates and dispatches the necessary personnel within the company who can provide whatever maintenance, troubleshooting, or parts assistance that is needed to support the operational phase of the activity.
- Maintenance crews at outstations can coordinate maintenance actions, the borrowing or buying of parts locally, and even the contracting of temporary third-party maintenance personnel through the MCC at the home base.

Training

- Maintenance training is an ongoing process.
- Although maintenance mechanics receive initial training through certain formal training schools to qualify for the job, continual training is required to keep them current, to refresh their skills when necessary, and to develop new skills and learn new processes and proce-dures as these are developed.
- The training section can be part of the maintenance and engineering organization or it can be part of the airline's overall training pro-gram that also covers the non maintenance training requirements.

Computing

- The computing section provides the equipment, the software, the training, and the support for all computing activities within the maintenance and engineering organization. In some airlines this section may be included within the company's computer organization.
- It is recommended, however, that computer support for maintenance have dedicated personnel and that they work closely with, if not directly for, the maintenance and engineering organization.
- Various computer programs are available for maintenance activities, which include modules for data collection on malfunctions; for parts tracking and control; for collecting and manipulating

reliability data, such as failure rates, removal rates, and time limitations for parts, etc.; for tracking of serial numbered parts; and for numerous other traceable information needs for monitoring maintenance activities.

- All maintenance activities need to be coordinated and tracked and the maintenance computer systems should be under the control of people who know maintenance as well as computers.

Publications

- The publication section (or technical library) of the maintenance and engineering organization is responsible for keeping all technical publications up to date, whether they are on paper, microfilm, or electronic media.
- The publications section receives all publications and is responsible for distributing the documents or revisions (partial or complete) to the appropriate work centers. The work center personnel are responsible for inserting changes and disposing of obsolete pages, but technical publications personnel should spot check the work centers to see that this is being done.
- During the yearly audit of each unit, QA will check to see that all documents are up to date

➢ Organization of Maintenance and Engineering

- The structure for an effective maintenance and engineering organization will vary with the size and type of organization. It may also vary with the management philosophy of the company. But one thing must be kept in mind: the organizational structure must allow the company to meet its goals and objectives and each unit within the company must be endowed with sufficient personnel and authority to carry out those objectives and meet those goals.

- The following structure was determined, from experience and observation, to be the most efficient and effective one for a midsized commercial airline.
- For application to large or small airlines, this structure will have to be modified; but all of the functions identified here will have to exist separately or in combination to accomplish all of the functions and activities identified in Chap. 6 as essential for effective operation.

Organizational Structure

- The basic organizational structure for our midsized airline is shown in Fig. below.
- There are three basic concepts underlying the structure we have defined. Two of these come from traditional management thinking.
- These are the concepts of span of control and the grouping of similar functions.
- The third concept is some-what unique to aviation: the separation of production activities (maintenance and engineering) from the oversight functions of inspection, control, and monitoring (quality assurance, quality control, reliability, and safety).

Span of control

- The span of control concept may be considered passé to some, but it is still a useful concept. This concept states that a supervisor or manager can effectively
- supervise or control three to seven people. Any less than three would be ineffective use of time and manpower, and any more than seven would spread the boss too thin. In the organizational structure shown in Fig., we have adhered to this concept.

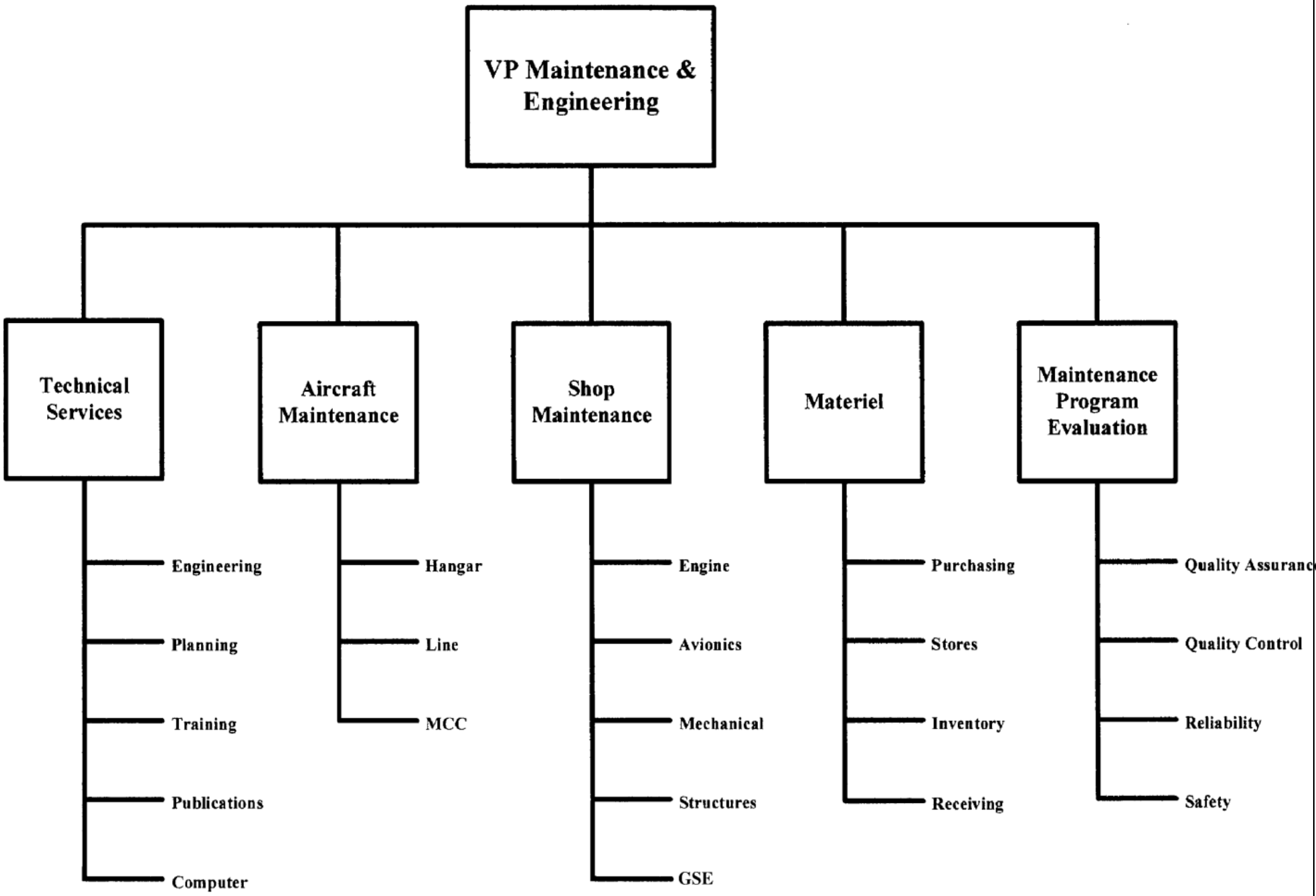
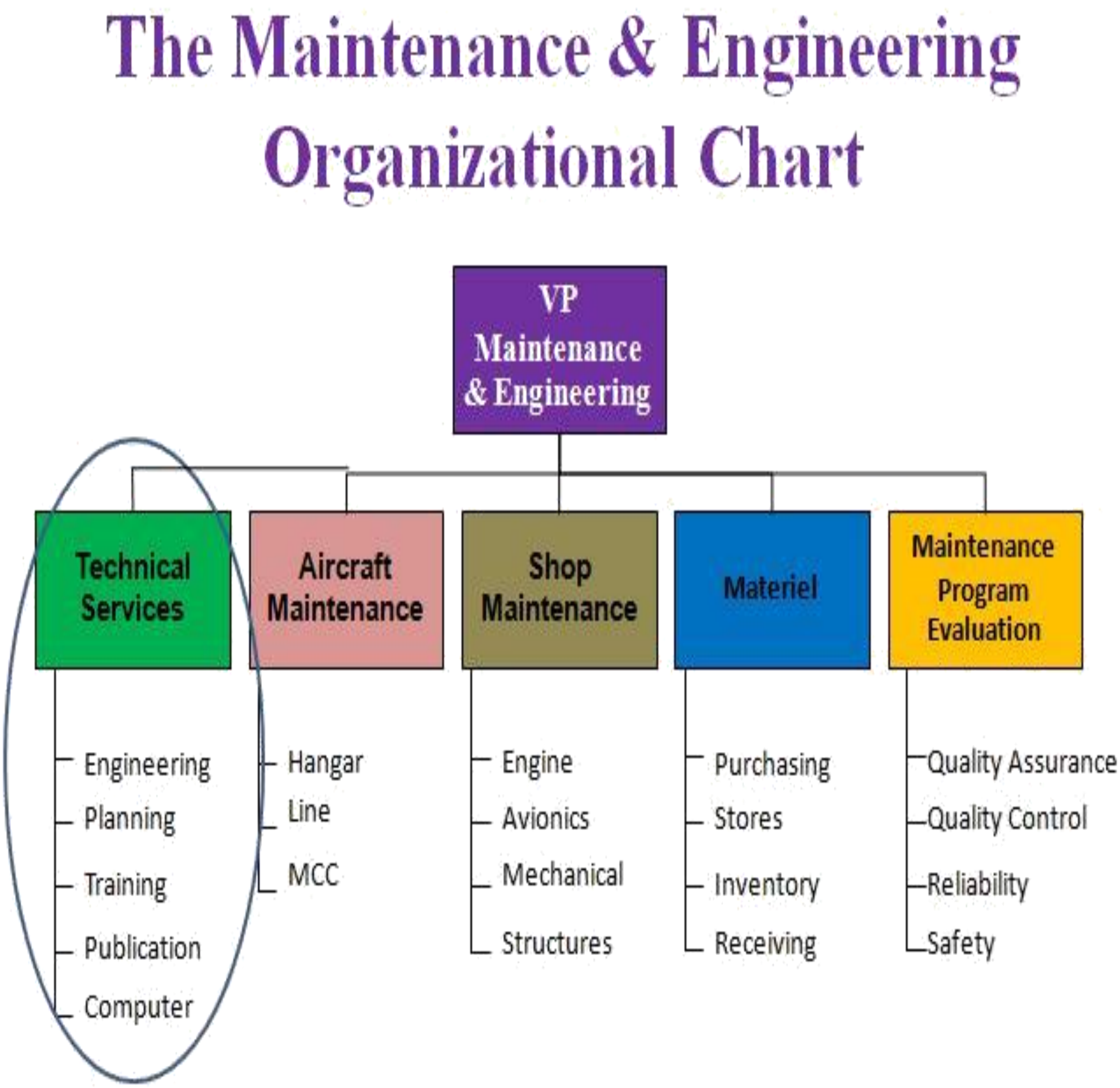


