Karpagam Academy of Higher Education

(Deemed to be University)
(Established Under Section 3 of UGC Act 1956)

FACULTY OF ENGINEERING

Department of Mechanical Engineering

(Aerospace Engineering)

Subject Name / Code : Airframe Maintenance and Repair (AFMR) / 17BTAR601 A (Credits - 3)

Name of the Faculty : R. Suresh Baalaji

Designation : Assistant Professor

Year/Semester : III / VI

Branch : UG / B.Tech - Aerospace Engineering

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Coimbatore - 641021

Faculty of Engineering

Department of Mechanical Engineering

(Aerospace Engineering)

16BTAR601 A AIRFRAME MAINTENANCE AND REPAIR 3 0 0 3 100

OBJECTIVES:

To study the maintenance aspect of airframe systems and rectification of snags

UNIT - I WELDING IN AIRCRAFT STRUCTURAL COMPONENTS

Types of Welding and Joints -Equipments used in welding shop and their maintenance – Ensuring quality welds – Welding jigs and fixtures – Soldering and brazing.
SHEET METAL REPAIR AND MAINTENANCE: Inspection of damage – Classification – Repair or replacement – Sheet metal inspection – N.D.T. Testing – Riveted repair design, Damage investigation – reverse technology.

UNIT - II PLASTICS AND COMPOSITES IN AIRCRAFT

Review of types of plastics used in airplanes – Maintenance and repair of plastic components – Repair of cracks, holes etc., various repair schemes – Scopes.
Inspection and Repair of composite components – Special precautions – Autoclaves.

UNIT - III AIRCRAFT JACKING, ASSEMBLY AND RIGGING

Airplane jacking and weighing and C.G. Location. Balancing of control surfaces – Inspection maintenance. Helicopter flight controls. Tracking and balancing of main rotor.

UNIT - IV REVIEW OF HYDRAULIC AND PNEUMATIC SYSTEM

Trouble shooting and maintenance practices – Service and inspection. – Inspection and maintenance of landing gear systems. – Inspection and maintenance of air-conditioning and pressurization system, water and waste system. Installation and maintenance of Instruments – handling – Testing – Inspection. Inspection and maintenance of auxiliary systems – Fire protection systems – Ice protection system – Rain removal system – Position and warning system – Auxiliary Power Units (APUs)

UNIT - V SAFETY PRACTICES

Classification of Fire, Types of Fire Extinguisher Equipments and their handling - Hazardous materials storage and handling, Aircraft furnishing practices – Equipments. Trouble shooting - Theory and practices.

TEXTBOOKS:

S.No.	Author	Title of the Book	Publisher	Year of Publication
1.	Kroes ,Watkins, Delp.	Aircraft Maintenance and Repair	McGraw-Hill New York.	2013
2.	Federal Aviation Administration (FAA) Staff	Airframe and Powerplant Mechanics: Airframe Handbook	Shroff Publishers & Distributors Pvt. Limited, Mumbai	2014

REFERENCES BOOKS:

S.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Larry Reithmeir	Aircraft Repair Manual	Palamar Books, Marquette, New York.	2012
2.	Ralph D. Bent, James L. McKinley	Aircraft Maintenance and Repair	McGraw-Hill Inc., New York, US	2017
3.	J.E. Heywood	Light Aircraft Inspection	Shroff Publishers Mumbai	2016
4.	Christy	Aircraft Construction Repair & Inspection	Shroff Publishers Mumbai	2015
5.	J.E. Heywood	Light Aircraft Maintenance	Sterling Book House,Mumbai	2013

WEB REFERENCES:

www.ndt.net/article/wcndt2004/pdf/aerospace/817_assler.pdf

www.manningmetal.com/repair__maintenance.htm

www.aviation-database.com/Aerospace_plastics.htm

www.faa.gov/training_testing/.../FAA-S-8081-27.pdf

www.gao.gov/new.items/d05728.pdf

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LESSON PLAN

Subject Name / Code	: Airframe Maintenance and Repair (AFMR) / 16BTAR601 A (Credits - 3)
Name of the Faculty	: R. Suresh Baalaji
Designation	: Assistant Professor
Year/Semester	: III / VI
Branch	: UG / B.Tech - Aerospace Engineering

Sl. No.	No. of Periods	Topics to be Covered	Support Materials
1.	1	Introduction to Airframe Maintenance and Repair	
UNIT – I : WELDING IN AIRCRAFT STRUCTURAL COMPONENTS			
1.	1	Fundamentals of Airframe Structures	
2.	1	Introduction to Welding and Sheet metal Works.	
3.	1	Types of Welding and Joints.	
4.	1	Equipments used in welding shop and their maintenance.	
5.	1	Ensuring quality welds and defects. Welding jigs and fixtures – Soldering and brazing.	Aircraft Maintenance and Repair
6.	1	Sheet Metal Repair and Maintenance: Inspection of sheet metal damage – Classification of sheet metal.	
7.	1	Repair or replacement – Sheet metal inspection.	Kroes, Watkins, Delp
8.	1	N.D.T. Testing and its types.	
9.	1	Riveted repair design, Damage investigation – reverse technology.	Lecture Notes - KAHE
10.	1	**Tutorial 1:** Summary of Unit I and Part A questions	
Total No. of Hours Planned for Unit - I			**9L + 1T 10 Hours**

Sl. No.	No. of Periods	Topics to be Covered	Support Materials
UNIT – II : PLASTICS AND COMPOSITES IN AIRCRAFT			
11.	1	Introduction to composites and Plastics.	
12.	1	Review of types of plastics used in airplanes.	
13.	1	Maintenance and repair of plastic components.	
14.	1	Repair of cracks, holes etc.,	
15.	1	Various types of Hand Tools used in Plastic repair works.	Aircraft Maintenance and Repair
16.	1	Various repair schemes – Scopes.	
17.	1	Inspection and Repair of composite components.	Kroes, Watkins, Delp
18.	1	Special precautions.	
19.	1	Autoclaves.	Lecture Notes - KAHE
20.	1	**Tutorial 2:** Summary of Unit II and Part A questions	

Total No. of Hours Planned for Unit - II	9L +1T 10 Hours

Sl. No.	No. of Periods	Topics to be Covered	Support Materials
UNIT – III : AIRCRAFT JACKING, ASSEMBLY AND RIGGING			
21.	1	Basics of Airplane and Helicopter	
22.	1	Airplane jacking, Leveling, Rigging and Mooring.	
23.	1	Aircraft weighing and C.G. Location.	
24.	1	Balancing of control surfaces.	
25.	1	Visual Inspection and maintenance.	
26.	1	Introduction to Helicopter.	Aircraft Maintenance and Repair
27.	1	Forces act on helicopter, Helicopter Motions.	
28.	1	Helicopter flight controls.	Kroes, Watkins, Delp
29.	1	Tracking and balancing of main rotor.	
30.	1	**Tutorial 3:** Summary of Unit III and Part A questions	Lecture Notes - KAHE
Total No. of Hours Planned for Unit - III			**9L + 1T 10 Hours**

Sl. No.	No. of Periods	Topics to be Covered	Support Materials
UNIT – IV : REVIEW OF HYDRAULIC AND PNEUMATIC SYSTEM			
31.	1	Trouble shooting and maintenance practices.	
32.	1	Service and inspection.	
33.	1	Inspection and maintenance of landing gear systems.	
34.	1	Inspection and maintenance of air-conditioning and pressurization system, water and waste system.	Aircraft Maintenance and Repair
35.	1	Installation and maintenance of Instruments – handling – Testing.	
36.	1	Inspection and maintenance of auxiliary systems.	Kroes, Watkins, Delp
37.	1	Fire protection systems.	
38.	1	Ice protection system – Rain removal system.	Lecture Notes - KAHE
39.	1	Position and warning system – Auxiliary Power Units (APUs).	
40.	1	**Tutorial 4:** Summary of Unit IV and Part A questions	
Total No. of Hours Planned for Unit - IV			**9L + 1T 10 Hours**

Sl. No.	No. of Periods	Topics to be Covered	Support Materials
UNIT – V : SAFETY PRACTICES			
41.	1	Introduction to Aircraft Safety Practices.	
42.	1	Classification of Fire.	
43.	1	Types of Fire Extinguisher.	
44.	1	Fire Extinguisher Equipments and their handling.	
45.	1	Types of Fire Vehicles.	Aircraft Maintenance and Repair
46.	1	Basics of Hazardous Materials.	
47.	1	Hazardous materials storage and handling.	Kroes, Watkins, Delp
48.	1	Aircraft furnishing practices.	
49.	1	Equipments Trouble shooting – Theory and practices.	Lecture Notes - KAHE
50.	1	**Tutorial 5:** Summary of Unit V and Part A questions	
Total No. of Hours Planned for Unit - V			**9L +1T 10 Hours**
1.	1	End Semester Possible Questions Discussion Discussion and Overview of All Five Units	

TOTAL PERIODS : 45 L + 5T = 50 Hours

TEXT BOOKS:

S.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Kroes, Watkins, Delp	Aircraft Maintenance and Repair	McGraw-HillNew York.	2013

REFERENCES BOOKS:

S.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Larry Reithmeir	Aircraft Repair Manual	Palamar Books, Marquette, New York.	2012

WEBSITES

www.ndt.net/article/wcndt2004/pdf/aerospace/817_assler.pdf

www.manningmetal.com/repair__maintenance.htm

www.aviation-database.com/Aerospace_plastics.htm

www.faa.gov/training_testing/.../FAA-S-8081-27.pdf

www.gao.gov/new.items/d05728.pdf

JOURNALS

J [1] – Journal of Aircraft Maintenance and services
J [2] – Journal of Aircraft repair and overhauling
J [3] – Journal of Aircraft systems

UNIT	Total No. of Periods Planned	Lecture Periods	Tutorial Periods
I	10	9	1
II	10	9	1
III	10	9	1
IV	10	9	1
V	10	9	1
TOTAL	50	45	05 + 02

I. CONTINUOUS INTERNAL ASSESSMENT : 40 Marks

(Internal Assessment Tests: 30(CIA – I -08 + CIA – II – 08 + Model Exam 14), Attendance: 5, Assignment/Seminar: 5)

II. END SEMESTER EXAMINATION : 60 Marks

TOTAL : 100 Marks

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FACULTY OF ENGINEERING

Department of Mechanical Engineering

(Aerospace Engineering)

Subject Name: Airframe Maintenance and Repair **Year / Semester**: III / VI

Subject Code: 16BTAR601 A **Programme:** UG / B.Tech. Aerospace Engg

COURSE OBJECTIVE

Principles of construction of aircraft wooden structures and repair of aircraft synthetic material; principles of rigging fixed and rotary winged aircraft; application of aircraft covering material, aircraft painting, rig rotary and fixed winged aircraft as specified by Federal Aviation Regulation.

LEARNING OUTCOMES

The graduate has reliably demonstrated the ability to:

1. Inspect and service aircraft systems utilizing current and relevant theories and principles.
2. Inspect, test, troubleshoot and repair aircraft and components.
3. Install aircraft engines, parts, components and structures as part of routine and unscheduled maintenance.
4. Diagnose malfunctions or other problems in aircraft systems, structures, instruments, and related components using technical manuals, technical drawings and standards of performance and safety.
5. Complete structural and non-structural repairs and modifications by following applicable procedures and safety precautions, and meeting airworthiness standards.
6. Perform maintenance, repair and modification procedures on aircraft systems, structures, instruments, and related components to maintain aircraft safety and airworthiness.
7. Dismantle and reassemble airframes, aircraft engines and other systems for inspection and repair.
8. Maintain detailed inspection, repair, maintenance, and certification records and reports to meet Canadian aviation regulations and logbook requirements.

FACULTY

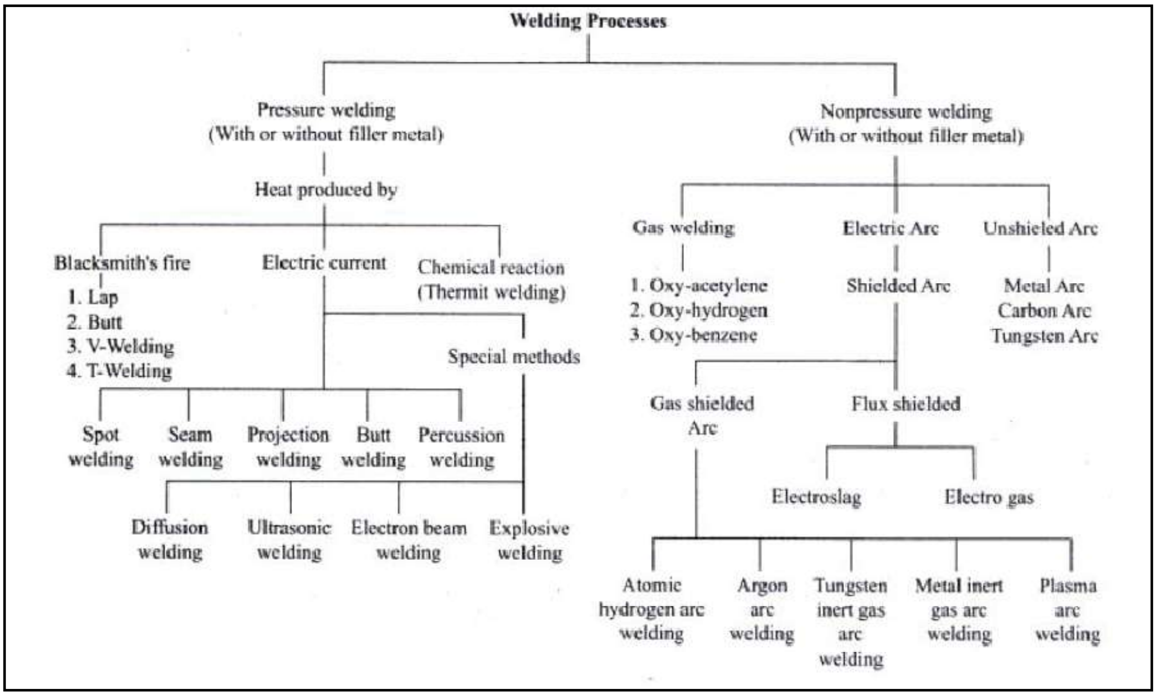
UNIT - I WELDING IN AIRCRAFT STRUCTURAL COMPONENTS

Welding

Welding is a process for joining two similar or dissimilar metals by fusion. It joins different metals/alloys, with or without the application of pressure and with or without the use of filler metal. The fusion of metal takes place by means of heat. The heat may be generated either from combustion of gases, electric arc, electric resistance or by chemical reaction.

Welding provides a permanent joint but it normally affects the metallurgy of the components. It is therefore usually accompanied by post weld heat treatment for most of the critical components. The welding is widely used as a fabrication and repairing process in industries. Some of the typical applications of welding include the fabrication of ships, pressure vessels, automobile bodies, off-shore platform, bridges, welded pipes, sealing of nuclear fuel and explosives, etc.

Welding is a materials joining process which produces coalescence of materials by heating them to suitable temperatures with or without the application of pressure or by the application of pressure alone, and with or without the use of filler material. Welding is used for making permanent joints. It is used in the manufacture of automobile bodies, aircraft frames, railway wagons, machine frames, structural works, tanks, furniture, boilers, general repair work and ship building.



Types

Plastic Welding or Pressure Welding

The piece of metal to be joined are heated to a plastic state and forced together by external pressure (Ex) Resistance welding

Fusion Welding or Non-Pressure Welding

The material at the joint is heated to a molten state and allowed to solidify

(Ex) Gas welding, Arc welding

Classification of welding processes:

Arc welding - Carbon arc, Metal arc, Metal inert gas, Tungsten inert gas, Plasma arc, Submerged arc and Electro-slag

Gas Welding - Oxy-acetylene, Air-acetylene and Oxy-hydrogen

Resistance Welding - Butt, Spot, Seam, Projection and Percussion

Thermit Welding

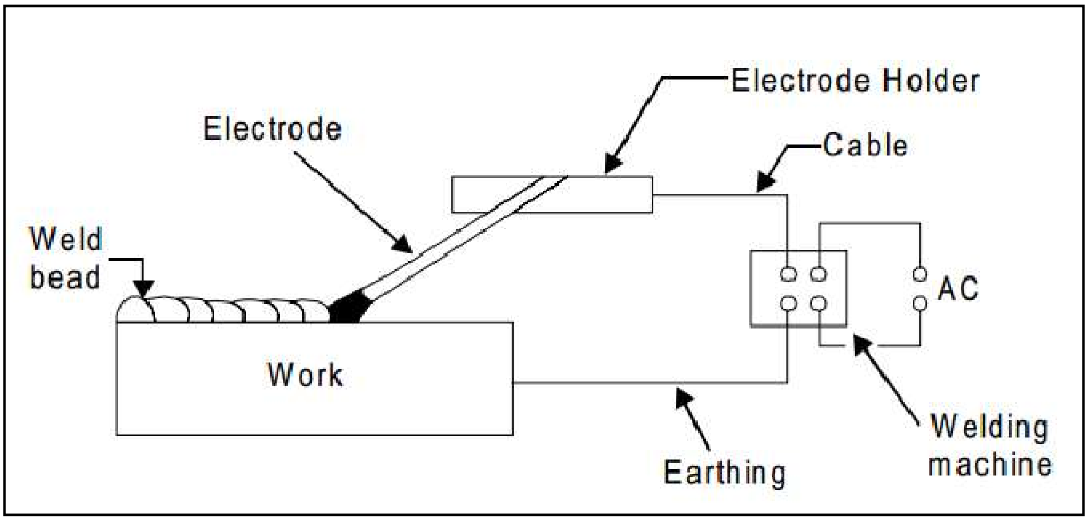
Solid State Welding - Friction, Ultrasonic, Diffusion and Explosive

Newer Welding - Electron-beam and Laser

Related Process - Oxy-acetylene cutting, Arc cutting, hard facing, Brazing and Soldering

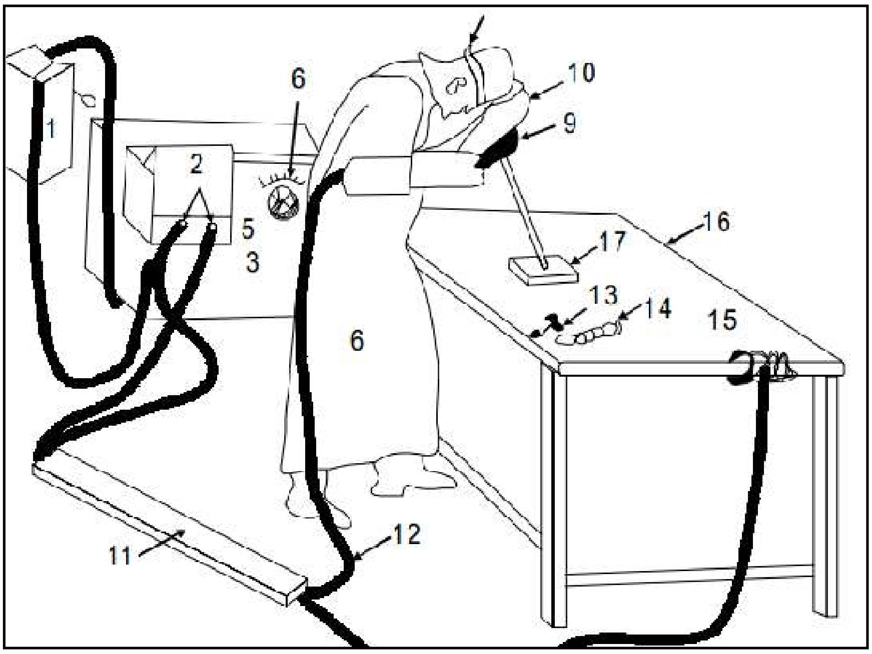
Welding Processes

The process, in which an electric arc between an electrode and a work-piece or between two electrodes is utilized to weld base metals, is called an arc welding process. The basic principle of arc welding is shown in Figure. However the basic elements involved in arc welding process are shown in Figure. Most of these processes use some shielding gas while others employ coatings or fluxes to prevent the weld pool from the surrounding atmosphere.