Fig - Typical maintenance and engineering organization.

- The VP of maintenance and engineering supervises five directors. Each director has the necessary number of managers under him or her to carry out the prescribed functions of the directorate. We find that by limiting the number of people that a manager has to supervise, the organization's work is divided into pieces that are more easily managed without losing the people-to-people contact that is so necessary for a happy and efficient work force.

➢ The M&E Organizational Chart



- Figure above is the basic organizational chart for the maintenance and engineering organization of our "typical" midsized airline.
- We will briefly discuss each layer and each function. T
- The structure starts with the VP level and continues downward with designations Director, Manager, and Supervisor as appropriate. Your organization may have other titles that their operatives prefer to use but the structure should be similar to Fig above.

General Groupings

Vice president of maintenance and engineering

- The head of the entire maintenance and engineering function within the airline should be at a relatively high level of the airline's structure. He or she should be directly under the head of the airline or under the head of the company's operational activity (President, Chief Operating Officer, or whatever title is used). The VP of M&E position should also be at the same level as the head of flight operations (VP Flight Ops or whatever he or she is called). Flight operations and maintenance are considered to be two sides of the same coin; they complement each other and carry equal weight.
- The flight operations department is responsible for conducting the air transportation operations; i.e., the flying. Maintenance and engineering, on the other hand, is responsible for delivering airworthy vehicles to the operations department to meet the flight schedule.
- The M&E department is responsible for con-ducting all scheduled maintenance, modification, etc. on the vehicles within the specified limits of the maintenance schedule and still meet the operations department's flight schedule. Without maintenance, flight operations would be quite limited in their activities; without flight operations, maintenance wouldn't have much purpose in maintaining the equipment. They need each other and the airline needs both.

Directors of major functions

- The five major functions shown in Fig. above are, in the order addressed in this topic , technical services (which includes engineering, planning, training, technical publications, and computing); aircraft maintenance (flight line, hangar, out-stations, and the maintenance control center); overhaul shops (for off-aircraft maintenance, repair, and overhaul); material services (responsible for ordering and maintaining supplies, handling warranties, and moving repairable and consumable parts through the system); and maintenance program evaluation (the monitoring activity for the organization, its workers and its suppliers).
- As you can see, there is more here than just maintenance and engineering. We will discuss each of these in more detail later.

Managers and supervisors

- Within each directorate, there are several managers. Each of these managers has a specialized area of responsibility within the overall scope of the directorate's function. Specific activities within each manager's area of responsibility require staffs of specialists with supervision by knowledgeable people.
- In some large organizations, the supervisor may need additional separation of activities or duties and appoint "leads" or "straw bosses" to decrease his span of control to a workable size. However, for most operators, the span of control can be much wider at this level.

➢ Manager Level Functions—Technical

Services Directorate

- The technical services directorate contains numerous activities and services that support the maintenance and inspection functions. In the typical setup of Fig. above, we have identified various activities for each directorate.
- Each activity is under the direction of a manager. There may be further echelons of management, such as supervisors and leads as necessary.
- The manager of engineering is responsible for all engineering functions within the M&E organization.
- This includes
- (*a*) The development of the initial maintenance program (tasks, intervals, schedules, blocking, etc.);
- (*b*) the evaluation of service bulletins (SBs) and service letters (SLs) for possible inclusion into the airline's equipment;
- (*c*) oversight of the incorporation of those SBs and SLs that they deem beneficial;
- (*d*) overseeing the incorporation of airworthiness directives (ADs), the modifications that are required by the regulatory authority;
- (*e*) the evaluation of maintenance problems determined by the reliability program and for problems (if any) resulting from the maintenance checks performed by maintenance; and
- (*f*) for establishing the policies and procedures for the M&E organization.
- The engineering department is also involved in the planning of facilities (new hangars, maintenance shops, storage facilities, buildings, etc.) for the airline, which are to be used by the M&E organization.
- Although engineering usually will not actually do the design and engineering work, they will work with the engineering consulting firm or contractor that has responsibility for the project to ensure that the final result meets the airline's requirements.