Switch box, Secondary terminals, Welding machine, Current reading scale, Current regulating hand wheel, Leather apron, Asbestos hand gloves, Protective glasses strap, Electrode holder, Hand shield, Channel for cable protection, Welding cable, Chipping hammer, Wire brush, Earth clamp, Welding table (metallic) and Job.

Welding Equipment



Arc welding equipment, setup and related tools and accessories are shown in Figure. However some common tools of arc welding are shown separately through Figure. Few of the important components of arc welding setup are described as under.

Welding power source

Both direct current (DC) and alternating current (AC) are used for electric arc welding, each having its particular applications. DC welding supply is usually obtained from generators driven by electric motor or if no electricity is available by internal combustion engines. For AC welding supply, transformers are predominantly used for almost all Arc-welding where mains electricity supply is available. They have to step down the usual supply voltage (200-400 volts) to the normal open circuit welding voltage (50-90 volts). The following factors influence the selection of a power source:

Type of electrodes to be used and metals to be welded

Available power source (AC or DC)

Required output

Duty cycle

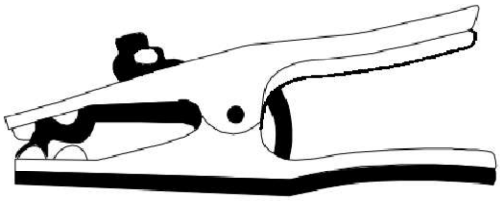
Efficiency

Initial costs and running costs

Available floor space

Versatility of equipment

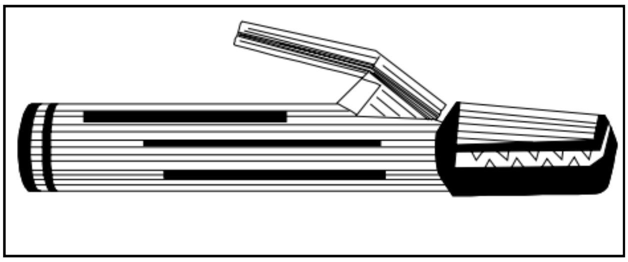
Welding cables



Welding cables are required for conduction of current from the power source through the electrode holder, the arc, the work piece and back to the welding power source. These are insulated copper or aluminum cables.

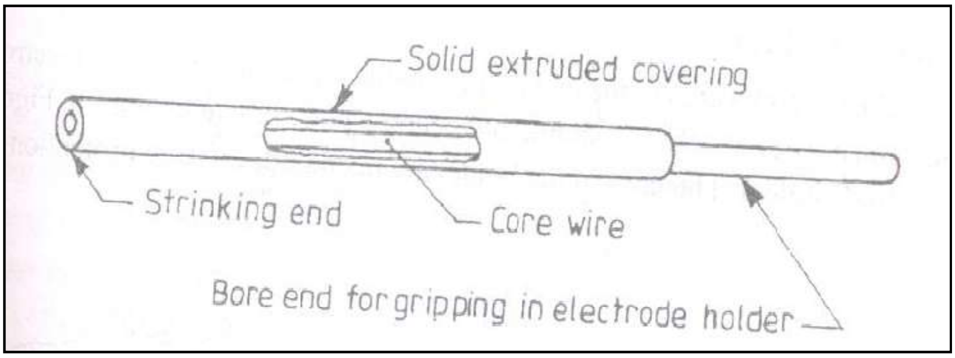
Electrode holder

Electrode holder is used for holding the electrode manually and conducting current to it. These are usually matched to the size of the lead, which in turn matched to the amperage output of the arc welder. Electrode holders are available in sizes that range from 150 to 500 Amps.



Welding Electrodes

An electrode is a piece of wire or a rod of a metal or alloy, with or without coatings. An arc is set up between electrode and work piece.



Welding electrodes are classified into following types-

(i) Consumable Electrodes

(a) Bare Electrodes

(b) Coated Electrodes

(ii) Non-consumable Electrodes

(a) Carbon or Graphite Electrodes

(b) Tungsten Electrodes

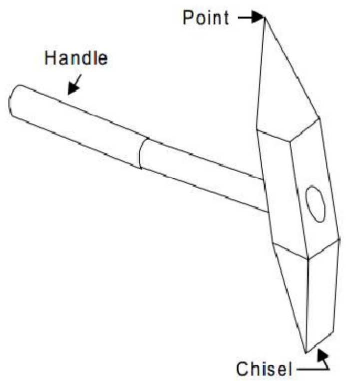
Consumable electrode is made of different metals and their alloys. The end of this electrode starts melting when arc is struck between the electrode and work piece. Thus consumable electrode itself acts as a filler metal. Bare electrodes consist of a metal or alloy wire without any flux coating on them. Coated electrodes have flux coating which starts melting as soon as an electric arc is struck. This coating on melting performs many functions like prevention of joint from atmospheric contamination, arc stabilizers etc.

Non-consumable electrodes are made up of high melting point materials like carbon, pure tungsten or alloy tungsten etc. These electrodes do not melt away during welding. But practically, the electrode length goes on decreasing with the passage of time, because of oxidation and vaporization of the electrode material during welding. The materials of non-consumable electrodes are usually copper coated carbon or graphite, pure tungsten, thoriated or zirconiated tungsten.

Hand Screen

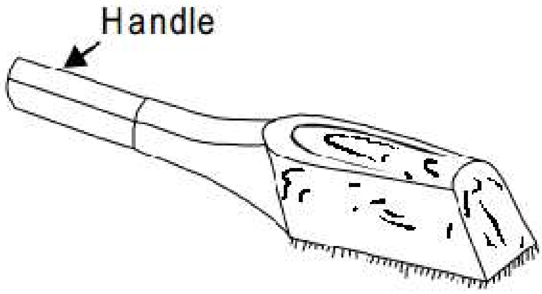
Hand screen used for protection of eyes and supervision of weld bead.

Chipping hammer



Chipping Hammer is used to remove the slag by striking.

Wire brush



Wire brush is used to clean the surface to be weld.

Protective clothing

Operator wears the protective clothing such as apron to keep away the exposure of direct heat to the body.

Safety Recommendations for ARC Welding

The beginner in the field of arc welding must go through and become familiar with these general safety recommendations which are given as under.

1. The body or the frame of the welding machine shall be efficiently earthed. Pipe lines containing gases or inflammable liquids or conduits carrying electrical conductors shall not be used for a ground return circuit All earth connections shall be mechanically strong and electrically adequate for the required current.

2. Welding arc in addition to being very is a source of infra-red and ultra-violet light also; consequently the operator must use either helmet or a hand-shield fitted with a special filter glass to protect eyes

3. Excess ultra-violet light can cause an effect similar to sunburn on the skin of the welder

4. The welder's body and clothing are protected from radiation and burns caused by sparks and flying globules of molten metal with the help of the following:

5. Gloves protect the hands of a welder.

6. Leather or asbestos apron is very useful to protect welder's clothes and his trunk and thighs while seated he is doing welding.

7. For overhead welding, some form of protection for the head is required

8. Leather skull cap or peaked cap will do the needful.

9. Leather jackets and 1ather leggings are also available as clothes for body protection.

10. Welding equipment shall be inspected periodically and maintained in safe working order at all times.

11. Arc welding machines should be of suitable quality.

12. All parts of welding set shall be suitably enclosed and protected to meet the usual service conditions.

Arc welding methods

Metal arc welding

It is a process of joining two metal pieces by melting the edges by an electric arc. The electric arc is produced between two conductors. The electrode is one conductor and the work piece is another conductor. The electrode and the work piece are brought nearer with small air gap. (3mm app.)

When current is passed an electric arc is produced between the electrode and the work piece. The work piece and the electrode are melted by the arc. Both molten piece of metal become one. Temperature of arc is about 4000°c Electrodes used in arc welding are coated with a flux. This flux produces a gaseous shield around the molten metal. It prevents the reaction of the molten metal with oxygen and nitrogen in the atmosphere. The flux removes the impurities from the molten metal and form a slag. This slag gets deposited over the weld metal. This protects the weld seam from rapid cooling. Fig.1 shows arc welding process.

Equipments:

- A welding generator (D.C.) or Transformer (A.C.)
- Two cables- one for work and one for electrode
- Electrode holder, Electrode
- Protective shield, Gloves
- Wire brush, Chipping hammer, Goggles

Advantages

- ➢ Most efficient way to join metals
- ➢ Lowest-cost joining method
- ➢ Affords lighter weight through better utilization of materials
- ➢ Joins all commercial metals
- ➢ Provides design flexibility

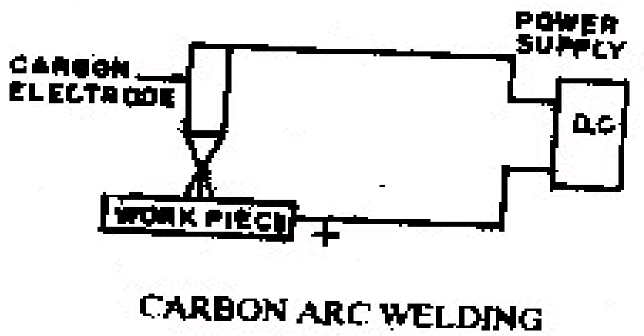
Limitations

1. Manually applied, therefore high labor cost.
2. Need high energy causing danger
3. Not convenient for disassembly.
4. Defects are hard to detect at joints.

Carbon arc welding

In carbon arc welding, the intense of heat of an electric arc between a carbon electrode and work piece metal is used for welding. DC power supply is used. The carbon electrode is connected to negative terminal and work piece is connected to positive terminal, because positive terminal is hotter (4000°c) than the negative terminal (3000°c) when an arc is produced. So carbon from the electrode will not fuse and mix up with the metal weld. If carbon mixes with the weld, the weld will become weak and brittle. To protect the molten metal from the atmosphere the welding is done with a long arc. In this case, a carbon monoxide gas is produced, which surrounds the molten metal and protects it.

Carbon arc welding is used to weld both ferrous and non ferrous metals. Sheets of steel, copper alloys, brass and aluminium can be welded in this method.



Carbon Arc Welding

Comparison of A.C. and D.C. arc welding

	Alternating Current (from Transformer)	**Direct Current (from Generator)**
1	More efficiency	Less efficiency
2	Power consumption less	Power consumption more
3	Cost of equipment is less	Cost of equipment is more
4	Higher voltage – hence not safe	Low voltage – safer operation
5	Not suitable for welding non ferrous metals	suitable for both ferrous non ferrous metals
6	Not preferred for welding thin sections	preferred for welding thin sections
7	Any terminal can be connected to the work or electrode	Positive terminal connected to the work Negative terminal connected to the electrode

GAS WELDING

Oxy-Acetylene welding

In gas welding, a gas flame is used to melt the edges of metals to be joined. The flame is produced at the tip of welding torch. Oxygen and Acetylene are the gases used to produce the welding flame. The flame will only melt the metal. A flux is used during welting to prevent oxidations and to remove impurities. Metals 2mm to 50mm thick are welded by gas welding. The temperature of oxyacetylene flame is about 3200°c. Fig 3 shows Gas welding equipments.

Gas Welding Equipment

1. Gas Cylinders

    Pressure

    Oxygen – 125 kg/cm^2

    Acetylene – 16 kg/cm^2

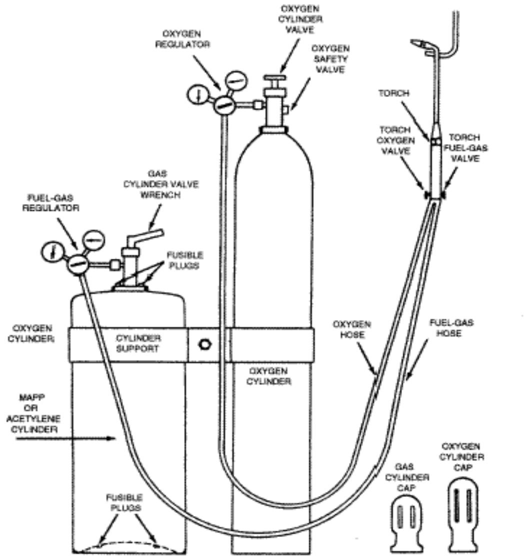
2. Regulators

    Working pressure of oxygen 1 kg/cm^2

    Working pressure of acetylene 0.15 kg/cm^2

    Working pressure varies depends upon the thickness of the work pieces welded.

3. Pressure Gauges
4. Hoses
5. Welding torch
6. Check valve
7. Non return valve

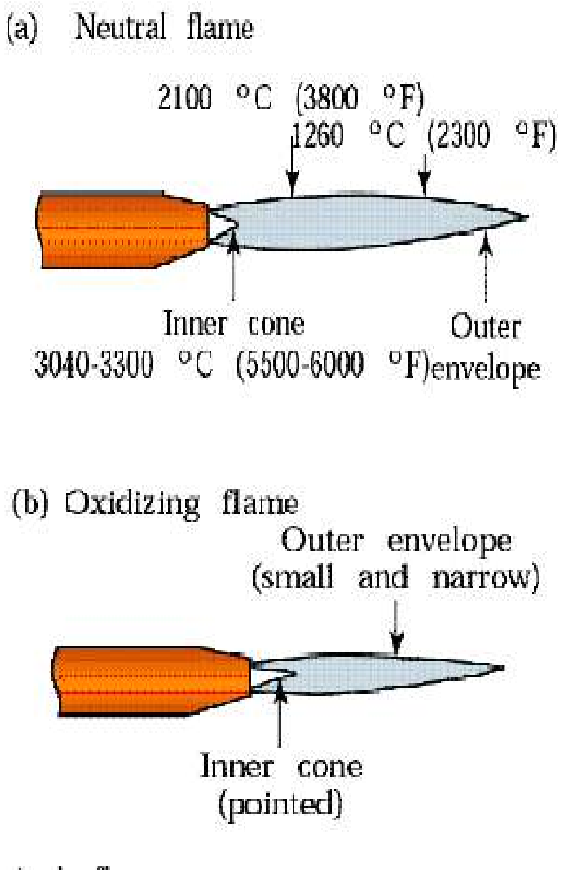


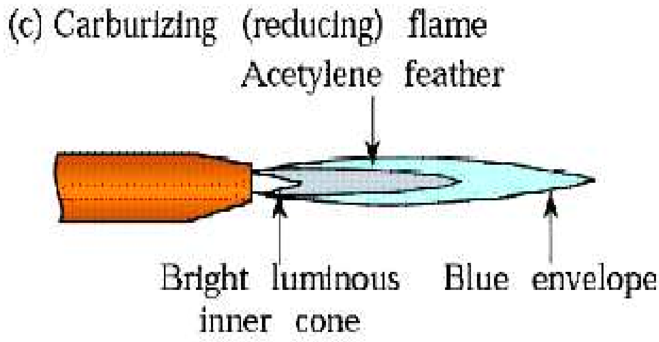
Gas Welding Equipment

TYPES OF FLAMES

- When acetylene is burned in air, it produces a yellow sooty flame, which is not enough for welding applications
- Oxygen is turned on, flame immediately changes into a long white inner area (Feather) surrounded by a transparent blue envelope is called **Carburizing flame** (30000c)
- This flames are used for hardening the surfaces
- Addition of little more oxygen give a bright whitish cone surrounded by the transparent blue envelope is called **Neutral flame** (It has a balance of fuel gas and oxygen)
- Most commonly used flame because it has temperature about 32000c
- Used for welding steels, aluminium, copper and cast iron
- If more oxygen is added, the cone becomes darker and more pointed, while the envelope becomes shorter and more fierce is called **Oxidizing flame**
- Has the highest temperature about 34000c
- Used for welding brass and brazing operation

Fig 4 shows the types of flames.