Production planning and control

- The manager of production planning and control (PP&C) is responsible for maintenance scheduling and planning.
- This function must plan and schedule the manpower, parts, facilities, tools, and any special assistance required for all maintenance or modification activities. Included in the functions of PP&C are the following: (*a*) all planning activities related to maintenance and engineering (short, medium, and long term); (*b*) the establishment of standards for man-hours, material, facilities, tools, and equipment; (*c*) work scheduling; (*d*) control of hangars; (*e*) on-airplane maintenance; and (*f*) monitoring of work progress in the support shops.

Training

- The manager of technical training is responsible for curriculum, course development, administration, and training records for all formal training attended by the M&E unit's employees.
- The organization coordinates any training required outside the unit (vendor training) and coordinates with line and hangar maintenance personnel for the development of on-the-job training and remedial or one-time training activities.
- The training section must be able to establish new and special training courses to meet the needs of the airline. These course requirements are often the result of problem investigation by reliability, incorporation of new equipment or modifications, or the addition of aircraft types to the fleet.

Technical publications

- The manager of technical publications is responsible for all technical publications used by the M&E organization.
- The technical publications (Tech Pubs) keeps a current list of all documents received from manufacturers and vendors, as well as those produced in-house by the airline. Also on record are the number of copies, in paper, microfilm, or compact disc (CD) format, that each work center should receive.
- The Tech Pubs organization is also responsible for ensuring that appropriate documents and revisions are distributed to these various work centers.
- Work centers are responsible for keeping their own documents current, but Tech Pubs usually conducts periodic checks to see that this is being done.
- Tech Pubs is also responsible for maintaining the main technical library and any satellite libraries within the airline's system, including those at out-stations.

Computing services

- The manager of computing services is responsible for the definition of the M&E organization's computing requirements:
- (*a*) selection of software and hardware to be used, with usage information and requirements inputs from the individual units;
- (*b*) training of maintenance, inspection, and management personnel on computer usage; and
- (*c*) Provide continuing support to the using organizations.

➢ Manager Level Functions—Aircraft Maintenance Directorate

- The aircraft maintenance directorate has responsibility for the major aircraft maintenance activities: maintenance on the flight line and maintenance per-formed in the hangar.
- Three managers report to the director of airplane maintenance: one for each of these activities and one for MCC.
- For airlines with different model aircraft or with two or more maintenance bases, the number of aircraft maintenance managers may be increased as necessary for the scope of the operation.

Hangar maintenance

- The manager of hangar maintenance is responsible for compliance with the airline's policies and procedures relative to all work done on the aircraft in the hangar, such as modifications, engine changes, "C" checks (and higher), corrosion control, painting, etc.
- The hangar maintenance function also includes various support shops (welding, seat and interior fabric, composites, etc.), as well as ground support equipment.

Line maintenance

- The manager of line maintenance is responsible for compliance with the airline's policies and procedures relative to the work done on the aircraft on the flight line while the aircraft is in service.
- Such activities include turnaround maintenance and servicing, daily checks, short interval checks (less than "A" check interval), and "A" checks.
- Sometimes, simple modifications can be done by line maintenance in order to avoid unnecessary use of the hangar.
- Line maintenance may also be utilized to perform line maintenance activities for other airlines under contract.

Maintenance control center

- The function known as the maintenance control center (MCC) keeps track of all aircraft in flight and at outstations.
- All maintenance needs of these vehicles are coordinated through the MCC. The MCC also coordinates downtime and schedule changes with the flight department.
- Some airlines might have a supervisor of line stations to coordinate outstation activities, but he or she is often part of the home base MCC operation.

➢ Manager Level Functions—Overhaul Shops Directorate

- The overhaul shops directorate consists of those maintenance shops that perform maintenance on items removed from the aircraft.
- These shops include engine shop(s), electrical shop, electronics (or avionics) shop, and various mechanical shops.
- These may be separate shops or some may be combined for convenience, depending on the operation. Some of these shops may also perform contract work for other airlines.

Engine shops

- The manager of the engine overhaul shops is responsible for all maintenance and repair done on the organization's engines and auxiliary power units (APUs).

- If more than one type engine is used, there may be a separate engine shop for each type performing the work, but these would usually be under one senior manager with a supervisor for each engine type.
- The engine build up activities would generally come under the engine shop manager.

Electrical and electronics (avionics) shops

- The manager of electrical/electronic shops is responsible for all off-aircraft maintenance of electrical and electronics components and systems.
- There are a variety of components and systems in this field with wide variations in the equipment and in the skills needed to address them.
- There may be several shops (radio, navigation, communications, computers, electric motor–driven components, etc.) with separate supervisors. Shops are combined at times, however, to optimize manpower and space and to reduce test equipment inventories.

Mechanical component shops

- The manager of mechanical component shops has responsibilities similar to those of the manager of avionics shops. The only difference, of course, is that these shops would address mechanical components: actuators, hydraulic systems and components, aircraft surfaces (flaps, slats, and spoilers), fuel systems, oxygen, pneumatics, etc.

Structures

- The structures shop is responsible for maintenance and repair of all aircraft structural components. This includes composite material as well as sheet metal and other structural elements.

➢ Manager Level Functions—Material Directorate

- The material directorate is responsible for the handling of all parts and supplies for the M&E organization: (*a*) purchasing; (*b*) stocking and distribution (stores); (*c*) inventory control; and (*d*) shipping and receiving of parts and supplies used by the M&E organization.
- This includes not only the parts and supplies used in the maintenance, servicing, and engineering of the aircraft but also the sup-plies used for the administration and management of M&E (i.e., office supplies, uniforms, etc.).

Purchasing

- The manager of purchasing is responsible for buying parts and supplies and tracking these orders through the system. This begins with the initial issue of parts when a new aircraft is added to the fleet and a continual replenishment of those parts based on usage.
- The purchasing unit is also responsible for handling warranty claims and contract repairs.

Stores

- The manager of stores takes responsibility for the storage, handling, and distribution of parts and supplies used by the maintenance personnel in line, hangar, and shop maintenance activities.

Stores areas, or parts issue points, are placed near the various work centers to allow mechanics quick access to parts and supplies and to minimize the time spent obtaining those parts and supplies.

Inventory control

- The manager of inventory control is responsible for ensuring that the parts and supplies on hand are sufficient for the normal, expected usage rate without tying up excessive funds in nonmoving items and without running out of stock too soon or too often for commonly used items.

Shipping and receiving

- The manager of shipping and receiving is responsible for packing, waybill preparation, insurance, customs, etc. for outgoing materials, as well as customs clearance, unpacking, receiving inspection, tagging, etc. for incoming materials. This includes all parts being shipped into and out of the airline.

➢ Manager Level Functions—Maintenance

Program Evaluation Directorate

- The maintenance program evaluation (MPE) directorate is an organization tasked with monitoring the maintenance and engineering organization. The MPE unit is responsible for the CASS activities. The unit's functions include quality assurance, quality control, reliability, and safety.