Types of Gas Flames

Advantages

1. Equipment has versatile
2. Same equipment can be used for oxy acetylene cutting and brazing by varying the torch size
3. Heat can controlled easily

Disadvantages

1. Slower process
2. Risk is involved in handling gas cylinders

GAS CUTTING

- Ferrous metal is heated in to red hot condition and a jet of pure oxygen is projected onto the surface, which rapidly oxidizes
- Oxides having lower melting point than the metal, melt and are blown away by the force of the jet, to make a cut
- Fast and efficient method of cutting steel to a high degree of accuracy
- Torch is different from welding
- Cutting torch has preheat orifice and one central orifice for oxygen jet
- **PIERCING** and **GOUGING** are two important operations
- **Piercing**, used to cut a hole at the centre of the plate or away from the edge of the plate
- **Gouging**, to cut a groove into the steel surface

Weld joint

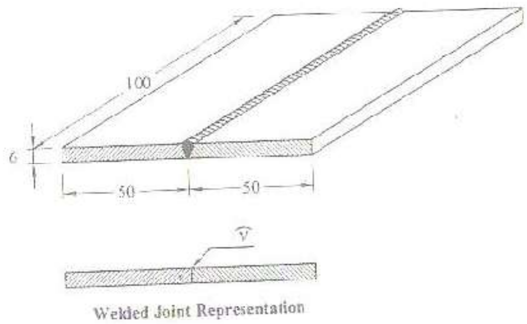
There are 5 basic joint types in welding

- Butt joint: Two materials are in the same plane, joined from the edges.
- Corner joint:The corners of two materials form a right angle and joined.
- Lap joint: Two parts overlaps.
- Tee joint: One part is perpendicular to the other, making a T shape.
- Edge joint: Edges of the two materials joined.

Types of Welding and Joints

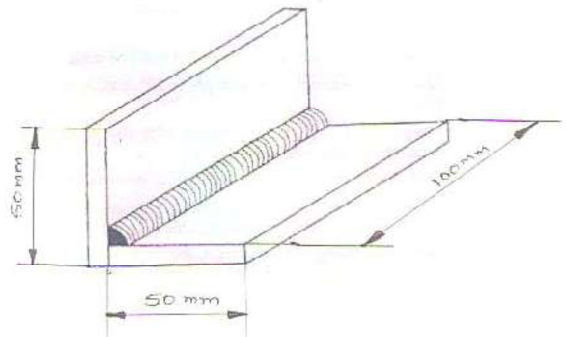
Butt Joint

A butt weld, or a square-groove, is the most common and easiest to use. Consisting of two flat pieces that are parallel to one another, it also is an economical option. It is the universally used method of joining a pipe to itself, as well as flanges, valves, fittings, or other equipment. However, it is limited by any thickness exceeding 3/16".



Corner Joint

A corner weld is a type of joint that is between two metal parts and is located at right angles to one another in the form of a L. As the name indicates, it is used to connect two pieces together, forming a corner. This weld is most often used in the sheet metal industry and is performed on the outside edge of the piece.

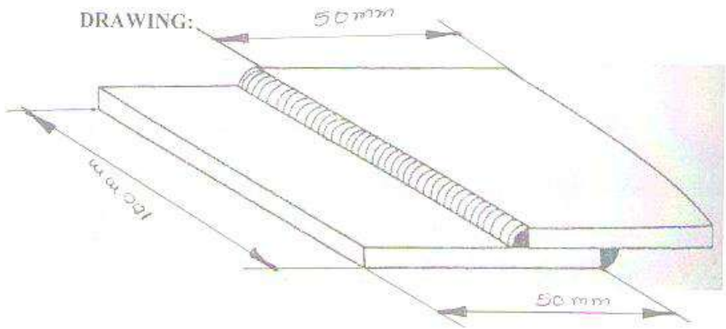


Edge Joint

Edge welding joints, a groove type of weld, are placed side by side and welded on the same edge. They are the most commonly replaced type of joints due to build up accumulating on the edges. They are often applied to parts of sheet metal that have edges flanging up or formed at a place where a weld must be made to join two adjacent pieces together.

Lap Joint

This is formed when two pieces are placed atop each other while also over lapping each other for a certain distance along the edge. Considered a fillet type of a welding joint, the weld can be made on one or both sides, depending upon the welding symbol or drawing requirements. It is most often used to join two pieces together with differing levels of thickness.

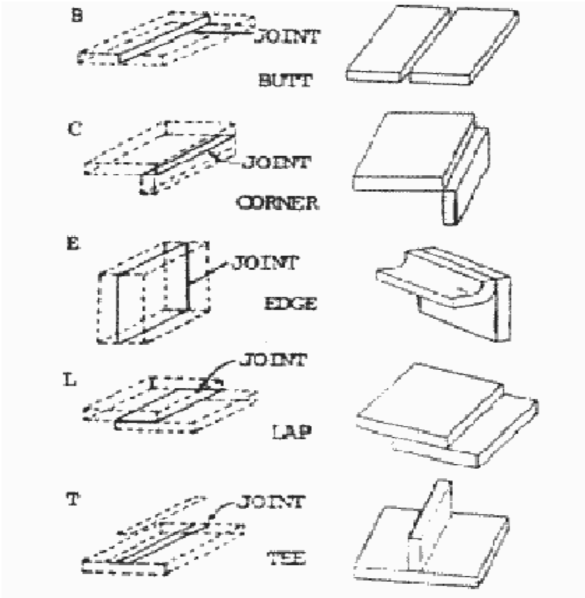


Tee Joint

Tee joints, considered a fillet type of weld, form when two members intersect at 90° resulting in the edges coming together in the middle of a component or plate. It may also be formed when a tube or pipe is placed on a base plate.

Types of weld

1. Fillet weld: Used in T joints,corner joints, lap joints.
2. Groove weld:Used in butt joints.
3. Plug weld: Used in lap joints.
4. Slot weld: Used in lap joints.
5. Spot weld: Used in lap joints.
6. Seam weld: Used in lap joints.
7. Flange weld:Used in edge joints.
8. Surfacing weld:Not a joining process, it is used to increase the thickness of the plate, or provide a protective coating on the surface.



Types of Weld Joints

Weld ability is the ease of a material or a combination of materials to be welded under fabrication conditions into a specific, suitably designed structure, and to perform satisfactorily in the intended service

Welding Defects

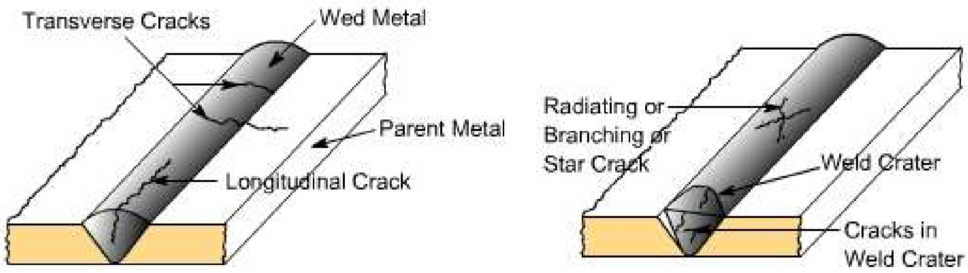
The defects in the weld can be defined as irregularities in the weld metal produced due to incorrect welding parameters or wrong welding procedures or wrong combination of filler metal and parent metal.

Weld defect may be in the form of variations from the intended weld bead shape, size and desired quality. Defects may be on the surface or inside the weld metal. Certain defects such as cracks are never tolerated but other defects may be acceptable within permissible limits. Welding defects may result into the failure of components under service condition, leading to serious accidents and causing the loss of property and sometimes also life.

Various welding defects can be classified into groups such as cracks, porosity, solid inclusions, lack of fusion and inadequate penetration, imperfect shape and miscellaneous defects.

Cracks

Cracks may be of micro or macro size and may appear in the weld metal or base metal or base metal and weld metal boundary. Different categories of cracks are longitudinal cracks, transverse cracks or radiating/star cracks and cracks in the weld crater. Cracks occur when localized stresses exceed the ultimate tensile strength of material. These stresses are developed due to shrinkage during solidification of weld metal.

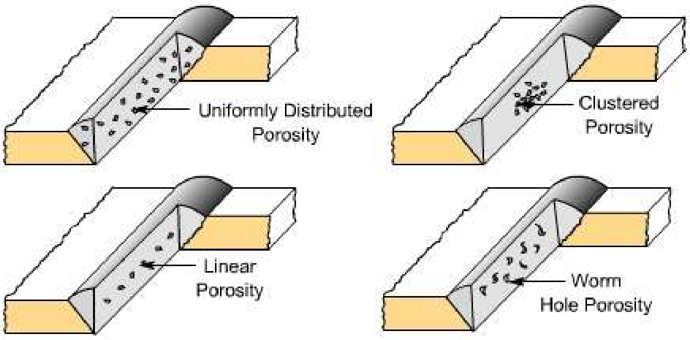


Various Types of Cracks in Welds

Cracks may be developed due to poor ductility of base metal, high sulpher and carbon contents, high arc travel speeds i.e. fast cooling rates, too concave or convex weld bead and high hydrogen contents in the weld metal.

Porosity

Porosity results when the gases are entrapped in the solidifying weld metal. These gases are generated from the flux or coating constituents of the electrode or shielding gases used during welding or from absorbed moisture in the coating. Rust, dust, oil and grease present on the surface of work pieces or on electrodes are also source of gases during welding. Porosity may be easily prevented if work pieces are properly cleaned from rust, dust, oil and grease.Futher, porosity can also be controlled if excessively high welding currents, faster welding speeds and long arc lengths are avoided flux and coated electrodes are properly baked.

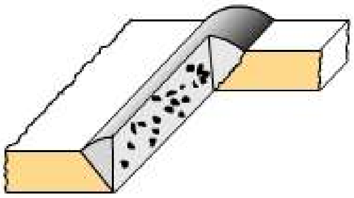


Different Forms of Porosities

Solid Inclusion

Solid inclusions may be in the form of slag or any other nonmetallic material entrapped in the weld metal as these may not able to float on the surface of the solidifying weld metal. During arc welding flux either in the form of granules or coating after melting, reacts with the molten weld metal removing oxides and other impurities in the form of slag and it floats on the surface of weld metal due to its low density. However, if the molten weld metal has high viscosity or too low temperature or cools rapidly then the slag may not be released from the weld pool and may cause inclusion.

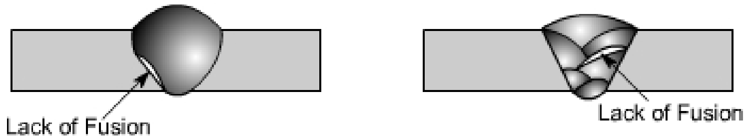
Slag inclusion can be prevented if proper groove is selected, all the slag from the previously deposited bead is removed, too high or too low welding currents and long arcs are avoided.



Slag Inclusion in Weldments

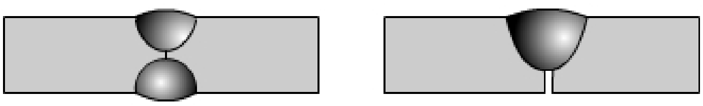
Lack of Fusion and Inadequate or incomplete penetration:

Lack of fusion is the failure to fuse together either the base metal and weld metal or subsequent beads in multipass welding because of failure to raise the temperature of base metal or previously deposited weld layer to melting point during welding. Lack of fusion can be avoided by properly cleaning of surfaces to be welded, selecting proper current, proper welding technique and correct size of electrode.



Types of Lack of Fusion

Incomplete penetration means that the weld depth is not upto the desired level or root faces have not reached to melting point in a groove joint. If either low currents or larger arc lengths or large root face or small root gap or too narrow groove angles are used then it results into poor penetration.



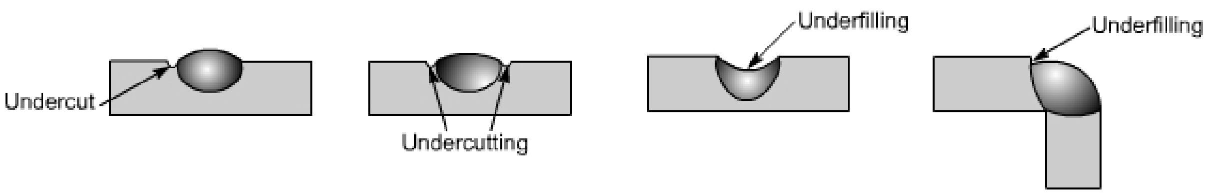
Examples of Inadequate Penetration

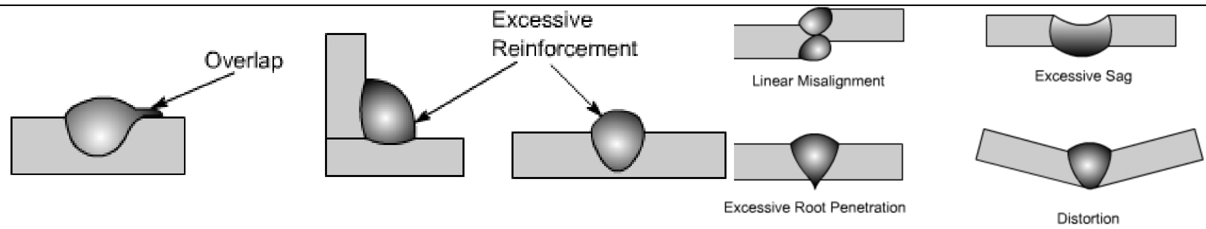
Imperfect Shape

Imperfect shape means the variation from the desired shape and size of the weld bead.

During undercutting a notch is formed either on one side of the weld bead or both sides in which stresses tend to concentrate and it can result in the early failure of the joint. Main reasons for undercutting are the excessive welding currents, long arc lengths and fast travel speeds.

Under filling may be due to low currents, fast travel speeds and small size of electrodes. Overlap may occur due to low currents, longer arc lengths and slower welding speeds.





Various Imperfect Shapes of Welds

Excessive reinforcement is formed if high currents, low voltages, slow travel speeds and large size electrodes are used. Excessive root penetration and sag occur if excessive high currents and slow travel speeds are used for relatively thinner members.

Distortion is caused because of shrinkage occurring due to large heat input during welding.

Miscellaneous Defects

Various miscellaneous defects may be multiple arc strikes i.e. several arc strikes are one behind the other, spatter, grinding and chipping marks, tack weld defects, oxidized surface in the region of weld, un removed slag and misalignment of weld beads if welded from both sides in butt welds.

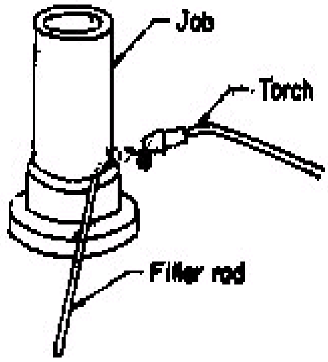
Brazing and Soldering

Brazing

It is a low temperature joining process. It is performed at temperatures above 840º F and it generally affords strengths comparable to those of the metal which it joins. It is low temperature in that it is done below the melting point of the base metal. It is achieved by diffusion without fusion (melting) of the base

Depending upon the method of heating, brazing can be classified as

1. Torch brazing
2. Dip brazing
3. Furnace brazing
4. Induction brazing



BRAZING

Brazing

Advantages

- Dissimilar metals which cannot be welded can be joined by brazing
- Very thin metals can be joined
- Metals with different thickness can be joined easily
- In brazing thermal stresses are not produced in the work piece. Hence there is no distortion
- Using this process, carbides tips are brazed on the steel tool holders

Disadvantages

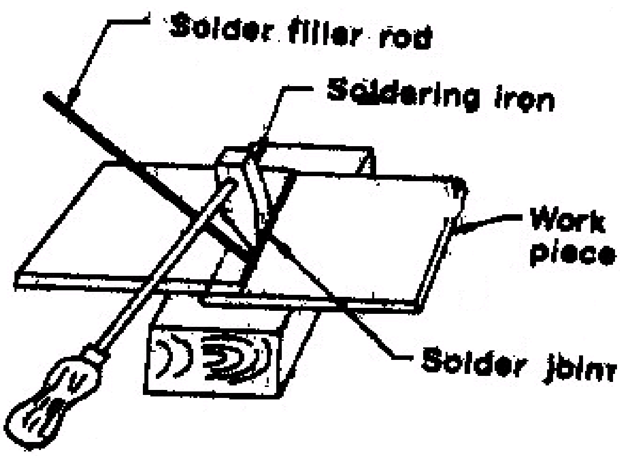
- Brazed joints have lesser strength compared to welding
- Joint preparation cost is more
- Can be used for thin sheet metal sections

Soldering

It is a low temperature joining process. It is performed at temperatures below 840ºF for joining.

Soldering is used for,

- Sealing, as in automotive radiators or tin cans
- Electrical Connections
- Joining thermally sensitive components
- Joining dissimilar metals



Soldering

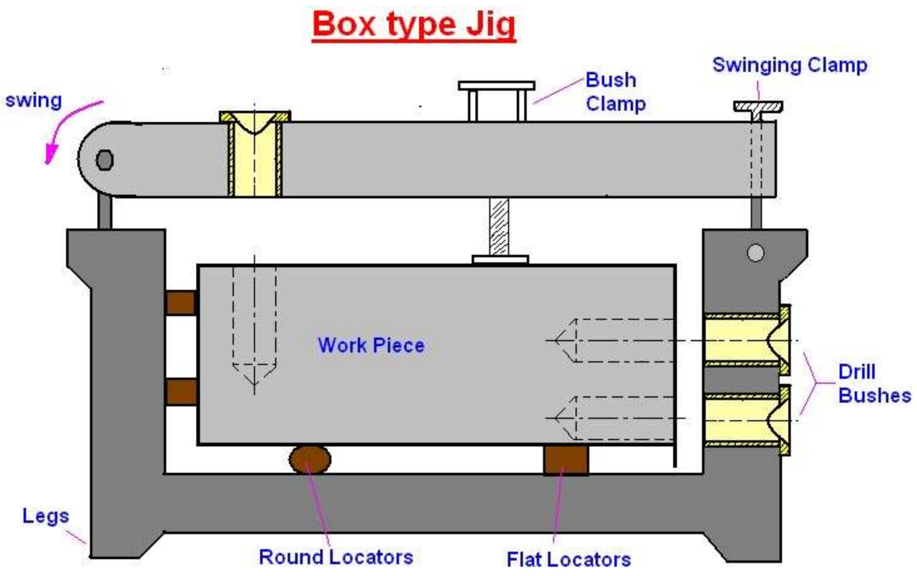
Welding Jigs and Fixtures

The successful running of any mass production depends upon the interchangeability to facilitate easy assembly and reduction of unit cost. Mass production methods demand a fast and easy method of positioning work for accurate operations on it.