Quality assurance

- The manager of quality assurance is responsible for assuring that all units of M&E adhere to the company policies and procedures as well as FAA requirements.
- The manager of QA sets the standards for the M&E operation, and the QAauditors ensure compliance to those standards through yearly audits. Quality assurance is also responsible for auditing outside suppliers and contractors for compliance with the company's, as well as the regulatory authorities, rules and regulations.

Quality control

- The manager of quality control is responsible for conducting routine inspections of maintenance and repair work, certifying maintenance and inspection personnel, and management of the required inspection items (RIIs) program.
- This latter function involves the identification of RIIs and the certification of specific personnel authorized to inspect and accept the work.
- The QC organization is also responsible for the calibration of maintenance tools and test equipment and performs or oversees the nondestructive testing and inspection (NDT/NDI) procedures.

➢ Reliability

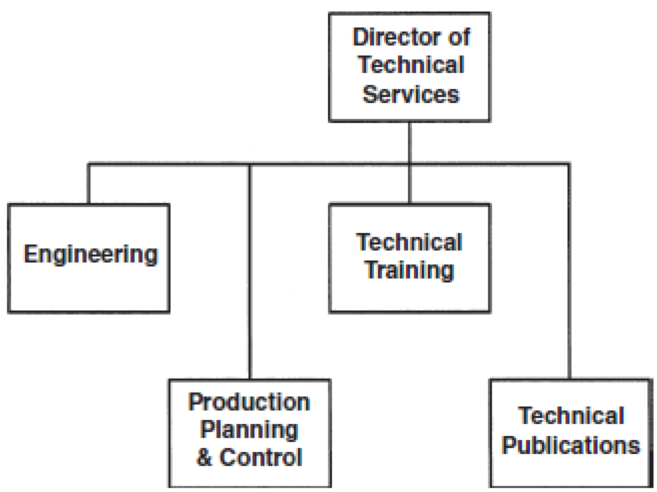
- The manager of reliability is responsible for conducting the organization’s reliability program and ensuring that any problem areas are promptly addressed.
- This responsibility includes data collection and analysis, identification of possible problem areas (which are then addressed in detail by engineering), and publication of the monthly reliability report.

Safety

- The safety organization is responsible for developing, implementing, and administering the safety- and health-related activities within the M&E organization.
- The safety manager is also responsible for handling all reports and claims regarding M&E safety issues.

UNIT – III
TECHNICAL SERVICES

- The technical services directorate is responsible for providing technical support and assistance; continuous monitoring, updating, and development of maintenance programs for the airline's fleet type; maintenance program change; articulating aircraft manuals and their distribution; and all other M&E activities.
- The main job of engineering is to establish the maintenance program and subsequent schedules and to provide engineering expertise in new notice of proposed rulemaking (NPRM), new airworthiness directives (ADs) review, aircraft manufacturer documents, service letters, notice to aircraft operators, service bulletins, and to provide technical assistance to all other units within the M&E.
- Production planning and control (PP&C), discussed, is the primary force driving the day-to-day work activities of aircraft maintenance.
- This department is responsible for planning and scheduling all aircraft maintenance activities in the airline.
- The other functions of technical services are Technical Publications, , which is responsible for document receiving, distribution, and updates.
- Technical Training , is responsible for all training activities in M&E, including maintenance management, inspection, auditing personnel, and administrative support.
- Figure shows the organizational chart of the technical services units.



Organizational chart for technical services

➢ Engineering

- Engineering is defined by the Engineers' Council for Professional Development as the "profession in which knowledge of the mathematical and natural sciences gained by study, experience, and practice is applied with judgment to develop ways to utilize economically the materials and forces of nature for the benefit of mankind." The Encyclopedia Americana says "Engineers, unlike scientists, work toward the solution of specific practical problems."

- The Encyclopedia Britannica adds: "All engineers must have a positive interest in the translation of the theoretical into the practical." In other words, an engineer is one who applies mathematics and scientific principles to the effort of resolving practical problems.
- Engineers are usually identified by some specialty: civil, mechanical, electrical, aeronautical, transportation, nuclear, to name a few. None of these specialties apply directly to aviation except aeronautical, and these aero engineers would normally be involved with design and development of air and space systems and equipment which, as we have said, the airline no longer does.
- The engineering department of an airline can vary widely; they perform many functions for the airline as a whole and specifically for the M&E organization. In some airlines, engineering is a corporate unit separate from the M&E operations, and in others it is part of M&E.
- The size of the airline often determines which is most desirable. In those airlines where engineering is outside the M&E organization, their function is usually oriented toward major engineering type activities, such as the development and support of buildings and other facilities; major aircraft modification design; and detailed engineering studies of maintenance problems as well as other airline technical problems.

- **Makeup of Engineering**

- The airline engineering department is made up of the more experienced people of the maintenance organization.
- They must be knowledgeable of the total maintenance operation as well as the airline and regulatory requirements. Ideally, an airline would have both degreed engineers and senior licensed mechanics in the engineering department.
- There would be engineering staff for each type of equipment: avionics, electrical, hydraulic, pneumatic, power plant (engines and APU), structures, and mechanical systems. Avionics may even be divided into communications and navigation systems; and mechanical systems into flight controls, hydraulics, etc. Some airlines may have different groups of engineers for each model of airplane and/or engine.

- **Mechanics and Engineers**

- Some airlines have engineering departments made up entirely of mechanics, while others have departments made up entirely of degreed engineers. Neither of these schemes is entirely satisfactory for our purposes.
- Although the mechanics are fully versed in the details of the systems and components in service, are experienced in the governing rules and regulations, and understand the idiosyncrasies of their fleet, they often do not have the same analytical discipline and other training of engineers.
- On the other hand, graduates of engineering colleges, more often than not, lack a suitable understanding of airplanes, air-craft engines, and the multitude of systems and components needed to provide airworthy vehicles for air transportation. The engineering curricula provide no training in maintenance and very little about other engineering disciplines.

- Engineers and mechanics are trained differently, and each approaches problems in different ways. While the mechanic's approach is somewhat reactive, the engineer's approach is more proactive. But, it takes both disciplines to run an effective engineering operation at an airline.

- **Engineering Department Functions**
- The engineering department provides preparation, study, and analysis of various aspects of the maintenance operation.
- They evaluate maintenance requirements and establish the maintenance program for the airline.
- They also evaluate suggested modifications of aircraft systems for possible incorporation into the fleet and provide technical assistance to maintenance.
- Engineering prepares the units for handling new equipment and facilities and provides assistance, where needed, in all other aspects of maintenance.
- These functions are discussed below.

- **Development of the maintenance program**
- Each airplane model has an initial maintenance program developed by the industry working groups and defined in the manufacturer supplied documentation.
- This is a suggested maintenance program for new operators and new equipment. Once in the field, operators can adjust the program to suit their own needs and operational environment
- This initial maintenance program is a generalized program and must be tailored to the individual operator from the very beginning. The manufacturer produces the FAA approved MRB report and a maintenance planning document
- It is the responsibility of the engineering department at the airline to package these tasks into workable units based on such factors as time, space, personnel, fleet schedules, and overall airline capabilities. For some airlines, the designated letter checks (A, B, C, and D) are sufficient.
- .The fleet is large enough for the airline to schedule people and facilities for continuing checks (e.g., one airplane per week or per month).
- In small airlines, there are not enough airplanes to allow this continued scheduling of "C" checks. Due to the higher manpower requirements for the "C" check, it is necessary for the small airline to adjust the schedule to smooth out the work.
- For most operators, the "A" check is done monthly. The "C" check comes about yearly (every 12 to 18 months for newer models) and requires a concentration of personnel for the 3 to 7 days required to perform it.
- For the small airline, staffing this annual effort is not feasible.
- To remedy the matter, the "C" check is divided into parts, called phases, and each part is conducted separately.
- For example, a "C" check could be divided into four phases (C1, C2, C3, and C4), each one carried out every 3 months until the entire "C" check is performed. An air-line may divide the "C" check into 12 packages and perform one package a month along with each scheduled "A" check. In either case, the personnel utilization is more constant throughout the year, the checks are done within the prescribed time limit, and the airline workload is stabilized.