Jigs and fixtures are production tools used to accurately manufacture duplicate and interchangeable parts. Jigs and fixtures are specially designed so that large numbers of components can be machined or assembled identically, and to ensure interchangeability of components.

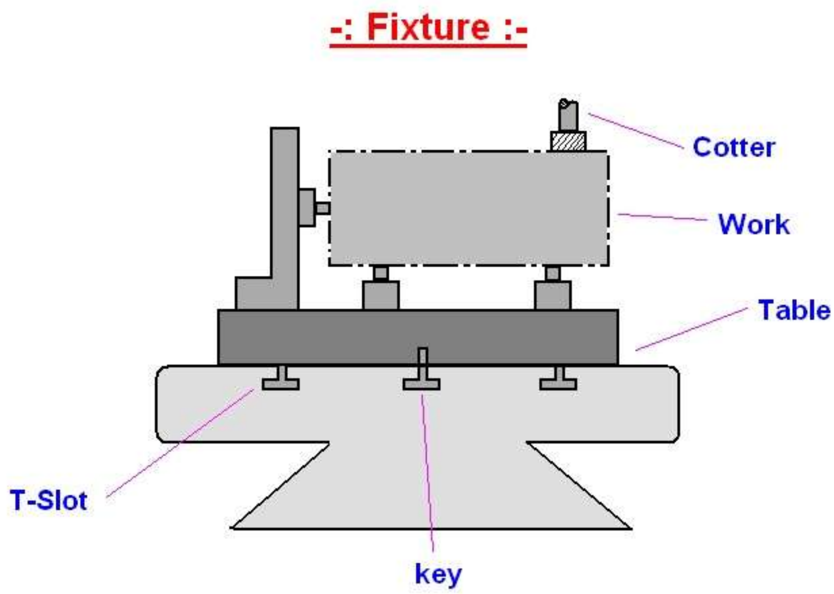
JIGS

It is a work holding device that holds, supports and locates the work piece and guides the cutting tool for a specific operation. Jigs are usually fitted with hardened steel bushings for guiding or other cutting tools. a jig is a type of tool used to control the location and/or motion of another tool. A jig's primary purpose is to provide repeatability, accuracy, and interchangeability in the manufacturing of products. A device that does both functions (holding the work and guiding a tool) is called a jig. An example of a jig is when a key is duplicated, the original is used as a jig so the new key can have the same path as the old one.



FIXTURES

It is a work holding device that holds supports and locates the work piece for a specific operation but does not guide the cutting tool. It provides only a reference surface or a device. What makes a fixture unique is that each one is built to fit a particular part or shape. The main purpose of a fixture is to locate and in some cases hold a work piece during either a machining operation or some other industrial process. A jig differs from a fixture in that a it guides the tool to its correct position in addition to locating and supporting the work piece. Examples: Vises, chucks



JIG	FIXTURES
1. It is a work holding device that holds, supports and locates the work piece and guides the cutting tool for a specific operation	1. It is a work holding device that holds, supports and locates the work piece for a specific operation but does not guide the cutting tool
2. Jigs are not clamped to the drill press table unless large diameters to be drilled and there is a necessity to move the jig to bring one each bush directly under the drill.	2. Fixtures should be securely clamped to the table of the machine upon which the work is done.
3. The jigs are special tools particularly in drilling, reaming, tapping and boring operation.	3. Fixtures are specific tools used particularly in milling machine, shapers and slotting machine.
4. Gauge blocks are not necessary.	4. Gauge blocks may be provided for effective handling.
5. Lighter in construction.	5. Heavier in construction.

SHEET METAL REPAIR AND MAINTENANCE

Basic Principles of Sheet Metal Repair

Aircraft structural members are designed to perform a specific function or to serve a definite purpose. The primary objective of aircraft repair is to restore damaged parts to their original condition. Very often, replacement is the only way this can be done effectively. When repair of a damaged part is possible, first study the part carefully to fully understand its purpose or function. Strength may be the principal requirement in the repair of certain structures, while others may need entirely different qualities. For example, fuel tanks and floats must be protected against leakage; cowlings, fairings, and similar parts must have such properties as neat appearance, streamlined shape, and accessibility. The function of any damaged part must be carefully determined to ensure the repair meets the requirements.

An inspection of the damage and accurate estimate of the type of repair required are the most important steps in repairing structural damage. The inspection includes an estimate of the best type and shape of repair patch to use; the type, size, and number of rivets needed; and the strength, thickness, and kind of material required to make the repaired member no heavier (or only slightly heavier) and just as strong as the original.

When investigating damage to an aircraft, it is necessary to make an extensive inspection of the structure. When any component or group of components has been damaged, it is essential that both the damaged members and the attaching structure be investigated, since the damaging force may have been transmitted over a large area, sometimes quite remote from the point of original damage. Wrinkled skin, elongated or damaged bolt or rivet holes, or distortion of members usually appears in the immediate area of such damage, and any one of these conditions calls for a close inspection of the adjacent area. Check all skin, dents, and wrinkles for any cracks or abrasions.

Nondestructive inspection methods (NDI) are used as required when inspecting damage. NDI methods serve as tools of prevention that allow defects to be detected before they develop into serious or hazardous failures. A trained and experienced technician can detect flaws or defects with a high degree of accuracy and reliability. Some of the defects found by NDI include corrosion, pitting, heat/stress cracks, and discontinuity of metals.

When investigating damage, proceed as follows:

• Remove all dirt, grease, and paint from the damaged and surrounding areas to determine the exact condition of each rivet, bolt, and weld.

• Inspect skin for wrinkles throughout a large area.

• Check the operation of all movable parts in the area.

• Determine if repair would be the best procedure. In any aircraft sheet metal repair, it is critical to:

• Maintain original strength,

• Maintain original contour, and

• Minimize weight.

Inspection of Damage

When visually inspecting damage, remember that there may be other kinds of damage than that caused by impact from foreign objects or collision. A rough landing may overload one of the landing gear, causing it to become sprung; this would be classified as load damage.

During inspection and sizing up of the repair job, consider how far the damage caused by the sprung shock strut extends to supporting structural members. A shock occurring at one end of a member is transmitted throughout its length; therefore, closely inspect all rivets, bolts, and attaching structures along the complete member for any evidence of damage. Make a close examination for rivets that have partially failed and for holes that have been elongated. Whether specific damage is suspected or not, an aircraft structure must occasionally be inspected for structural integrity.

The following paragraphs provide general guidelines for this inspection. When inspecting the structure of an aircraft, it is very important to watch for evidence of corrosion on the inside. This is most likely to occur in pockets and corners where moisture and salt spray may accumulate; therefore, drain holes must always be kept clean. While an injury to the skin covering caused by impact with an object is plainly evident, a defect, such as distortion or failure of the substructure, may not be apparent until some evidence develops on the surface, such as canted, buckled or wrinkled covering, and loose rivets or working rivets.

A working rivet is one that has movement under structural stress, but has not loosened to the extent that movement can be observed. This situation can sometimes be noted by a dark, greasy residue or deterioration of paint and primers around rivet heads. External indications of internal injury must be watched for and correctly interpreted. When found, an investigation of the substructure in the vicinity should be made and corrective action taken. Warped wings are usually indicated by the presence of parallel skin wrinkles running diagonally across the wings and extending over a major area. This condition may develop from unusually violent maneuvers, extremely rough air, or extra hard landings. While there may be no actual rupture of any part of the structure, it may be distorted and weakened. Similar failures may also occur in fuselages.

Small cracks in the skin covering may be caused by vibration and they are frequently found leading away from rivets. Aluminum alloy surfaces having chipped protective coating, scratches, or worn spots that expose the surface of the metal should be recoated at once, as corrosion may develop rapidly. The same principle is applied to aluminum clad surfaces.

Scratches, which penetrate the pure aluminum surface layer, permit corrosion to take place in the alloy beneath. A simple visual inspection cannot accurately determine if suspected cracks in major structural members actually exist or the full extent of the visible cracks. Eddy current and ultrasonic inspection techniques are used to find hidden damage.

Types of Damage and Defects

Types of damage and defects that may be observed on aircraft parts are defined as follows:

• Brinelling—occurrence of shallow, spherical depressions in a surface, usually produced by a part having a small radius in contact with the surface under high load.

• Burnishing—polishing of one surface by sliding contact with a smooth, harder surface. Usually there is no displacement or removal of metal.

• Burr—a small, thin section of metal extending beyond a regular surface, usually located at a corner or on the edge of a hole.

• Corrosion—loss of metal from the surface by chemical or electrochemical action. The corrosion products generally are easily removed by mechanical means. Iron rust is an example of corrosion.

• Crack—a physical separation of two adjacent portions of metal, evidenced by a fine or thin line across the surface caused by excessive stress at that point. It may extend inward from the surface from a few thousandths of an inch to completely through the section thickness.

• Cut—loss of metal, usually to an appreciable depth over a relatively long and narrow area, by mechanical means, as would occur with the use of a saw blade, chisel, or sharp-edged stone striking a glancing blow.

• Dent—indentation in a metal surface produced by an object striking with force. The surface surrounding the indentation is usually slightly upset.

• Erosion—loss of metal from the surface by mechanical action of foreign objects, such as grit or fine sand. The eroded area is rough and may be lined in the direction in which the foreign material moved relative to the surface.
• Chattering—breakdown or deterioration of metal surface by vibratory or chattering action. Although chattering may give the general appearance of metal loss or surface cracking, usually, neither has occurred.

• Galling—breakdown (or build-up) of metal surfaces due to excessive friction between two parts having relative motion. Particles of the softer metal are torn loose and welded to the harder metal.

• Gouge—groove in, or breakdown of, a metal surface from contact with foreign material under heavy pressure. Usually it indicates metal loss but may be largely the displacement of material.

• Inclusion—presence of foreign or extraneous material wholly within a portion of metal. Such material is introduced during the manufacture of rod, bar or tubing by rolling or forging.

• Nick—local break or notch on an edge. Usually it involves the displacement of metal rather than loss.

• Pitting—sharp, localized breakdown (small, deep cavity) of metal surface, usually with defined edges.

• Scratch—slight tear or break in metal surface from light, momentary contact by foreign material.

• Score—deeper (than scratch) tear or break in metal surface from contact under pressure. May show discoloration from temperature produced by friction.

• Stain—a change in color, locally causing a noticeably different appearance from the surrounding area. • Upsetting—a displacement of material beyond the normal contour or surface (a local bulge or bump). Usually it indicates no metal loss.

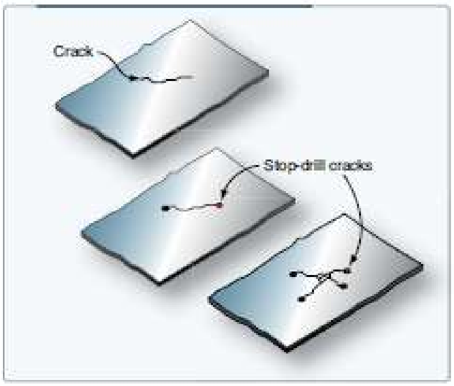
Classification of Damage

Damages may be grouped into four general classes. In many cases, the availabilities of repair materials and time are the most important factors in determining if a part should be repaired or replaced.

Negligible Damage

Negligible damage consists of visually apparent, surface damage that do not affect the structural integrity of the component involved. Negligible damage may be left as is or may be corrected by a simple procedure without restricting flight. In both cases, some corrective action must be taken to keep the damage from spreading.

Negligible or minor damage areas must be inspected frequently to ensure the damage does not spread. Permissible limits for negligible damage vary for different components of different aircraft and should be carefully researched on an individual basis. Failure to ensure that damages within the specified limit of negligible damage may result in insufficient structural strength of the affected support member for critical flight conditions. Small dents, scratches, cracks, and holes that can be repaired by smoothing, sanding, stop drilling, or hammering out, or otherwise repaired without the use of additional materials, fall in this classification.



Negligible Damage

Repairing bends and dents from steel tubing

The first step in any repair process is assessing the damage to determine whether it's simple or major. Minor damage to a sheet metal structure includes missing or damaged rivets, scratches or small dents, a small crack, and a corroded sheet metal surface. Damage that exceeds the scope of these items is, in most cases, major. For example, deformed rivets often indicate damage to a sheet metal structure, and your inspection should include an area well past the deformed rivets.

Scratches, Dents, and Small Cracks

Scratches happen, and you should repair them to prevent corrosion from taking place. In addition, scratches can lead to cracks. To prevent this, in most cases you can burnish or polish scratches smooth, and the best tool to use is a high-speed grinder with a Cratex abrasive wheel. This special, rubberized wheel is designed for use on sheet metal. Available at most industrial supply houses, it will allow you to easily remove the damaged area without further damage.

Small cracks are a common problem on sheet metal airplanes. Created by vibration, you'll often find them developing on areas like the engine cowling. The common fix is to "stop drill" the crack with a small diameter drill bit. In other words, you drill a small hole at each end of the crack in the hope of stopping its growth. This fix is not a repair. To repair the crack, after you stop drill it, rivet a small sheet metal patch of the same type and thickness metal over the crack to restore the area's strength and to keep vibration from acting on it further.

Corroded Sheet Metal

It should be obvious that corrosion weakens sheet metal. To prevent this, remove all corrosion you discover with fine sandpaper, Scotch-Brite pads, or aluminum wool. A high-speed grinder with a Cratex wheel is another good way to remove corrosion. Never use a steel wheel or a wire brush.

After removing the corrosion, acid etch the aluminum by washing it with Poly-Fiber's E-2310 Acid Etch, diluted with water, or a similar product. An acid etch removes oil and light corrosion, and it etches or roughens the surface to create a good surface for the primer to bond to.

After thoroughly rinsing the area, wash it with E-2300 Conversion Coating. This inhibits corrosion and further enhances the primer adhesion. Rinse the area again and let it dry completely before priming and painting the surface.

Depending on the corrosion's location, you might have to remove and replace rivets, and we discussed this process earlier. In some cases, the corrosion might be so great you'll need to replace the sheet metal itself. Generally, this counts as a major repair, and you should seek assistance from knowledgeable sources before attempting the repair.

Step 1 - Clean the Pipe

You need to remove any form of residue inside the pipe. Use a hose and run clean water into the exhaust system. Do this 2 to 3 times to make sure the system is free from gas deposits. Remove all gas deposits prior operation.

Step 2 - Pressurize the Pipes

Use automotive style block plugs to seal the exhaust system. Put the plugs are at the far end in order to be attached to the vice grips of the pipe. This will help the pipe from exploding under pressure. Make sure that the pipes are connected to the air compressor. Leaks are unavoidable during this process. Switch on the air compressor and check the pressure reaches from 80 to 120 psi. The amount of pressure will depend on the pipe’s damage.

Step 3 – Heat the Metal

Make sure the pipes glow red once you start heating the pipes up with a torch. Be cautious not to melt the metal. The use of heat will make the dents to come out. Heat the pipes slowly. Be careful not to go near the heated area. Remember, wear protective gloves or use rags to prevent your hands from getting burned. You will need to use goggles once you start hammering the pipes.

Step 4 - Hammer the Dents

Get your hammer and tap the dents out in a slow circular motion. You will use a hammer to shape the dented pipes. Always put in mind to do things slowly. This may seem tedious at first, especially if you are not used to handling automotive procedures. Hammering the pipes in quick motion could result to damaging the pipes. Hammer until everything is smooth.

Step 5 - Cool down the Pipe

After hammering, wait for the pipe to cool down. This may take some minutes. Once the pipe cooled down, get your rotary wire wheel to sand the pipes. Use a steel wool for the hard-to-reach areas. Continue sanding until the metal is shiny and smooth again. It’s optional if you want to put a layer of automotive paint. Just make sure all the dents are smoothed before your apply paint. Overlooked dents are obvious once you start painting the pipes. You will have to start all over again.

The first step in any repair process is assessing the damage to determine whether it's simple or major. Minor damage to a sheet metal structure includes missing or damaged rivets, scratches or small dents, a small crack, and a corroded sheet metal surface. Damage that exceeds the scope of these items is, in most cases, major. For example, deformed rivets often

UNIT - II PLASTICS AND COMPOSITES IN AIRCRAFT

Review of types of plastics used in airplanes

Aircraft components

The airframe, aircraft fairing components, wings, nose, fuselage and tail plane are made of a number of components. The materials used for these must have good thermal and mechanical properties as well as good resistance to aging.

Door fairings
Fuselage and tail plane components
Wings: Slats and flaps, boxes, panels
Airframe: Doors, components, electrics, pipes and leads, cable ducts Material and parts

Antenna covers, bearing bushes, sliding elements (vacuum)

Construction and insulation components Wire coils, sealing rings, Radar cover e Torque cylinder, Fixing elements, Pipe holders

Components Fasteners, Bearings, Sealing, Bushings, Re-fuelling and fuel systems

Plastics used for such functions as fixing elements, ball bearings, seals or sliding bearings have excellent mechanical properties.

Equipment and systems

For materials used in the propulsion elements, control units or landing gear, good electrical and thermal properties are essential. Controlled fire behavior, low fume toxicity, good sliding properties and high chemical resistance are also a requirement.

Actuation & Control Systems: Air management, thermal and power management, engine control, electrical landing system (ISR), sensors, e actuators and integration lighting, de-icing, flight control, door opening/closing control

Landing Gear: Main and nose landing gear, steering system, extension/ retraction system, kneeling system, wheels and brakes

Cabin interior

Because plastics are used in lighting systems, seats, the on-board kitchen and cooling systems, in the oxygen supply, drinking water and disposal systems, as well as freight loading facilities, in some cases supplementary specifications such as FDA, fungus test and drinking water approvals are additionally required.

Seating, cabin lighting, galley, chilling systems, oxygen systems, drinking water systems, vacuum waste systems, cargo equipment

Propulsion systems

For applications in machines, components or housings, materials are required above all to offer good thermal resistance and sliding properties.

Engines and components: Propeller system, turbines bearing bushes for engine guide vanes e Nacelles

Repair of cracks, holes etc., various repair schemes – Scopes.

Surface Crack Repair

Unlike plaster, drywall has a seamless paper covering that rarely cracks or splits. When a crack appears, it is usually on a seam where two drywall sheets meet, and it is easily fixed.

If the crack is on a vertical or horizontal seam, carefully widen the crack with the corner of a paint scraper, utility knife or chisel to determine if the crack extends completely through the paper that is covering the seam; and if the tape has pulled loose from the wall surface. If the tape is intact and well-adhered, the crack was probably caused by the old drywall compound drying and shrinking. Simply fill the crack with new compound. When applying the compound, hold the knife at a 70-degree angle and swipe across the crack. Make sure the knife is clean by scraping both sides of it over the edge of the pan. Allow the joint compound to dry completely then lightly sand the area. Wipe away the dust then paint over it.

Deep Crack Repair

If the crack extends through the seam’s paper tape, or if the tape has pulled loose from the wall, use a razor knife to cut the tape about 6 to 12 inches from both ends of the damage. Remove the tape but be careful not to tear away the drywall’s paper covering. Scrape away any loose compound, and use a razor knife or drywall saw to expand the crack through the wall surface into the stud cavity. Avoid removing solid, well-adhered compound beyond the crack itself.

Fill the crack with new drywall compound, and apply a thin coat of compound to the wall surface where the old tape was removed. While the compound is still wet, place a strip of fiberglass tape over the seam, bridging the gap between the ends of the existing tape. Use a putty knife to gently flatten wrinkles and to bed the tape into the compound.

After the compound dries, add a second thin coat of compound over the taped area. Cover the tape and taper or “feather” the edges of the new compound onto the surrounding wall surface. Drywall compound needs to be applied in multiple thin layers because thicker layers are too difficult to smooth out and will eventually cause cracking.

When the second coat is thoroughly dry, sand lightly to smooth out any bumps. Next, use a wide (8- to 12-inch) joint-compound taping knife to completely cover the patch with a third and final coat. Try to blend this coat as seamlessly as possible onto the wall surface. After it dries, sand lightly, wipe away dust and repaint the entire area.

Nail Pop Repair

A common drywall problem, especially in newer homes, is “nail pops,” or nail heads that pull away from the wood studs and protrude through the drywall tape or paint. This is usually caused by warped wood that was inadequately dry when installed. Although the drywall is rarely in danger of falling off the wall, the bumps are visible and unsightly.

Use a utility knife to scrap away the drywall until the screw is exposed.
Then there are two ways to fix nail pops: use a screwdriver or hammer to drive the nail back into the studs, then bracket each nail head with closely spaced drywall screws; or, remove the nail and drive a screw in its place, along with a second screw nearby, to re-secure the drywall to the stud.
When using drywall screws, be sure to recess the heads slightly, creating a dimple in the drywall surface that can be covered with joint compound, but be careful not to tear through the paper surface. Where several screws are placed in a row, spot-patch each with compound and cover them with a strip of fiberglass tape as described in the steps above.

Hole Repair

For holes up to about six inches across, a variety of drywall patch kits are available. The kits typically have a reinforced center panel surrounded by self-sticking tape. Simply adhere the patch to the wall and cover with drywall compound.

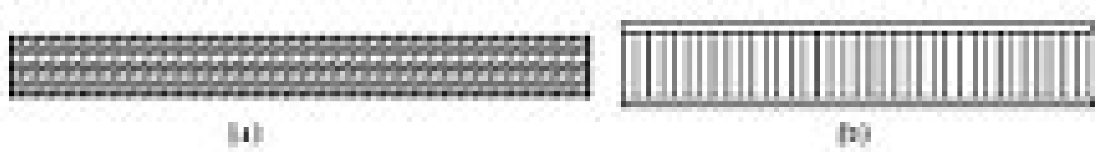
You can create your own patch to repair larger holes in drywall. For holes that don’t extend to studs on either side, you will need to reinforce the hole. Measure the hole then cut a scrap piece of drywall that is slightly larger than the hole’s diameter. Place drywall piece over the damaged area (image 1) and trace around it with a pencil. Use a drywall or reciprocating saw to cut out the area within the traced lines. Cut two pieces of 2x4 slightly larger than the hole. Position the 2x4s vertically inside the hole on each side of the hole. (It is not necessary to reinforce the horizontal edges of the replacement drywall.) Secure the 2x4s to the drywall with drywall screws. Set the new drywall into the hole and secure to the 2x4s with screws.

Trim the rough edges of drywall around the patch. Lay strips of fiberglass tape over the patched area to reinforce it , extending the tape a few inches beyond the patch. Do not overlap the tape. Embed the tape and cover the entire area with a thin coat of drywall compound, and complete the repair as described in the steps above.

Composite repairs

Composite materials nowadays are used in a wide range of applications in aerospace, marine, automotive, surface transport and sports equipment markets. Damage to composite components is not always visible to the naked eye and the extent of damage is best determined for structural components by suitable Non Destructive Test (NDT) methods. The concept for composite repair of composite or metallic structures is simple. The bonded repair reduces stresses in the damaged region and keeps the cracks from opening and therefore from growing.

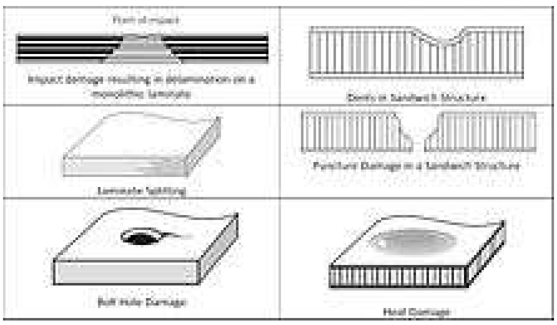
Composite structures of interest



Composite structures (a) laminated and (b) sandwich

The composite structures of interest are mainly components composed of laminated plies or sandwich structures. Laminate structures are assembled so that the fibre orientation provides most of the desired mechanical properties and the matrix largely determines the environmental performance. In sandwich structures thin, high strength skins are separated by, and bonded to, lightweight honeycomb cores; the thicker the core the stiffer the panel with minimal weight increase.

Typical damage of composite structures



Typical damage cases of laminates and sandwich structures

The most important damage to fibre reinforced composites is the result of impact incidents. Low velocity and high velocity impact can result in significantly different damage patterns for a given composite configuration. In metals the impact energy is dissipated through elastic and plastic deformations and still the structure retains a good margin of structural integrity. In fibre reinforced composite materials however, the damage is usually more extensive than that seen on the surface. Some typical damage cases for composite structures are shown in Figure 2.

In monolithic laminates the underlying damage can extend to a much greater extent than the barely visible evidence on its surface. Other type of damage is laminate splitting. Here the damage does not extend through the full length of the part. The effects on the mechanical performance depend on the length of split relative to the component thickness.

In sandwich structures, impact results in dents of various sizes and depending on the energy levels, puncture damage is not unusual. In this case both skins may be damaged. Other common damage types include heat damage and bolt hole damage. The heat damage is caused by the exposure at high temperature which causes a local fracture with separation of surface plies. The bolt hole damage is cause by the bearing stresses at the contact surfaces of the composite structure with a bolt or rivet used for joining purposes. This could result in elongation of the hole causing laminate splitting, or damage to the upper plies. In any case, the effect on the mechanical performance depends on the thickness of the damaged part.

Further implications, apart from the initial impact damage, come from the exposure of the damaged area to moisture and other degrading factors like chemicals, lubricants, fuel, hydraulic fluids, etc. The presence of such environments may result in further deterioration of the mechanical performance.

Typical composite repairs

A typical composite repair usually starts after damage detection either by unarmed eye or various other NDT-techniques. After evaluating the extent of the damage, the damage zone is prepared for reparation. This is done by removing the composite material around the damage zone

1. Three techniques are known to be utilised, being slightly different depending on the nature of the composite, When a composite repair is applied the proper surface treatment is essential for a successful result.

2. The above-mentioned repairs can be time consuming and often require high skills and experience to be performed. This is why current developments tend to focus on automating this process either by advanced mechanical milling or alternate technologies like nanosecond-pulsed lasers

3. After the damage zone has been completely excavated, surfaces are cleaned and further prepared for the final repair by patches. This can be done by plasma burning of surface contaminants, exposing fibres by removing matrix material through laser radiation or

improving the surface wet ability for adhesives by photochemical reactions induced by UV-laser light.

4. In a typical repair, the patch is applied under vacuum and at temperatures high enough for the curing of the adhesive. For these purposes a portable hot bonder device may be used for in the field repairs. For more complex and higher quality repairs an autoclave should be used.

In any case, the application of a vacuum bag is a necessary step for high quality repairs. Vacuum bag processing is suited to components with thin sections and large sandwich structures. The vacuum bag technique involves the placing and sealing of a flexible bag over a composite lay-up and evacuating all the air from under the bag as schematically.

The removal of air forces the bag down onto the lay-up with consolidation pressure of 1 atmosphere (1 bar). The completed assembly, with vacuum still applied, is heated up to the desired temperature for curing . This can be achieved by using heating mat or by placing the assembly inside an oven with good air circulation. For thicker sections and high quality bonding, the use of an autoclave with regulated temperature and additional overpressure should be sought.

The most important technical challenges in the implementation of a successful composite patch repair are:

(a) Proper design of the repair patch and the procedures that will be followed,

(b) Selection of the most suitable materials and tools for the application,

(c) Careful surface preparation

(d) Implementation of the composite patch repair and careful application of the cure cycle,

(e) Non destructive evaluation of the repair by suitable methodology and

(f) Monitoring of the structural integrity of the repair either at specific time intervals either continuously.

Autoclaves

Autoclaves are pressure vessels used to process parts and materials which require exposure to elevated pressure and temperature. The manufacture of high-performance components from advanced composites often requires autoclave processing.

Principle of operation

Small autoclave with electric heat, used in the manufacture of advanced composite parts. This autoclave features a low-cost manual-latch door design. Note the removable works-on-a-trolley back end.

An autoclave applies both heat and pressure to the workload placed inside of it. Typically, there are two classes of autoclave. Those pressurized with steam process workloads which can withstand exposure to water, while circulating heated gas provides greater flexibility and control of the heating atmosphere.

Processing by autoclave is far more costly than oven heating and is therefore generally used only when isostatic pressure must be applied to a workload of comparatively complex shape. For smaller flat parts, heated presses offer much shorter cycle times. In other applications, the pressure is not required by the process but is integral with the use of steam, since steam temperature is directly related to steam pressure. Rubber vulcanizing exemplifies this category of autoclaving.

For exceptional requirements, such as the curing of ablative composite rocket engine nozzles and missile nosecones, a hydroclave can be used, but this entails extremely high equipment costs and elevated risks in operation. The hydroclave is pressurized with water; the pressure keeps the water in liquid phase despite the high temperature.

The key component of the industrial autoclave is the fast-opening door; this is also the critical component in cost of autoclave construction. On one hand, the operator must be able to open and close the door quickly and easily; on the other, the door must satisfy stringent safety requirements. Such is the quality of autoclave door design that the US experiences as few as an estimated five or six autoclave failures annually.

Autoclave design is driven by various safety standards, foremost among which is the ASME Pressure Vessel Code. While most nations use the ASME code, some have developed their own. The CE standard in Europe applies to vessels as well as to electrical controls, and China requires that pressure vessels comply with their domestic code. All codes specify conservative requirements intended to maximize safety. Local governments may also impose licensing requirements related to autoclave operation.

UNIT - III AIRCRAFT JACKING, ASSEMBLY AND RIGGING

Mooring:

The following is a list of equipment need to park and/or moor (tie down) the airplane.
• 4 wheel chocks
• 3 screw-in mooring rings (left and right wing, and tail)
• 3 ropes (nylon or other non-shrinking/non-stretching synthetic material)

If wheel brakes are hot from prolonged taxi, allow brakes to cool before setting parking brake.

Controls may be secured with ailerons neutral and horizontal stabilizers leading edge down by pulling the control stick aft as far as possible and fastening seat belt snugly around it.

Short-Term Parking

Perform this procedure for short-term parking of the airplane.
1. Taxi or tow airplane to desired parking position.
2. Align nose of airplane into the wind.
3. Ensure nose wheel is centered.
4. In windy or gusty weather, moor (tie down) the airplane, see Section 10-20 Mooring (Tying Down) on page 11 of this chapter.
5. Set the parking brake. If wheel brakes are hot from prolonged taxi, allow brakes to cool before setting parking brake.
6. Place chocks in front of and behind main wheels.
7. Release the parking brake.
8. Secure flight controls in neutral position; retract flaps. Controls may be secured with ailerons neutral and horizontal stabilizers leading edge down by pulling the control stick aft as far as possible and fastening seat belt snugly around it.

9. Close and lock the doors.

Long-Term Parking

Perform this procedure for long-term parking of the airplane.
1. Perform the steps for short-term: parking.
2. Moor (tie down) the airplane, see Section 10-20 Mooring (Tying Down)

3. Install external rudder lock if available.

All gust locks must be removed from the aircraft prior to taxi and flight. care should be taken not to deform or damage the structure during installation and removal of these locks. All deformation, damage and interference must be reviewed by a qualified mechanic or technician prior to flight.

4. Install pitot/static, canopy, and propeller covers as applicable.
5. Refer to engine, electrical, and fuel system chapters of this manual for information on required servicing for long-term storage.
The airplane has three mooring points: one under each wing, and one under the tail. Mooring rings are provided to secure tie down ropes into the mooring points. Park the airplane, see the procedures for short and long term parking of the airplane.
Attach tie-down ropes to ground tie-downs and aircraft mooring rings. Leave sufficient play or looseness in the ropes to prevent inadvertent loading of the structure. Also, if using a rope, tie a bowline knot to allow tension freedom.

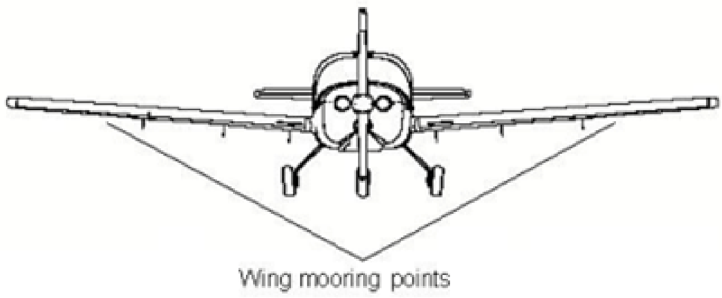
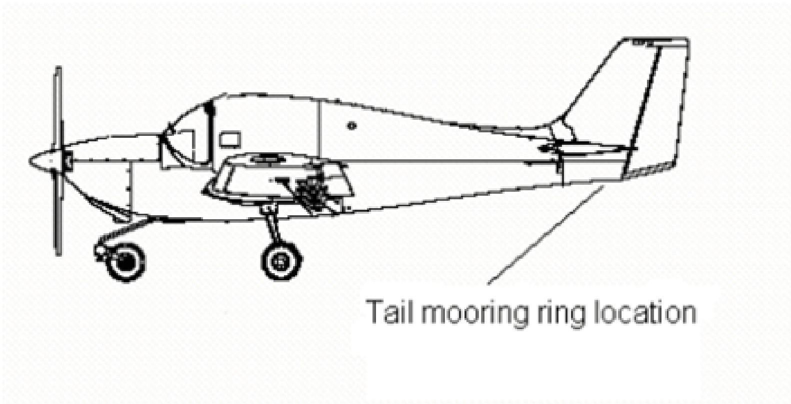


Figure 10-1 Mooring Points on the Wings



Proper tie-down procedure is the best precaution against damage to the aircraft by gusty or strong winds. To tie-down the aircraft securely, proceed as follows:

1. Head the aircraft into the wind

2. Place chocks fore and aft of each main wheel.

When chocking the wheels, ensure that the chocks used are not too large to come in contact with the wheel fairings. The use of chocks that are too large may damage the fairings.

3. Drive stakes into the ground approximately three feet outboard of each wing tip and to either side of tail wheel.

4. Install one tie-down ring in each wing tip rib.

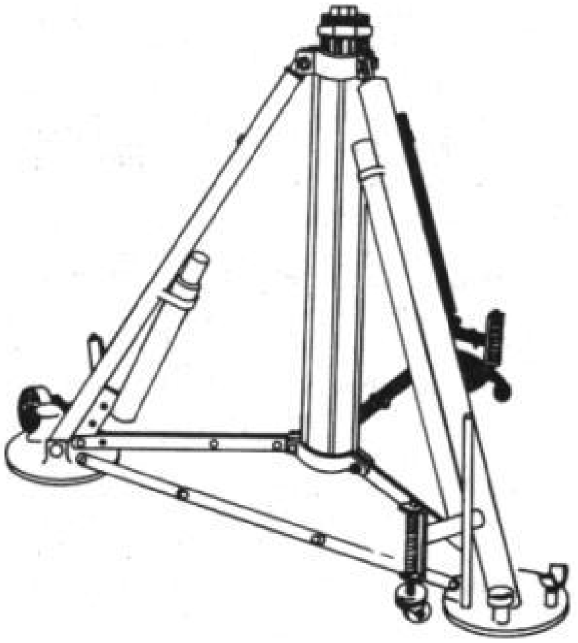
5. Tie a sufficiently strong rope to each wing tie-down ring and anchor to the ground stakes. Allow a little slack in each tiedown rope.