- The tasks performed by maintenance at any of these checks can be quite detailed. To ensure that they are carried out correctly, task cards are issued to the mechanics. Many airlines use task cards produced by the airplane manufacturers and some write their own cards. Still others develop a combination of the two. Whichever method is used, it is the responsibility of engineering to develop these task cards, assemble them into appropriate packages, and ensure that they are current and effective.

- **Develop technical policies and procedures**
  Manual for M&E
- This document contains all the necessary information to describe the M&E organization, and its responsibilities.
- It identifies the organizational structure, provides information on duties and responsibilities of key personnel and key organizations, and provides a series of maps and layouts of the airline's facilities.
- It also gives detailed descriptions of how work is to be carried out, who is to perform the work, and how it will be managed, inspected, and released (if applicable). Engineering is responsible for developing this document with inputs from the other M&E units.
- The FAA defines the minimum requirements for the manual in FAR 121.369, but consideration should be given to additional policies and procedures that provide complete instructions to maintenance and engineering personnel for the conduct of their work.
- The manual can be a single document in loose-leaf form, it can be a series of separate documents, or it can be a multiple-volume set

- **Evaluate changes in the maintenance program**
- From time to time there will be problems with the effectiveness of the maintenance program.
- Individual tasks may be ineffective or less than adequate.
- Some MRB tasks eliminated from the original program may, in retrospect, need to be reinstated.

Evaluate changes in aircraft or system configuration

- From time to time, the airplane, engine, and component manufacturers develop modifications and improvements for their respective systems, which are intended to improve operations, reliability, and/or maintenance processes. These are issued as service bulletins (SBs) or service letters (SLs). If a safety or air-worthiness issue is involved, the modification may be issued by the FAA as an airworthiness directive (AD).
- Airworthiness directives are mandatory, so there is no need for engineering to evaluate the change. Engineering will, however, be required to provide the information needed by maintenance to accomplish the modification regardless of whether it is an AD, SB, or SL. This will be accomplished by issuing a detailed instruction produced in the form of an engineering order (EO) which is discussed below.

Evaluation of new aircraft added to the fleet

- One of the primary functions of engineering is to evaluate new equipment for the airline.
- When the business people of the airline decide to expand the operation, one of the first questions to resolve is "What airplane/engine combination should we buy?" Part of this decision is based on the routes to be flown, the destination cities, the expected market share and, of course, the cost of the equipment versus the revenue expected. These are operations and business decisions based on market conditions and airline goals and objectives.
- Another important part of the decision, however, is "What is the best equipment to buy from the maintenance and engineering standpoint?" The two decisions—business and technical—must be reconciled to the satisfaction of the overall airline goals. At this point, for the sake of the present course of study, we will skip the business decision and concentrate on the technical decision.

Evaluation of used aircraft to be added to the fleet

- If the airline is contemplating the purchase or lease of used airplanes from another airline or leasing organization, other items must be considered in addition to the above items relating to equipment differences from the existing fleet. These items would include such information as the current configuration of the airplane, including engine type; the maintenance program and check schedule that the current operator is using; status of modifications (ADs and SBs).

Evaluation of new ground support equipment

- On a smaller scale, the engineering department will also be called upon to evaluate the need for new equipment in support of aircraft added to the fleet.
- This would include tools, test equipment, stands, electric and pneumatic carts, heaters; tow bars, tractors, etc. Some existing equipment may or may not be usable with the new airplane models (purchased or leased). In some cases, the GSE, though usable, may not be available in sufficient quantity to serve the increased fleet size. Additional purchase would be necessary in such cases.

Development of new facilities for M&E

- At times, it is necessary for the airline to build new facilities or expand existing ones to support new equipment, airline expansion, or modernization efforts.
- This would include such projects as hangars, engine test facilities, component shops, storage facilities for various types of equipment, and storage for special parts.
- The engineering department will not (usually) be involved in the design and construction of these new facilities. That will be contracted out to more appropriate companies.
- Engineering will, however, have a considerable input into the design in terms of requirements. A hangar, a workshop, or any other facility must be designed for the express use of the airline and the M&E organizations that will occupy it. Therefore, the engineering department will act as liaison between the users and the designers and builders to ensure that the finished product is acceptable.

- **Issuance of engineering orders**
- Any work performed by maintenance in the form of standard checks—daily, 48-hour, transit, "A" check, "C" check—is done on standing orders from the VP of maintenance and engineering as identified in the maintenance section of the Ops Specs.
- Any work not included in these standard checks must be assigned by engineering order.
- Some airlines may call this document by another name, such as work order, technical order, or engineering authorization (EA). This EO is developed by engineering, with inputs from appropriate work centers, to define the scope of the job and schedule the work. Work performed as a result of SBs, SLs, ADs, and all work resulting from evaluation of problems defined by reliability investigations or QC reports, will be issued on an engineering order.
- All work centers involved in the particular project will be defined on the EO: maintenance (line, hangar, or shop as appropriate); material (for parts, supplies, tools); quality control (inspection of work if required); training (remedial, upgrade, or new course).
- Engineering releases the EO after all involved organizations (maintenance, material, planning, etc.) have agreed to its contents.

- **Provide assistance in troubleshooting difficult problems**
- The day-to-day problems that mechanics run into on the line, in the hangar, and in the shops, are often routine and call for well-defined responses.
- At times, the problems are more elusive and the mechanic must apply his or her troubleshooting skills to resolve the problem. When the problem eludes the mechanic's expertise, assistance is available from engineering to get to the bottom of the problem. This assistance can be given to line, hangar, and shop people, as well as vendor's handling warranty claims or working on contract. Parts suppliers who perform repairs on rot able units and contractors doing third-party maintenance may also require engineering's assistance.
- It should be noted that this is not the primary responsibility of engineering and should be used only in difficult circumstances. Engineering is not a substitute or replacement for maintenance.

- **Other engineering functions**
- Engineering can also provide expertise to training, material, the technical library, or any other M&E organization needing technical help. They are considered the technical experts of the organization and are available to lend technical assistance to anyone in the airline needing such assistance.

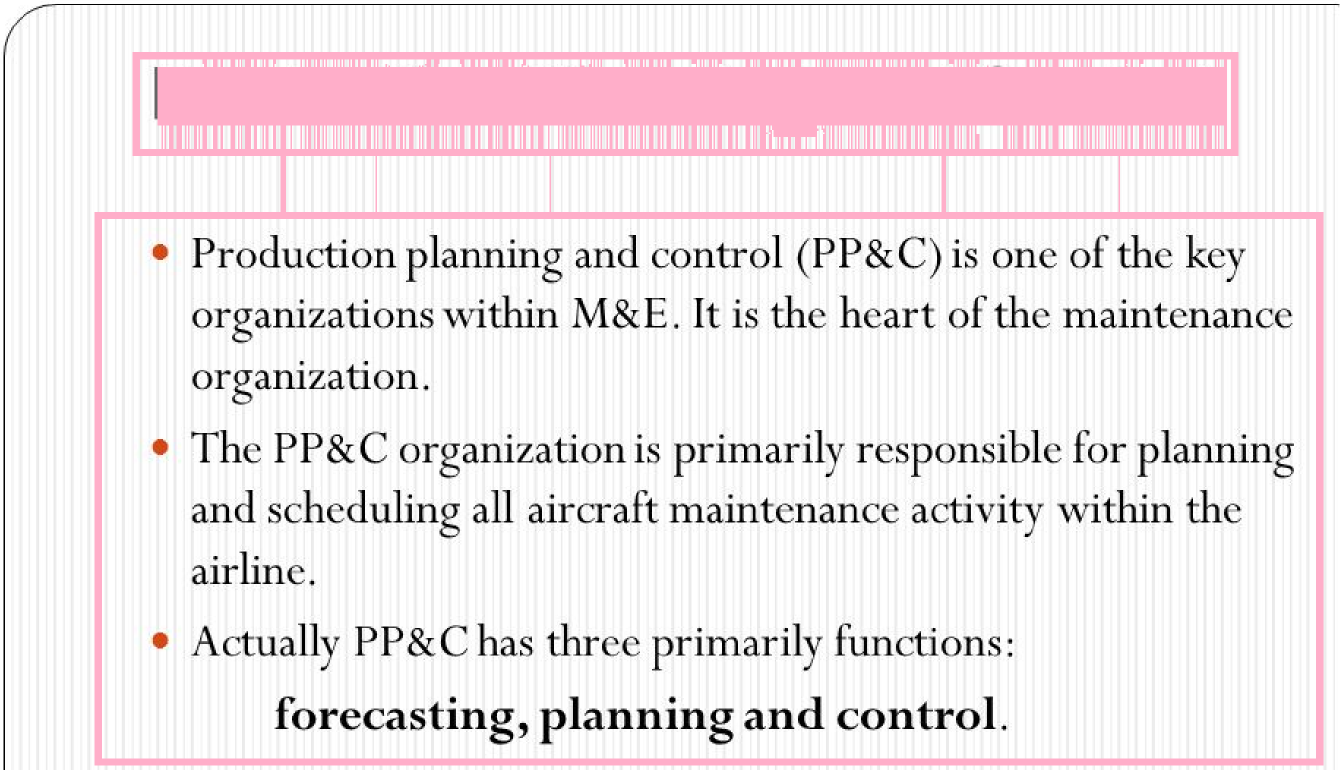
Engineering Order Preparation

Engineering initiates an engineering order for any work not included in the standard maintenance program plans as established by the Ops Specs. However, the need for an EO can be generated from various sources. Its implementation can also take various paths depending on the type and complexity of the work involved.

- For example, EOs related to maintenance modifications and other directives (ADs, SBs, SLs, etc.) will be scheduled by the planning organization (PP&C).
- Other problems may necessitate changes in the maintenance program (intervals, tasks, etc.); change in processes; parts procurement activities; or may require training (refresher or upgrade; classroom or on the job).
- In these cases, the EO might be issued directly to the M&E unit or units involved. The following eight steps generalize the process:

1. A decision is made to do work based on one of the following: reliability program alert; work force requirement (QA, QC, maintenance manager, or mechanic); an AD, SB, SL, or fleet campaign.
2. Engineering analyzes the work requirements (problem and solution): troubleshoot or investigate the problem to determine scope and needs; analyze AD, SB, SL, etc. if applicable for time, personnel, etc. requirements.
3. Determine the approach to follow: incorporate work into PP&C check or other scheduled or unscheduled maintenance activity; schedule other corrective action as necessary; issue EO as required.
4. Identify the needs for schedule and performance of the work: engineering studies, plans, etc.; the need for special skills if any (in-house or contract); the need for parts and supplies (on hand or order, consider lead time for delivery); determine need and availability for special tools and/or test equipment needed.
5. Identify work required: personnel (maintenance, engineering, contract, etc.); facilities (hangar space, GSE, etc.); time requirements for work to be done.
6. Call a coordinating meeting to finalize EO (if necessary): all organizations involved in the work; coordinate and resolve difficulties.
7. Issue engineering order: PP&C will plan work and monitor execution; or EO may go directly to material, training, etc. as necessary.
8. Engineering closes EO when all work is completed: notification comes from each work center involved in the particular EO; for fleet campaigns, ADs, etc. involving entire fleets, EO remains open, PP&C schedules each aircraft for incorporation; engineering closes EO when fleet is complete.

➢ Production Planning and Control



• Introduction

- Production is planning and control (PP&C), because of its key role in planning and scheduling, is the heart of the maintenance and engineering (M&E) organization. Although the title PP&C is common throughout the airline industry, the activities actually performed sometimes fall short of the ideal notion of what PP&C should be. The PP&C organization is primarily responsible for planning and scheduling all aircraft maintenance activity within the airline.

• PP&C Organization

- The planning work can be done by a centralized or decentralized PP&C group.
- In the centralized group, all functions—forecasting, planning, and control—are done within the organization, with liaisons to the work centers during actual performance of work.
- In a partially decentralized organization, the forecasting and planning would be done by PP&C, and the control would be done by personnel in the hangar or other work centers. In some airlines, the PP&C function is entirely decentralized. That is, all the planning and control is done by each work center.
- If the airline structure and size is such that the planning has to be done by the individual work centers instead of a centralized group, there must still be some coordination and control at the M&E organizational level.

- The M&E organization is normally led by the vice president of maintenance and engineering. The production planning and control department typically reports to the VP of M&E. The PP&C department is normally overseen by a man-ager, followed by the maintenance planner, and long-range planner.

- ## Manager, PP&C
- The PP&C manager is normally responsible for the planning department and its functions.
- This includes making sure that all assigned maintenance and inspection planning activities are accomplished according to the airline's policy and FAR's and the company's required maintenance programs.
- The PP&C manager must have the cross-functional ability to work with other departments within the airline's organization; plan, coordinate, and route aircraft to maintenance bases in a timely manner; and take appropriate and necessary action which may affect the airline's daily operation

- ## Maintenance planner, PP&C
- Maintenance planners are assigned to different maintenance bases. One maintenance planner can track two to three different maintenance bases and is normally the contact for maintenance bases for planning schedules.
- The maintenance planner's primary function is to develop all scheduled work and/or work scope needed for all line maintenance and hangar maintenance aircraft.
- It is the maintenance planner's duty to track and monitor the completion of all planned work assigned to a maintenance base and the aircraft.
- The maintenance planner coordinates the aircraft routing to the maintenance base and also coordinates with the stores department about any logistics required for maintenance planning.