6. Tie the center of the rope to the tail wheel fork and anchor the rope ends to the ground stakes at either side of the tail wheel.

7. Ensure that the canopy is closed waterproof and locked.

JACKING AIRCRAFT

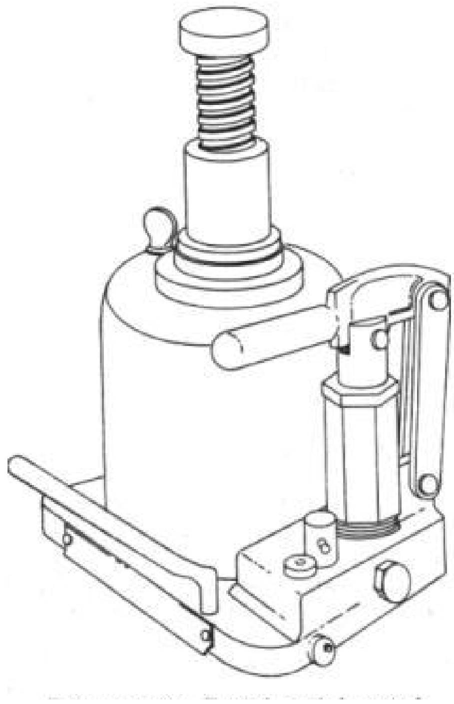
The aviation technician must be familiar with the jacking of aircraft in order to perform maintenance and inspection. Since jacking procedures and safety precautions vary for different types of aircraft, only general jacking procedures and precautions are discussed. Consult the applicable aircraft manufacturer's maintenance instructions for specific jacking procedures.



Extensive aircraft damage and serious personal injury have resulted from careless or improper jacking procedures. As an added safety measure, jacks should be inspected before use to determine the specific lifting capacity, proper functioning of safety locks, condition of pins, and general serviceability. Before raising an aircraft on jacks, all work stands and other equipment should be removed from under and near the aircraft. No one should remain in the aircraft while it is being raised or lowered, unless maintenance manual procedures require such practice for observing leveling instruments in the aircraft.

The aircraft to be jacked must be located in a level position, well protected from the wind. A hangar should be used if possible. The manufacturer's maintenance instructions for the aircraft being jacked should be consulted for the location of the jacking points. These jacking points are usually located in relation to the aircraft center of gravity so the aircraft will be well balanced on the jacks. However, there are some exceptions to this. On some aircraft it may be necessary to add weight to the nose or tail of the aircraft to achieve a safe balance. Sandbags are usually used for this purpose.

Tripod jacks similar to the one shown in figure 11-38 are used when the complete aircraft is to be jacked.



A small single base jack similar to the one shown in figure 11-39 is used when only one wheel is to be raised. The jacks used for jacking aircraft must be maintained in good condition; a leaking or damaged jack must never be used. Also, each jack has a maximum capacity, which must never be exceeded.

Jacking Complete Aircraft

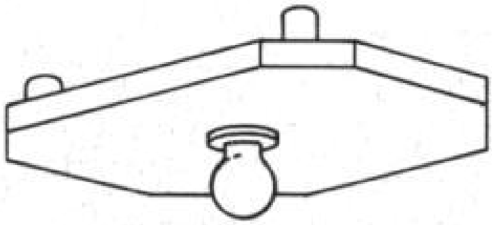
Prior to jacking the aircraft, an overall survey of the complete situation should be made to determine if any hazards to the aircraft or personnel exist. Tripod jacks of the appropriate size for the aircraft being jacked should be placed under the aircraft jacking points and perfectly centered to prevent them from cocking when the aircraft is raised. The legs of the jacks should be checked to see that they will not interfere with the operations to be performed after the aircraft is jacked, such as retracting the landing gear.

At least three places or points are provided on aircraft for jacking purposes; a fourth place on some aircraft is used to stabilize the aircraft while it is being jacked at the other three points. The two main places are on the wings, with a smaller one on the fuselage near either the tail or the nose, depending on the landing gear design.

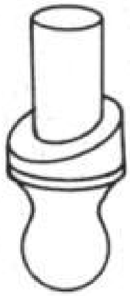
Most aircraft have jack pads located at the jack points. Others have removable jack pads that are inserted into receptacles bolted in place prior to jacking. The correct jack pad should be used in all cases. The function of the jack pad is to ensure that the aircraft load is properly distributed at the jack point and to provide a convex bearing surface to mate with the concave jack stem. Figure 11-40 illustrates two types of jack pads.

Prior to jacking, determine if the aircraft configuration will permit jacking. There may be equipment or fuel which has to be removed if serious structural damage is to be avoided during jacking. If any other work is in progress on the aircraft, ascertain if any critical panels have been removed. On some aircraft the stress panels or plates must be in place when the aircraft is jacked to avoid structural damage.

Extend the jacks until they contact the jack pads. A final check for alignment of the jacks should be made before the aircraft is raised, since most accidents during jacking are the result of misaligned jacks.



Wing jack pad assembly

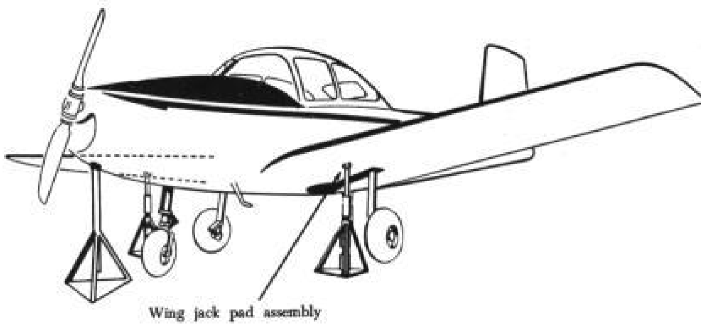


Forward jack fitting

When the aircraft is ready to be raised, a man should be stationed at each jack. The jacks should be operated simultaneously to keep the aircraft as level as possible and to avoid overloading any of the jacks. This can be accomplished by having the crew leader stand in front of the aircraft and give instructions to the men operating the jacks. Figure 11-41 shows an aircraft being jacked.

Caution should be observed, since on many jacks the piston can be raised beyond the safety point; therefore, never raise an aircraft any higher than is necessary to accomplish the job.

The area around the aircraft should be secured while the aircraft is on jacks. Climbing on the aircraft should be held to an absolute minimum, and no violent movements should be made by persons who are required to go aboard. Any cradles or necessary supports should be placed under the fuselage or wings of the aircraft at the earliest possible time, particularly if the aircraft is to remain jacked for any length of time.

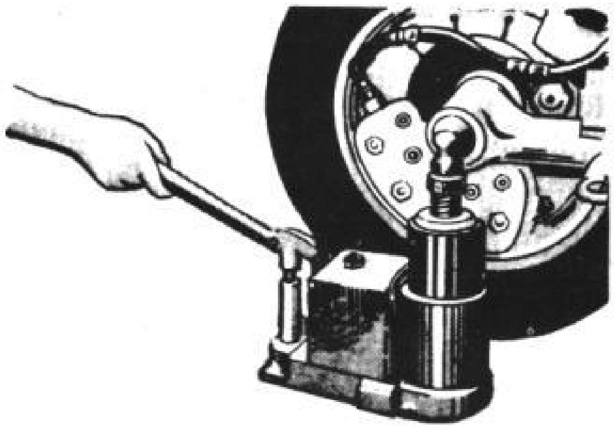


On collet equipped jacks, the collet should be kept within two threads of the lift tube cylinder during raising, and screwed down firmly to the cylinder after jacking is completed to prevent settling.

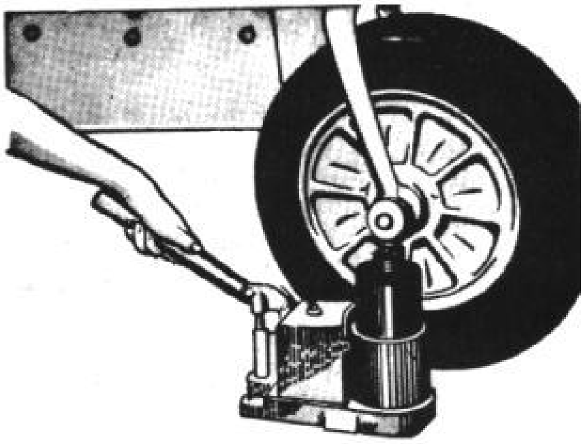
Before releasing jack pressure and lowering the aircraft, make certain that all cribbing, work stands, equipment, and persons are clear of the aircraft, that the landing gear is down and locked, and that all ground locking devices are properly installed.

Jacking One Wheel of an Aircraft

When only one wheel has to be raised to change a tire or to grease wheel bearings, a low single base jack is used. Before the wheel is raised, the remaining wheels must be chocked fore and aft to prevent movement of the aircraft. If the aircraft is equipped with a tail wheel, it must be locked. The wheel should be raised only high enough to clear the concrete surface. Figure 11-42 shows a wheel being raised using a single base jack.



Main landing gear jack pad



Nose landing gear jack pad

LEVELING

Longitudinal Leveling

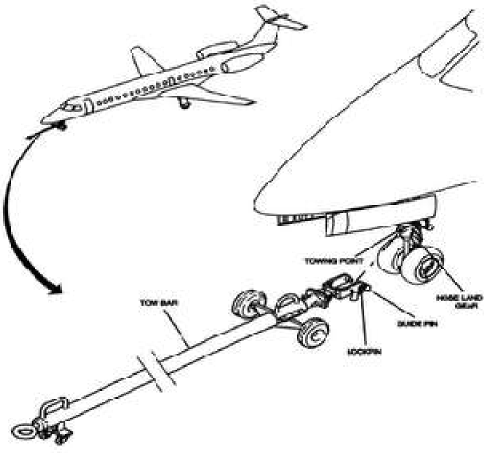
Place a spirit level on the upper edge of the lower cabin door in closed position for longitudinal leveling (refer to figure 08-01). Check with indication of spirit level installed in the door. Level the aircraft by increasing or decreasing air pressure in the nose wheel tire.

Lateral Leveling

Place a spirit level on the inner front seat rails for lateral leveling. Level the aircraft by inflating or deflating the main wheel tires.

Aircraft Towing

On aircraft with a nose-wheel landing gear, a steering arm should be fitted to the nose wheel to guide the aircraft Light aircraft can be moved and guided, by hand or by a tug.



Special attention should be paid to the following:

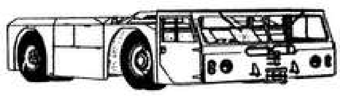
- Force should not be applied to the thin trailing or rear edges of wings or control surfaces such as ailerons or elevators.
- Generally speaking it is better to push an aircraft backwards rather than forwards, because the leading edges of the wings and tail-plane are stronger than the trailing edges.
- The struts, which support the undercarriage on some aircraft, are suitable for pushing the aircraft as these are the strength parts of the aircraft.
- The flat of the hands should be used when pushing, so as to spread the load over the largest area.
- When pushing on struts, the force should be applied as near to the end fittings as possible.
- A propeller must never be used to push or pull the aircraft, as the engine should always be regarded as ‘live’ and a propeller may kick if it is turned.

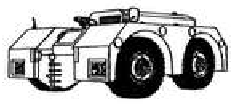
On aircraft with a steering nose wheel connected to the rudder pedals, care must be taken not to exceed the turning limits. Normally the maximum limits are marked on nose wheel doors as “NO TOW”

On this type of aircraft it is also important that the rudder controls are not locked during the towing operations. This is because the rudder controls and the nose-wheel steering mechanism are interconnected and the excessive movements could damage the mechanical linkages.

When towing aircraft by tow bar and tug special care should be given to below facts,

The correct tow-bar should be connected between the towing attachment at the base of the nose undercarriage leg and the tug.

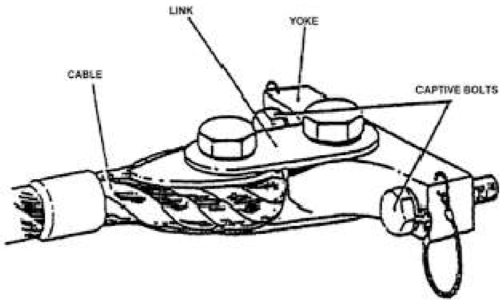

LOW PROFILE TUG

PUSH OUT TUG


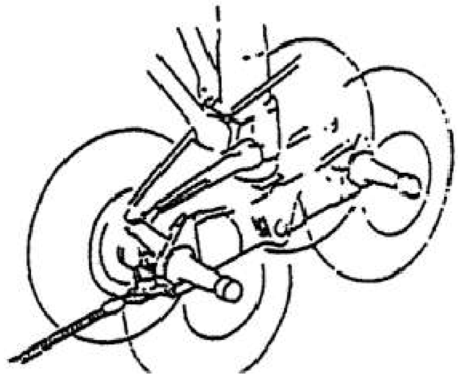
A person familiar with the aircraft brake system should be seated in the cockpit/cabin to operate the brakes in an emergency. The brakes should not normally be applied unless the aircraft is stationary.

Once the tow-bar is connected, the brakes, and if fitted, the rudder lock, may be released and the aircraft towed at a safe speed. A safe speed is considered to be walking speed.

A close watch should be kept on the wing tips and tail, particularly in confined spaces, to ensure that they do not come into contact with other stationary or moving object.



In circumstances where the ground over which the aircraft has to be towed is either boggy or very uneven, the strain imposed on the nose undercarriage may be excessive and it may be necessary to tow the aircraft by means of bridles attached to each main undercarriage. If towing attachments are not provided on the main undercarriage legs, ropes should be passed carefully around the legs as near to the top as possible and avoiding fouling on adjacent pipes or structure. A separate tug should be connected to each main undercarriage assembly. Steering should be carried out by means of a steering arm attached to the nose wheel rather than by differential movement of the tugs.



The most common means of towing a large aircraft nowadays is by means of a tow bar-less aircraft handling tractor. These tractors tend to be front wheel driven and therefore when towing an aircraft, are acting to 'pull' the tractor/aircraft combination. The tow-barless tractor consists of a low level tractor with a rear mounted cradle, comprising of a 'scoop and gate' assembly.

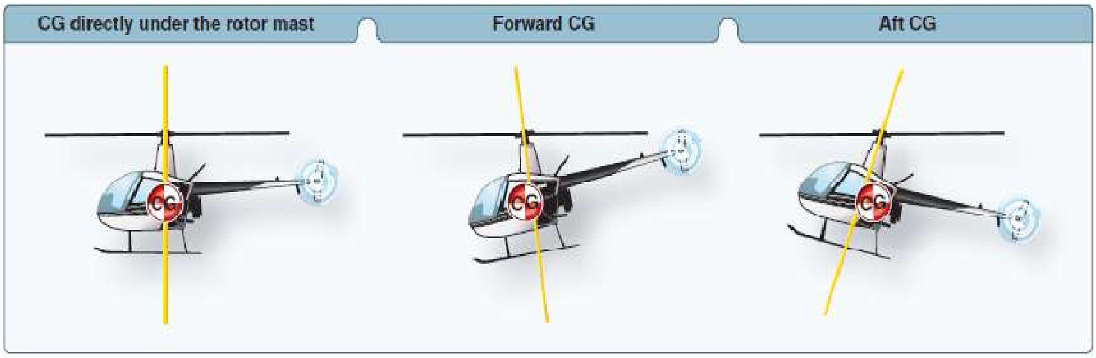
Owing to the tractor's low height it can easily move-in under the aircraft's fuselage to couple-up with the aircraft's nose wheel. During operation the nose wheel is raised by about 20cms by the tractor and after the towing is completed the nose wheel is lowered and the nose wheel is released from the cradle.

Center of Gravity

Ideally, a pilot should try to balance a helicopter perfectly so that the fuselage remains horizontal in hovering flight, with no cyclic pitch control needed except for wind correction. Since the fuselage acts as a pendulum suspended from the rotor, changing the CG changes the angle at which the aircraft hangs from the rotor. When the CG is directly under the rotor mast, the helicopter hangs horizontally; if the CG is too far forward of the mast, the helicopter hangs with its nose tilted down; if the CG is too far aft of the mast, the nose tilts up.

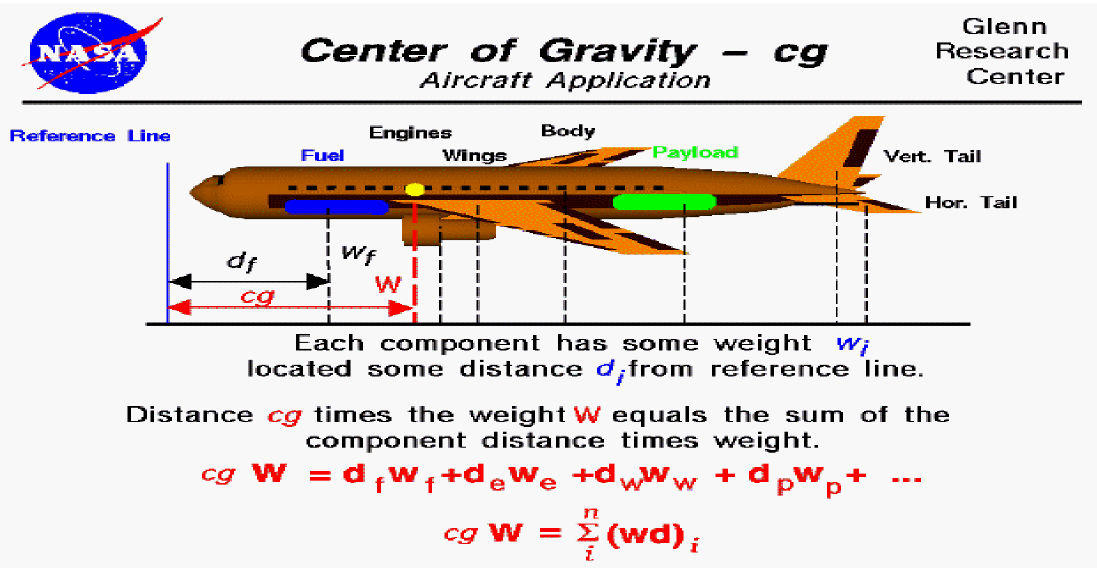
CG Forward of Forward Limit

A forward CG may occur when a heavy pilot and passenger take off without baggage or proper ballast located aft of the rotor mast. This situation becomes worse if the fuel tanks are located aft of the rotor mast because as fuel burns the CG continues to shift forward.