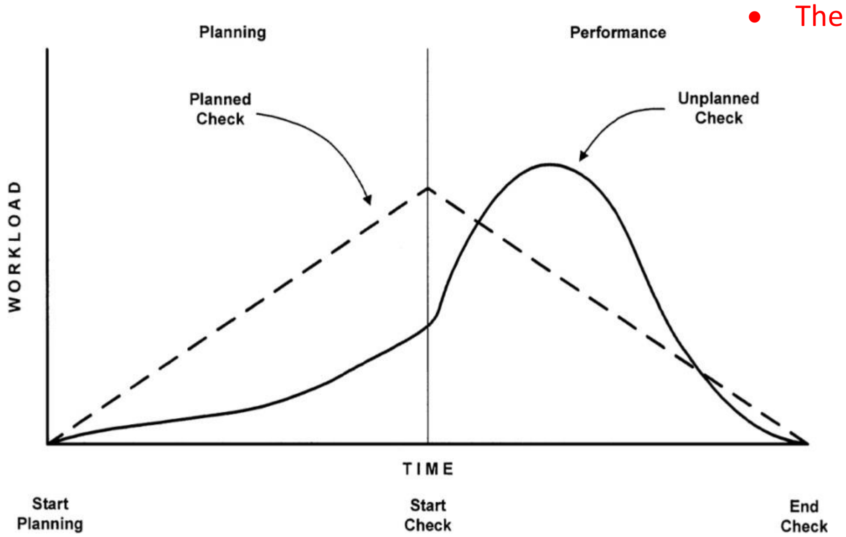
The Production Planning & Control Department's Function

- The PP&C title is a bit misleading.
- It implies two functions: planning and control.
- PP&C actually has three functions: forecasting, planning, and control.
- Forecasting activities include estimating maintenance workload for the existing fleet, creating business plans, and being aware of any changes in the forecast period.

  Planning involves scheduling upcoming maintenance, and includes planning and scheduling details (manpower, parts, and facility) and timeframe requirements for such maintenance: less than "A" check items, daily items, 48-hour checks, and letter checks. These plans would include incorporation of SBs, fleet campaign directives (FCDs), SLs, and ADs, as well as other maintenance tasks, such as engine changes, fuel nozzle changes, gear changes, and generator changes deemed necessary by the airlines.
- The plan is somewhat idealized, however. During the actual performance of maintenance, many things occur that require altering the plan.

- The control function allows for adjustments to the plan and keeps (or attempts to keep) a check on schedule.
- There are several methods of adjusting the plan, including deferral of maintenance to a later check, addition of personnel to complete the work, or outsourcing the work to a contractor. Feedback from a check allows PP&C to adjust the planning effort for future checks.

- The importance of planning



➢ Forecasting

- Forecasting is concerned with the future workload of the M&E organization.
- The PP&C department is responsible for reviewing and providing upcoming maintenance on the aircraft fleet.
- This requires workload planning, goal setting, implementing, and monitoring.
- It must also take into account the routine and non routine maintenance requirements, as well as planned changes in future operations relative to maintenance.
- Any changes in fleet size, routine structure, facilities, manpower, or skill requirements are tracked.
- Future plans may also accommodate the aging and replacement of equipment, corrosion prevention control program, addition of new equipment, modification of equipment, and the upcoming ADs and SBs. Activities throughout M&E will change as these assets and requirements change.
- The forecast function ensures that M&E and PP&C are up to date on these changes and ready to adjust their processes and procedures accordingly.
- Forecasts are usually made for the long and short term but often an intermediate term forecast is also made.

• Production Planning

- While forecasting is long range and general, planning deals with the day-to-day activities of M&E.

- The goal of M&E is to deliver airworthy vehicles to the flight department in time to meet the flight schedule, with all maintenance activities completed or properly deferred. In business terms, this is what we "produce"— airworthy vehicles with all maintenance properly addressed. Thus, the activities of line, hangar, and shop maintenance constitute the production aspect of M&E. Production planning, then, is the planning of that work with the stated goals in mind.
- Production planning involves the planning of all maintenance activities: daily, 48-hour, and transit checks; letter checks; and modifications due to airworthiness directives, service bulletins, service letters, and engineering orders. It also involves the planning and scheduling of all aspects of these checks, including manpower, parts, supplies, and facilities. Coordination with flight operations and with ground handling and support activities is also included in the planning effort.

- ## "A" check planning

- "A" checks are usually routine.
- The tasks required are defined by engineering using the MRB or Ops Specs document. The time, manpower, and parts and supplies needed are generally fixed.
- There are variations, however, that must be addressed. When there is a write-up in the aircraft maintenance log that cannot be addressed at turnaround or on daily or overnight checks, it may be deferred until a later time. The deferral may be a result of a lack of parts, a temporary lack of skilled labor, or lack of sufficient time required (at the time of occurrence) to effect resolution. In these cases, the deferred maintenance is scheduled by PP&C for the next "A" check.
- The necessary parts, supplies, and personnel should be available at that time.
- Performance of an "A" check may also include, because of time and parts constraints, some "less than "A" check" items (100 hours, 250 cycles, etc.). These may be near the time or cycle interval and so are placed with the "A" check for convenience. If there are SBs or SLs that do not require extensive time or parts to complete, these may also be scheduled for the "A" check.
- [illegible] This allows adjustment for changes in circumstances. [illegible]
- The "B" checks, if they are used, are often similar to "A" checks but involve different tasks, usually at intervals which fall between consecutive "A" checks.
- The planning for these is essentially the same as for "A" checks.

- ## "C" check planning

- The "C" check is usually done about once a year (12 to 18 months on the newer model aircraft), depending on the airline flight schedule.
- The planning effort is more detailed and more elaborate than for the "A" check.
- Normally, a "C" checks will take 4 to 7 days to complete, depending upon the model and the circumstances. The number of shifts worked, the availability of manpower and parts, and the skill requirements for the work will affect the length of time involved.
- The check will consist of three categories of tasks: routine, variable routine, and nonroutine.
- **Routine tasks** are those tasks identified in the MRB document. These are items that must be performed at the specified interval. Since some of these items are performed every "C" check and others are performed every second, third, or fourth check (2C, 3C, or 4C), the amount of time

required to perform each scheduled check will vary from check to check. This scheduling and variation in time requirements are PP&C's concern.

- Variable routine tasks are those tasks which vary from one check to another and from one aircraft to another. These tasks include incorporation of service bulletins and airworthiness directives, as well as fleet campaigns, items deferred from previous maintenance checks, and any other one-time maintenance actions required for a particular aircraft. The time required to accomplish these tasks is generally fixed, so these items are similar to the routine tasks for planning purposes.
- Non routine tasks are those work items that are generated by the accomplishment of other, routine tasks.
- For example, if a routine task says to inspect the wheel-well area for hydraulic leaks, the task will take a certain amount of time (scheduled). If a leak is discovered, however, it must be addressed. This constitutes the production of a non routine maintenance task and subsequently a non routine task card. Since the number of non routines can only be estimated and the amount of time required to complete the non routine item varies with many factors, it becomes an interesting task for PP&C to properly estimate the time needed to complete these non routine items and the entire check.

- Below is a list of items that might be included in a "C" check. Not all of these would be included each time, however.
    1. "C" check items from the approved maintenance program (routine)
    2. Deferred maintenance from line or other check packages (variable routine)
    3. Incorporation of SBs, SLs, ADs (variable routine)
    4. Incorporation of airline mods and fleet campaigns (variable routine)
    5. Cleaning, painting of aircraft (variable routine)
    6. Work generated by inspections and routine items (non routine).
- Once the package is set and the time estimated, PP&C must arrange for and schedule all the necessary elements for proper execution of the package. That would include the following:

1. Locate and secure hangar space for the duration of the check
2. Obtain a release of the airplane from operations for maintenance purposes (this may be accomplished by MCC)
3. Arrange for and schedule the washing of the aircraft
4. Secure tow vehicles and manpower needed to move the airplane to the wash rack and then into the hangar
5. Ensure all parts and supplies needed to carry out the check will be on hand
6. Ensure delivery of those parts and supplies to the hangar at the time needed
7. Identify manpower and skills needed for the check

➢ Production Control

- The plan produced by PP&C allows a certain amount of time for the performance work based on past knowledge of the work to be done and also based on the assumption that parts, supplies, manpower, and facilities will be available when needed.
- The plan also assumes that there is no variation in the flow of work activity. The PP&C planners can only estimate the amount of time required for non routine items, and this can be less than accurate. Take, for instance, a routine task that says "check the hydraulic line for leaks."
- If there are no leaks, the inspection task should take a specific amount of time, but since there is no way for the planner to determine if there will be leaks or to know the extent of any leak(s) found, there is no way for him or her to accurately estimate the time required to perform the nonroutine task of repairing the leaks. The time needed to fix a leak still must be estimated and scheduled.

➢ Technical Publications

- The technical publication department is vital to aircraft maintenance operations, since this entity is solely responsible for receiving and distributing publications throughout the airline maintenance bases, hubs, and smaller stations.

➢ Functions of Technical Publications

The technical publication organization essentially has three functions:

1. To receive and distribute, within the airline, all those publications issued by outside sources
2. To print and distribute the publications generated by the various organizations within the airlines
3. To establish and maintain a complete, up-to-date library system for all such documents needed for M&E operations.

- Outside sources of documents would include airframe and engine manufacturers, vendors and manufacturers of equipment installed on the aircraft, and manufacturers of special tools and test equipment used in the maintenance effort.

➢ Airline Libraries

- The primary reason for having a technical publications organization is to ensure that all applicable publications related to the airline operation are available to the users and are up to date with the latest changes.
- The most common way to accomplish this is to establish a main library for the M&E organization. If the M&E organization is of any appreciable size, the location of a single library would be inconvenient for many users and the number of copies of each document might be limited. For that reason, the technical publications organization at most air-lines maintains, in addition to the main library, one or more satellite libraries strategically located to minimize travel times to access the information needed.

- Each library—main and satellite—should contain the necessary tables, chairs, shelves, microfilm readers and printers, computer terminals, and copy machines as needed to serve the users and the document for-mats (paper, microfilm, electronic) which will be available there.

Maintenance control center (flight line)
Line stations (1 or more)
Hangar dock
Overhaul shops in hangar
Engineering
Maintenance training
Production planning
Quality assurance
Reliability (may be colocated with engineering or QA)
Material

Satellite Libraries

Control of Publications

- Maintenance-related documents are classified as either "uncontrolled" or "controlled" documents.
- Uncontrolled documents are issued for general information only and are not used to certify airworthiness. They do not require any of the tracking system requirements discussed below for controlled documents.
- Controlled documents are used to certify airworthiness of the aircraft, engines, and components. Each controlled document will contain a list of effective pages (LEP) and a record of revisions to the document identifying the revision number or letter and the date of that revision. The LEP will also reflect the active page numbers of the latest revision. Table below is a typical list of controlled documents.

Operations specifications
Technical policies and procedures manual*
Manufacturer and vendor manuals (see Table 5-1)
Regulatory authority documents (see Table 5-2)
Applicable airworthiness directives
Applicable aircraft type data sheets
Applicable aircraft supplemental type certificate

Controlled Documents Listing

Training Organization

- Since all airline personnel require training of one sort or another, it is necessary to have a training organization to address these needs.
- This organization can take various forms.
- This can be an airline's training organization, training department, or school at the corporate level that is responsible for training of all airline personnel; or there can be a separate organization responsible for maintenance training, flight crews, cabin crews, ground handlers, and management and administrative personnel.
- Flight crew training is normally contracted out to various flight academies or the aircraft manufacturer, since they have the classroom facilities, aircraft simulators, and experienced pilots who train the flight crew.
- This depends on the airline's size and operations. Some airlines do have in-house simulators with a check airman pilot who acts as a flight instructor. Cabin crew is similar to aircraft flight crew in that their training may be performed by the manufacturer or in-house. The cabin crew's training emphasizes safety and evacuation of the aircraft with mock-ups and what to do in the event of an air-craft emergency on land or on water. They learn how to deploy slides and/or rafts.
- The ground handling crews have a separate training department and normally are trained in-house due to aircraft availability.

Airline Maintenance Training

- An airline maintenance training program is required by the FAA under FAR 121.375, which requires airlines to provide training to their maintenance personnel. The airline's maintenance training department is responsible for having a comprehensive training program that is effective in teaching its employees and contract maintenance workers how to service and maintain aircraft and their systems.
- In a commercial airline, the training department is led by the training manager, who is responsible for accuracy, functionality, training strategies, and the quality of the maintenance training program.
- The director of training normally works with the director of maintenance (DOM) and director of quality control (DQC) for their personnel training. This ensures that employees schedule the required training, refresher training for aircraft and related systems, and company-required training in a timely manner.
- The DQC normally works with the training department to comply with any airworthiness training, required inspection authorization (RII), and various other QA and QC training.
- For aircraft maintenance personnel, there are several kinds of required training activities.
- The training listed here is given by an airline after hiring an AMT with a valid A&P:
- (*a*) organizational training;
- (*b*) manufacturer or vendor training;
- (*c*) quality training;
- (*d*) on-the-job training (OJT);
- (*e*) equipment operation and safety training; and

- (*f*) refresher training.

➢ Airframe Manufacturer's Training Courses

- Whenever an airline buys one or more aircraft from the airframe manufacturer (Boeing, Lockheed, Airbus, etc.) they usually get, as part of the purchase price, a certain number of training slots for the manufacturer's training classes on that model.
- This would include courses on the airframe, power plant, and avionics equipment installed. Who attends these classes for the airline differs from operator to operator and is often dependent on airline size and management.
- For small airlines, the mechanics who will be working on the aircraft systems while in service or their supervisors will attend these classes.
- Very often, both will attend. In larger airlines, some or all of these training slots may be given to the maintenance instructors of the airline's training organization.
- The choice, of course, is at the airline's discretion. If airline training instructors attend, they will return with the responsibility of creating the airline's version of the course and presenting the material to the airline's mechanics.
- In cases where the new equipment is only partially different from equipment currently in use—a 767-300, for instance, going to an airline that already flies 767-200s—only the differences between the two models need be taught to the air-line personnel.
- Airframe, engine, and equipment manufacturers may provide a variety of one-time programs at the airline venue. This might include training on such topics as extended range operations with two-engine airplanes (ETOPS); corrosion protection and control program (CPCP); maintenance error detection aids (MEDA); nondestructive test and inspection techniques (NDT/NDI); aviation safety; reliability programs; and the like.
- Although these courses are presented by outside sources, the airline training office is involved, since they must provide classroom space and other assistance as necessary and they must update the training records of those in attendance.