This condition is easily recognized when coming to a hover following a vertical takeoff. The helicopter has a nose-low attitude, and excessive rearward displacement of the cyclic control is needed to maintain a hover in a no-wind condition. Do not continue flight in this condition, since a pilot could rapidly lose rearward cyclic control as fuel is consumed. A pilot may also find it impossible to decelerate sufficiently to bring the helicopter to a stop. In the event of engine failure and the resulting autorotation, there may not be enough cyclic control to flare properly for the landing.

A forward CG is not as obvious when hovering into a strong wind, since less rearward cyclic displacement is required than when hovering with no wind. When determining whether a critical balance condition exists, it is essential to consider the wind velocity and its relation to the rearward displacement of the cyclic control.



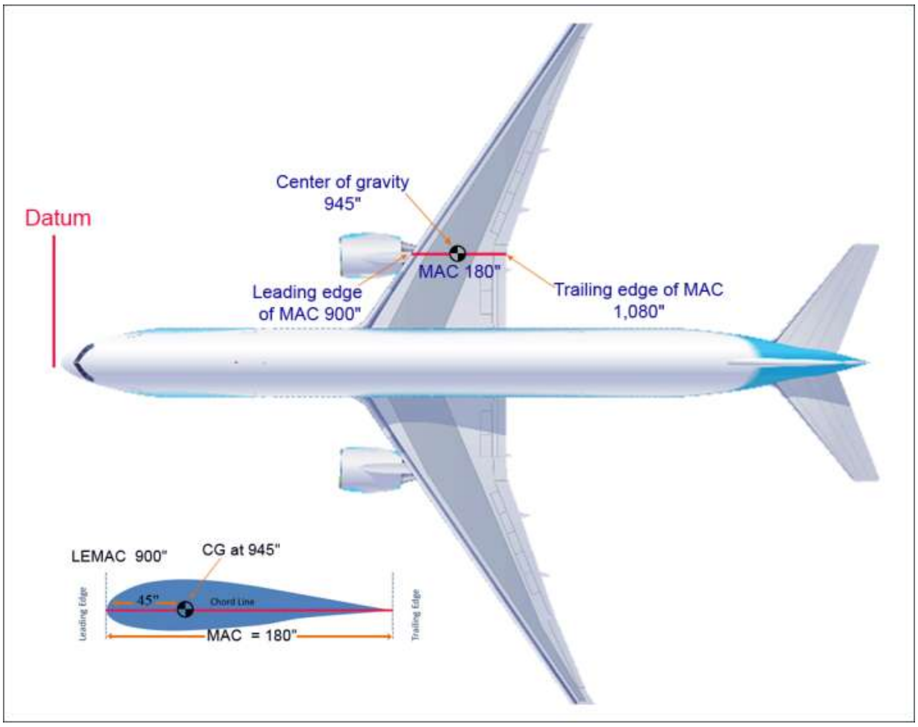
CG Aft of Aft Limit

Without proper ballast in the cockpit, exceeding the aft CG may occur when:

• A lightweight pilot takes off solo with a full load of fuel located aft of the rotor mast.

• A lightweight pilot takes off with maximum baggage allowed in a baggage compartment located aft of the rotor mast.

• A lightweight pilot takes off with a combination of baggage and substantial fuel where both are aft of the rotor mast.



A pilot can recognize the aft CG condition when coming to a hover following a vertical takeoff. The helicopter will have a tail-low attitude, and will need excessive forward displacement of cyclic control to maintain a hover in a no-wind condition. If there is a wind, even greater forward cyclic is needed.

If flight is continued in this condition, it may be impossible to fly in the upper allowable airspeed range due to inadequate forward cyclic authority to maintain a nose-low attitude. In addition, with an extreme aft CG, gusty or rough air could accelerate the helicopter to a speed faster than that produced with full forward cyclic control. In this case, dissymmetry of lift and blade flapping could cause the rotor disk to tilt aft. With full forward cyclic control already applied, a pilot might not be able to lower the rotor disk, resulting in possible loss of control, or the rotor blades striking the tail boom.

UNIT IV REVIEW OF HYDRAULIC & PNEUMATIC SYSTEMS

Hydraulic systems in aircraft provide a means for the operation of aircraft components. The operation of landing gear, flaps, flight control surfaces and brakes is largely accomplished with hydraulic power systems. Hydraulic system complexity varies from small aircraft that require fluid only for manual operation of the wheel brakes to large transport aircraft where the systems are large and complex.

Each subsystem has a power generating device (pump) reservoir, accumulator, heat exchanger, filtering system, etc. System operating pressure may vary from a couple hundred psi in small aircraft and rotorcraft to several thousand psi in large transports.

PURPOSES OF HYDRAULIC SYSTEMS

Hydraulic systems make possible the transmission of pressure and energy at the best weight per horsepower ratio.

TYPES OF HYDRAULIC FLUID

There are three principal categories of hydraulic fluids; mineral base fluids, polyalphaolefin base, and phosphate ester base fluids.

Mineral-Base Fluids

MIL-H-5606, mineral oil-based hydraulic fluid is the oldest, dating back to the 1940's. It is used in many systems, especially where the fire hazard is comparatively low.

Polyalphaolefin-Based Fluids

MIL-H-83282, is a fire-resistant hydrogenated polyalphaolefin-based fluid developed in the

1960's to overcome the flammability characteristics of MIL-H-5606. MIL-H-83282 is significantly more flame resistant than MIL-H-5606, but a disadvantage is the high viscosity at low temperature.

Phosphate Ester-Based Fluid (Skydrol/Hyjet)

These fluids are used in most commercial transport category aircraft, and are extremely fire-resistant. However, they are not fireproof and under certain conditions, they will burn.

Materials of Construction

Hydraulic systems require the use of special accessories that are compatible with the hydraulic fluid. Appropriate seals, gaskets, and hoses must be specifically designated for the type of fluid in use. Care must be taken to ensure that the components installed in the system are compatible with the fluid. When gaskets, seals, and hoses are replaced, positive identification should be made to ensure that they are made of the appropriate material.

HANDLING HYDRAULIC FLUID

In addition to any other instructions provided in the aircraft maintenance manual or by the fluid supplier, the following general precautions must be observed in the handling of hydraulic fluids:

a. **Ensure** that each aircraft hydraulic system is properly identified to show the kind of fluid to be used in the system. Identification at the filler cap or valve must clearly show the type of fluid to be used or added.

b. **Never** allow different categories of hydraulic fluids to become mixed. Chemical reactions may occur, fire resistant fluids may lose their fire resistance, seals may be damaged, etc.

c. **Never,** under any circumstances, service an aircraft system with a fluid different from that shown on the instruction plate.

d. **Make certain** that hydraulic fluids and fluid containers are protected from contamination of any kind. Dirt particles may cause hydraulic units to become inoperative, cause seal damage, etc. If there is any question regarding the cleanliness of the fluid, do not use it. Containers for hydraulic fluid must never be left open to air longer than necessary.

e. Do not expose fluids to high temperature or open flames. Mineral-based fluids are highly flammable.

HYDRAULIC SYSTEM MAINTENANCE PRACTICES

The maintenance of hydraulic and pneumatic systems should be performed in accordance with the aircraft manufacturer's instructions. The following is a summary of general practices followed when dealing with hydraulic and pneumatic systems.

Service

The servicing of hydraulic and pneumatic systems should be performed at the intervals specified by the manufacturer. Some components, such as hydraulic reservoirs, have servicing information adjacent to the component. When servicing a hydraulic reservoir, make certain to use the correct type of fluid.

Contamination Control

Contamination, both particulate and chemical, is detrimental to the performance and life of components in the aircraft hydraulic system. Contamination enters the system through normal wear of components, by ingestion through external seals, during servicing, or maintenance when the system is opened to replace/repair components, etc. To control the particulate contamination in the system, filters are installed in the pressure line, in the return line, and in the pump case drain line of each system. The filter rating is given in terms of ―micron,‖ and is an indication of the particle size that will be filtered out.

Flushing a Hydraulic System

When inspection of hydraulic filters or hydraulic fluid evaluation indicates that the fluid is contaminated, flushing the system may be necessary. This must be done according to the manufacturer's instructions; however, a typical procedure for flushing is as follows:

(1) Connect a ground hydraulic test stand to the inlet and outlet test ports of the system. Verify that the ground unit fluid is clean and contains the same fluid as the aircraft.

(2) Change the system filters.

(3) Pump clean, filtered fluid through the system, and operate all subsystems until no obvious signs of contamination are found during inspection of the filters. Dispose of contaminated fluid and filter.

(4) Disconnect the test stand and cap the ports.

(5) Ensure that the reservoir is filled to the FULL line or proper service level.

Inspections

Hydraulic and pneumatic systems are inspected for leakage, worn or damaged tubing, worn or damaged hoses, wear of moving parts, and security of mounting for all units, safe tying, and any other condition specified by the maintenance manual. A complete inspection includes considering the age, cure date, stiffness of the hose, and an operational check of all subsystems.

(1) Leakage from any stationary connection in a system is not permitted, and if found, it should be repaired. A small amount of fluid seepage may be permitted on actuator piston rods and rotating shafts. In a hydraulic system, a thin film of fluid in these areas indicates that the seals are being properly lubricated. When a limited amount of leakage is allowed at any point, it is usually specified in the appropriate manual.

(2) Tubing should not be nicked, cut, dented, collapsed, or twisted beyond approved limits. The identification markings or lines on a flexible hose will show whether the hose has been twisted.

(3) All connections and fittings associated with moving units must be examined for play evidencing wear. Such units should be in an unpressurized condition when they are checked for wear.

Troubleshooting

Hydraulic system troubleshooting varies according to the complexity of the system and the components in the system. It is, therefore, important that the technician refer to the troubleshooting information furnished by the manufacturer.

(1) Lack of pressure in a system can be caused by a sheared pump shaft, defective relief valve, the pressure regulator, an unloading valve stuck in the —kicked-out|| position, lack of fluid in the system, the check valve installed backward, or any condition that permits free flow back to the reservoir or overboard. If a system operates satisfactorily with a ground test unit but not with the system pump, the pump should be examined.

(2) If a system fails to hold pressure in the pressure section, the likely cause is the pressure regulator, an unloading valve, a leaking relief valve, or a leaking check valve. **(3)** If the pump fails to keep pressure up during operation of the subsystem, the pump may be worn or one of the pressure-control units may be leaking.

(4) High pressure in a system may be caused by a defective or improperly-adjusted pressure regulator, an unloading valve, or by an obstruction in a line or control unit.

(5) Unusual noise in a hydraulic system, such as banging and chattering, may be caused by air or contamination in the system. Such noises can also be caused by a faulty pressure regulator, another pressure-control unit, or a lack of proper accumulator action.

(6) Maintenance of hydraulic system components involves a number of standard practices together with specialized procedures set forth by manufacturers such as the replacement of valves, actuators, and other units, including tubing and hoses. Care should be exercised to prevent system contamination damage to seals, packing, and other parts, and to apply proper torque in connecting fittings. When installing fittings, valves, etc. always lubricate the threads with hydraulic fluid.

Disposal of Used Hydraulic Fluids

In the absence of organizational guidelines, the technician should be guided by local, state, and federal regulations, with regard to means of disposal of used hydraulic fluid. Presently, the most universally accepted procedure for disposal of phosphate ester-based fluid is incineration.

During inspection

Consider the following to determine whether seal replacement is necessary.

(1) How much fluid is permitted to seep past the seals? In some installations minor seepage is normal. Refer to the manufacturer's maintenance information.

(2) What effect does the leak have on the operation of the system? Know the system.

(3) Does the leak of fluid create a hazard or affect surrounding installations? A check of the system fluid and a knowledge of previous fluid replenishment is helpful.

(4) Will the system function safely without depleting the reservoirs until the next inspection?

INSPECTION AND MAINTENANCE OF LANDING GEAR

The landing gear on aircraft may be fixed or retractable. A fixed gear may be wheels, floats, or skis; and for amphibians a combination of floats and wheels.

Retractable gear on aircraft is usually operated with hydraulic or electric power, although some models of light general aviation aircraft have manual retract systems operated by a lever in the cockpit.

(1) In addition to the normal operating system, emergency systems are usually provided to ensure that the landing gear can be lowered in case of main-system failure.

(2) Emergency systems consist of backup hydraulic systems, or stored nitrogen gas bottles that can be directed into actuating cylinders, mechanical systems that can be operated manually, or free-fall gravity systems.

GENERAL INSPECTION

A thorough inspection of the landing gear involves the entire structure of the gear, including attachments, struts, wheels, brakes, actuating mechanisms for retractable gears, gear hydraulic system and valves, gear doors, and all associated parts. The manufacturer's inspection procedures should be followed where applicable.

CLEANING AND LUBRICATING.

It is recommended that only easily removable neutral solutions be used when cleaning landing gear components. Any advantage, such as speed or effectiveness, gained by using cleaners containing corrosive materials, can be quickly counteracted if these materials become trapped in close-fitting surfaces and crevices.

Wear points, such as landing gear up-and down latches, jack-screws, door hinges, pulleys, cables, bell cranks, and all pressure-type grease fittings, should be lubricated after every cleaning operation.

To prevent possible failure of a component due to incompatibility or breakdown of the grease, the following should be observed:

1. Use only greases approved for use by the product manufacturer.
2. Never mix different kinds of grease without approval from the product manufacturer.
3. Follow the manufacturer's instructions or FAA approved process for cleaning, purging, and lubricating of the component.

FIXED-GEAR INSPECTION

Fixed landing gear should be examined regularly for wear, deterioration, corrosion, alignment, and other factors that may cause failure or unsatisfactory operation. During a 100-hour or annual inspection of the fixed gear, the aircraft should be jacked up to relieve the aircraft weight. The gear struts and wheels should be checked for abnormal play and corrected.

Old aircraft landing gear that employs a rubber shock (bungee) cord for shock absorption must be inspected for age, fraying of the braided sheath, narrowing (necking) of the cord, and wear at points of contact with the structure and stretch. If the age of the shock cord is near 5 years or more, it is advisable to replace it with a new cord. A cord that shows other defects should be replaced, regardless of age.

The cord is color-coded to indicate when it was manufactured and to determine the life of the shock cord. According to MIL-C-5651A, the color code for the year of manufacture is repeated in cycles of 5 years. Table 9-1 shows the color of the code thread for each year and quarter year.

The color coding is composed of threads interwoven in the cotton sheath that holds the strands of rubber cord together. Two spiral threads are used for the year coding and one thread is used for the quarter of the year sheath, e.g. yellow and blue would indicate that the cord was manufactured in 1994 during April, May, or June.

Shock struts of the spring-oleo type should be examined for leakage, smoothness of operation, looseness between the moving parts, and play at the attaching points. The extension of the struts should be checked to make sure that the springs are not worn or broken The piston section of the strut should be free of nicks, cuts, and rust.

INSPECTION OF RETRACTABLE LANDING GEAR

Inspection of the retractable landing gear should include all applicable items mentioned in the inspection for the fixed gear. In addition, the actuating mechanisms must be inspected for wear looseness in any joint, trunnion, or bearing; leakage of fluid from any hydraulic line or unit; and, smoothness of operation. The operational check is performed by jacking the aircraft according to the manufacturer's instructions and then operating the gear retracting and extending system.

During the operational test, the smoothness of operation, effectiveness of up and- down locks, operation of the warning horn, operation of indicating systems, clearance of tires in wheel wells, and operation of landing-gear doors should be checked. Improper adjustment of sequence valves may cause doors to rub against gear structures or wheels. The manufacturer's checklist should be followed to ensure that critical items are checked. While the aircraft is still on jacks, the gear can be tested for looseness of mounting points, play in torque links, condition of the inner strut cylinder, play in wheel bearings, and play in actuating linkages. Emergency blow down gear bottles should be inspected for damage and corrosion and weighed to see if the bottle is still retaining the charge.

Mechanics should be aware that retread tires can be dimensionally bigger than a —new‖ tire. While this does not pose a problem on fixed landing gear aircraft, it may present a serious problem when installed on retractable landing gear aircraft. It is strongly recommended that if a retread tire is installed on a retractable landing gear aircraft, a retraction test be performed. With the gear in the up-and-lock position, the mechanic should determine that if the tire expands due to high ambient temperature, heat generated from taxi and take-off, repeated landings, or heavy braking, the tire will not expand to the point that it becomes wedged in the wheel well.

The proper operation of the ant retraction system should be checked in accordance with the manufacturer's instructions. Where safety switches are actuated by the torque links, the actual time of switch closing or opening can be checked by removing all air from the strut and then collapsing the strut. In every case, the adjustment should be such that the gear control cannot be placed in the UP position or that the system cannot operate until the shock strut is at the full extended position.

LANDING GEAR COMPONENTS

The following items are susceptible to service difficulties and should be inspected.

Shock Absorbers

Inspect the entire shock-strut for evidence of leaks, cracks, and possible bottoming of the piston, as this condition causes overloading of landing-gear components and contributes to fatigue cracks. Check all bolts, bolt holes, pins, and bushings for condition, lubrication, and proper torque values. Grease fitting holes (pressure-type) are especially vulnerable to cracks and cross threading damage. Check all safety wire and other locking devices, especially at the main packing gland nuts.

Nose Gear Assembly

Inspection of the steering mechanism should include torque links (scissors), torque-tubes, control rods and rod-end bearings, shimmy dampers, cables, and turning stops. In addition, check all nose landing gear components, including mud scrapers and slush deflectors, for damage.

Tail Wheels

Disassembly, cleaning, and re-rigging of tail wheels are periodically necessary. Inspect them for loose or broken bolts, broken springs, lack of lubrication, and general condition. Check steerable tail wheels for proper steering action, steering-horn wear, clearances, and for security and condition of steering springs and cables.

Gear Doors

Inspect gear doors frequently for cracks, deformation, proper rigging, and general condition. Gear door hinges are especially susceptible to progressive cracking, which can ultimately result in complete failure, allowing the door to move and cause possible jamming of the gear.

Wheels

Inspect the wheels periodically for cracks, corrosion, dents, distortion, and faulty bearings in accordance with the manufacturer's service information. In split type wheels, recondition bolt holes which have become elongated due to some play in the through-bolt, by the use of inserts or other FAA-approved means. Pay particular attention to the condition of the through-bolts and nuts. Carefully inspect the wheels used with tubeless tires for damage to the wheel flange and for proper sealing of the valve. The sealing ring used between the wheel halves should be free of damage and deformation.

Brakes

Disassemble and inspect the brakes periodically and examine the parts for wear, cracks, warpage, corrosion, elongated holes, etc. Discolored brake disks are an indication of overheated brakes and should be replaced. If any of these or other faults are indicated, repair, recondition, or replace the affected parts in accordance with the manufacturer's recommendations.

Hydraulic Brakes

For proper maintenance, periodically inspect the entire hydraulic system from the reservoir to the brakes. Maintain the fluid at the recommended level with proper brake fluid. When air is present in the brake system, bleed in accordance with the manufacturer's instructions. Replace flexible hydraulic hoses which have deteriorated due to long periods of service and replace hydraulic piston seals when there is evidence of leakage.

TYPES OF LANDING GEAR PROBLEMS

During inspection and before removing any accumulated dirt, closely observe the area being inspected while the wingtips are gently rocked up and down. Excessive motion between normally close-fitting landing gear components may indicate wear, cracks, or improper adjustment. If a crack exists, it will generally be indicated by dirt or metallic particles which tend to outline the fault. Seepage of rust inhibiting oils, used to coat internal surfaces of steel tubes, also assists in the early detection of cracks. In addition, a sooty, oily residue around bolts, rivets, and pins is a good indication of looseness or wear.

a. **Thoroughly clean and re-inspect** the landing gear to determine the extent of any damage or wear. Some components may require removal and complete disassembly for detailed inspection. Others may require a specific check using an inspection process such as dye penetrant, magnetic particle, radiographic, ultrasonic, or eddy current. The frequency, degree of thoroughness, and selection of inspection methods are dependent upon the age, use, and general condition of the landing gear.
b. **Inspect the aircraft** or landing gear structure surrounding any visible damage to ensure that no secondary damage remains undetected. Forces can be transmitted along the affected member to remote areas where subsequent normal loads can cause failure at a later date

Prime locations for cracks on any landing gear are bolts, bolt holes, pins, rivets, and welds. The following are typical locations where cracks may develop.

d. **Most susceptible areas for bolts** are at the radius between the head and the shank, and in the location where the threads join the shank.

e. **Cracks primarily occur** at the edge of bolt holes on the surface and down inside the bore.

f. **The usual types of failure** in riveted joints or seams are deformation of the rivet heads and skin cracks originating at the rivets' holes.

g. **Cracks and subsequent failures** of rod ends usually begin at the thread end near the bearing and adjacent to or under the jam nut

h. **Cracks develop primarily** along the edge of the weld adjacent to the base metal and along the centerline of the bead.

i. **Elongated holes** are especially prevalent in taper-pin holes and bolt holes or at the riveted joints of torque tubes and push-pull rods.

Deformation is common in rods and tubes and usually is noticeable as stretched, bulged, or bent sections. Because deformations of this type are difficult to see, feel along the tube for evidence of this discrepancy. Deformation of sheet-metal web sections, at landing-gear component attachment points, usually can be seen when the area is highlighted with oblique lighting.

SPECIAL INSPECTIONS

When an aircraft experiences a hard or overweight landing, the mechanic should perform a special structural inspection of the aircraft, including the landing gear. Landing gear support trusses should be inspected for cracked welds, sheared bolts and rivets, and buckled structures. Wheels and tires should be inspected for cracks and cuts, and upper and lower wing surfaces should be inspected for wrinkles, deformation, and loose or sheared rivets. If any damage is found, a detailed inspection is recommended.

RETRACTION TESTS

Periodically perform a complete operational check of the landing gear retraction system. Inspect the normal extension and retraction system, the emergency extension system, and the indicating and emergency warning system. Determine that the actuating cylinders, linkage, slide tubes, sprockets, chain or drive gears, gear doors, and the up-and-down locks are in good condition and properly adjusted and lubricated, and the wheels have adequate clearance in the wheel wells. In addition, an electrical continuity check of micro-switches and associated wiring is recommended. Only qualified personnel should attempt adjustments to the gear position and warning system micro-switches. Follow the manufacturer's recommendations.

TIRE AND TUBE MAINTENANCE

A program of tire maintenance can minimize tire failures and increase tire service life.

Correct balance is important since a heavy spot on an aircraft tire, tube, or wheel assembly is likely to cause that heavy spot to hit the ground first when landing. This results in excessive wear at one spot and an early failure at that part of the tire. A severe case of imbalance causes excessive vibration during take-off and landing, especially at high speed.

b. A protective cover should be placed over a tire while servicing units that might drip fluid on the tire.

TIRE INSPECTION AND REPAIR.

Tires should be inspected frequently for cuts, worn spots, bulges on the side walls, foreign bodies in the treads, and tread condition. Defective or worn tires may be repaired or retreaded. The term, retread, refers to several means of restoring a used tire, whether by applying a new tread alone or tread and side wall material in varying amounts. The following guidelines should be used for tire inspection:

a. Tread Wear. Inspect the tires visually for remaining tread. Tires should be removed when tread has worn to the base of any groove at any spot, or to a minimum depth as specified by the tire or aircraft manufacturer. Tires worn to fabric in the tread area should be removed regardless of the amount of tread remaining.

b. Uneven Wear. If tread wear is excessive on one side, the tire can be dismounted and turned around, providing there is no exposed fabric. Gear misalignment causing this condition should be corrected.

Tread Cuts

(1) Inspect tread for cuts and other foreign object damage, and mark with crayon or chalk. Remove tires that have the following:

(2) Any cuts into the carcass ply. Cuts extending more than half of the width of a rib and deeper than 50 percent of the remaining groove depth.

(3) Weather checking, cracking, cuts, and snags extending down to the carcass ply in the sidewall and bead areas.

(4) Bulges in any part of tire tread, sidewall, or bead areas that indicate a separation or damaged tire.

(5) Cracking in a groove that exposes fabric or if cracking undercuts tread ribs.

d. Flat Spots. Generally speaking, tires need not be removed because of flat spots due to skid or hydroplane burns unless fabric is exposed. If objectionable unbalance results, removethe tire from service.

Beads Inspect bead areas next to wheel flanges for damage due to excessive heat, especially if brake drag or severe braking has been reported during taxi, takeoff or landing.

f. Tire Clearance. Look for marks on tires, the gear, and in the wheel wells that might indicate rubbing due to inadequate clearance.

INFLATION OF TIRES

There is serious danger involved with inflating and tire assembly. The tire should not be inflated beyond the recommended pressure (when it is not being installed in a safety cage). Over inflation can cause damage to the aircraft, as well as personal injury. Under-inflation will cause excessive tire wear and imbalance. The airframe manufacturer’s load and pressure chart should be consulted before inflating tires. Sufficiently inflate the tires to seat the tire beads; then deflate them to allow the tube to assume its position. Inflate to the recommended pressure with the tire in a horizontal position. Tire check of storage aircraft should be done in accordance with the applicable aircraft storage manual.

PERSONAL SAFETY

When servicing aircraft tires, personnel should stand either in the front or rear of the wheel and avoid approaching from either side of the tire. Personnel should wear protective eye gear to reduce the risk of eye injury due to inflation and deflation of tires.

DISASSEMBLE THE WHEEL in accordance with aircraft manufacturer’s instructions.

Do not attempt to disassemble wheel until the tire has been completely deflated: otherwise serious injury or damage to equipment can result.

Do not attempt to remove valve core until tire has been completely deflated. Valve cores will eject at high velocity if unscrewed before air pressure has been released.

Never attempt to remove wheel bolts or break tire beads loose until tire has been completely deflated: otherwise, explosive separation of wheel components will result.

Do not pry between wheel flanges and tire beads as this can damage the wheel and tire.

Use caution when removing wheel bolts or nuts. Remove tire from wheel using a wheel demounting fixture.

REASSEMBLING THE WHEEL

The correct assembly of the wheel affects the balance of the tire. After the wheel halves and bolts/nuts have been inspected and found serviceable, put a little talc on the tube and insert it in the tire. Align the heavy spot of the tube (usually marked with a yellow line) with the light spot of the tire (usually marked with a red dot). If the tube does not have a balance mark, align the valve of the tube with the balance mark on the line. Remove the valve core and inflate the tube momentarily to ―seat‖ the tube and let the air run out. Put one wheel half in the tire and align the wheel half with the valve hole up with the valve on the tube. Insert the other wheel half in the tire and align the bolt holes. Insert the wheel bolts and torque to the manufacturer's recommended value.

Again inflate the tube with 5 or 10 psi and let the air out to re-seat the tube. Install the valve core, and fill the tire to the recommended pressure.

SLIPPAGE

To reduce the possibility of tire and tube failure due to slippage, and to provide a means of detecting tire slippage, tires should be marked and indexed with the wheel rim. Paint a mark one inch wide and two inches long across the tire side wall and wheel rim. Use permanent type paint in a contrasting color, such as white, red, or orange. Pre-flight inspection must include a check of slippage marks for alignment. If the slippage marks are not in alignment, a detailed inspection must be made, the reason determined, and if necessary, the condition corrected before the next flight.

WHEEL INSPECTION

Check wheels for damage. Wheels that are cracked or damaged must for repair or replacement in accordance with the manufacturers

WHEEL INSTALLATION

Various procedures are used for installing wheel assemblies on an aircraft.

a. The axle should first be cleaned and inspected for surface damage, damage to the axle threads, and the general condition and security of bolts holding the axle onto the landing-gear leg. The wheel bearings should be cleaned and packed with approved grease. The wheel bearing and tire must be inspected and assembled. Many aircraft have specific torque requirements for the wheel-retaining nuts. These torque requirements may have two values specified. The retaining nut is first tightened to the higher value to seat the bearing. It is then backed off and tightened to the lower value specified. While tightening the wheel retaining nuts, the wheel should be rotated.

b. Great care should be exercised to see that the wheel-retaining nuts are not over tightened.

In the absence of specific instructions, the wheel-retaining nut is tightened until bearing drag is felt. The nut is then backed off about one serration (castellation) or one-sixth turn before bending up the tab on the tab-lock washer or installing the cotter pin.

c. The grease cover or wheel cover, if used, is then installed. During this installation any required brake, air-pressure sensors, and speed-sensor components should be installed and connected, as appropriate, for the specific aircraft.

Aircraft Pneumatic Systems

Some aircraft manufacturers have equipped their aircraft with a high pressure pneumatic system (3,000 psi) in the past. The last aircraft to utilize this type of system was the Fokker F27. Such systems operate a great deal like hydraulic systems, except they employ air instead of a liquid for transmitting power. Pneumatic systems are sometimes used for:

- Brakes
- Opening and closing doors
- Driving hydraulic pumps, alternators, starters, water Injection pumps, etc.
- Operating emergency devices

Both pneumatic and hydraulic systems are similar units and use confined fluids. The word confined means trapped or completely enclosed. The word fluid implies such liquids as water, oil, or anything that flows. Since both liquids and gases flow, they are considered as fluids; however, there is a great deal of difference in the characteristics of the two.

Liquids are practically incompressible; a quart of water still occupies about a quart of space regardless of how hard it is compressed. But gases are highly compressible; a quart of air can be compressed into a thimbleful of space. In spite of this difference, gases and liquids are both fluids and can be confined and made to transmit power. The type of unit used to provide pressurized air for pneumatic systems is determined by the system's air pressure requirements.

High-Pressure Systems

For high-pressure systems, air is usually stored in metal bottles at pressures ranging from 1,000 to 3,000 psi, depending on the particular system. [Figure 12-70] This type of air bottle has two valves, one of which is a charging valve. A ground-operated compressor can be connected to this valve to add air to the bottle. The other valve is a control valve. It acts as a shutoff valve, keeping air trapped inside the bottle until the system is operated. Although the high-pressure storage cylinder is light in weight, it has a definite disadvantage. Since the system cannot be recharged during flight, operation is limited by the small supply of bottled air. Such an arrangement cannot be used for the continuous operation of a system. Instead, the supply of bottled air is reserved for emergency operation of such systems as the landing gear or brakes. The usefulness of this type of system is increased, however, if other air-pressurizing units are added to the aircraft.

Pneumatic System Components

Pneumatic systems are often compared to hydraulic systems, but such comparisons can only hold true in general terms. Pneumatic systems do not utilize reservoirs, hand pumps, accumulators, regulators, or engine-driven or electrically driven power pumps for building normal pressure. But similarities do exist in some components.

Air Compressors

On some aircraft, permanently installed air compressors have been added to recharge air bottles whenever pressure is used for operating a unit. Several types of compressors are used for this purpose. Some have two stages of compression, while others have three, depending on the maximum desired operating pressure.

Relief Valves

Relief valves are used in pneumatic systems to prevent damage. They act as pressure limiting units and prevent excessive pressures from bursting lines and blowing out seals.

Control Valves

Control valves are also a necessary part of a typical pneumatic system. illustrates how a valve is used to control emergency air brakes. The control valve consists of a three-port housing, two poppet valves, and a control lever with two lobes.

Check Valves

Check valves are used in both hydraulic and pneumatic systems. illustrates a flap-type pneumatic check valve. Air enters the left port of the check valve, compresses a light spring, forcing the check valve open and allowing air to flow out the right port. But if air enters from the right, air pressure closes the valve, preventing a flow of air out the left port. hus, a pneumatic check valve is a one-direction flow control valve.

Restrictors

Restrictors are a type of control valve used in pneumatic systems. The small outlet port reduces the rate of airflow and the speed of operation of an actuating unit.

Filters

Pneumatic systems are protected against dirt by means of various types of filters. A micronic filter consists of a housing with two ports, a replaceable cartridge, and a relief valve. Normally, air enters the inlet, circulates around the cellulose cartridge, and flows to the center of the cartridge and out the outlet port. If the cartridge becomes clogged with dirt, pressure forces the relief valve open and allows unfiltered air to flow out the outlet port.

A screen-type filter is similar to the micron filter but contains a permanent wire screen instead of a replaceable cartridge. In the screen filter, a handle extends through the top of the housing and can be used to clean the screen by rotating it against metal scrapers.

Emergency Extension Sequence:

1. Landing gear handle is placed in the DOWN position.
2. Red light in the landing gear control handle is illuminated.
3. EMER LDG GEAR handle is pulled fully outward.
5. Compressed nitrogen is released to the landing gear selector/dump valve.
6. Pneudraulic pressure actuates the dump valve portion of the landing gear selector/dump valve.
7. Blue DUMP legend is illuminated on the LDG GR DUMP switch.
8. Landing gear system is isolated from the remainder of hydraulic system.

9. Pneudraulic pressure is routed to the OPEN side of the landing gear door actuators, the UNLOCK side of the landing gear up lock actuators, and the EXTEND side of the main landing gear side brace actuators and nose landing gear extend/retract actuator.
10. Landing gear doors open.
11. Up lock actuators unlock.
12. Landing gear extends down and locks.
13. Three green DOWN AND LOCKED lights on the landing gear control panel are illuminated.
14. Landing gear doors remain open.

Pneumatic Power System Maintenance

Maintenance of the pneumatic power system consists of servicing, troubleshooting, removal, and installation of components, and operational testing. The air compressor's lubricating oil level should be checked daily in accordance with the applicable manufacturer's instructions. The oil level is indicated by means of a sight gauge or dipstick. When refilling the compressor oil tank, the oil (type specified in the applicable instructions manual) is added until the specified level. After the oil is added, ensure that the filler plug is torqued and safety wire is properly installed.

The pneumatic system should be purged periodically to remove the contamination, moisture, or oil from the components and lines. Purging the system is accomplished by pressurizing it and removing the plumbing from various components throughout the system. Removal of the pressurized lines causes a high rate of airflow through the system, causing foreign matter to be exhausted from the system. If an excessive amount of foreign matter, particularly oil, is exhausted from any one system, the lines and components should be removed and cleaned or replaced.

Upon completion of pneumatic system purging and after reconnecting all the system components, the system air bottles should be drained to exhaust any moisture or impurities that may have accumulated there. After draining the air bottles, service the system with nitrogen or clean, dry compressed air. The system should then be given a thorough operational check and an inspection for leaks and security.

Basic Fuel System Requirements

All powered aircraft require fuel on board to operate the engine(s). A fuel system consisting of storage tanks, pumps, filters, valves, fuel lines, metering devices, and monitoring devices is designed and certified under strict Title 14 of the Code of Federal Regulations (14 CFR) guidelines. Each system must provide an uninterrupted flow of contaminant free fuel regardless of the aircraft's attitude. Since fuel load can be a significant portion of the aircraft's weight, a sufficiently strong airframe must be designed. Varying fuel loads and shifts in weight during maneuvers must not negatively affect control of the craft in flight.ir

Fuel System Independence

Each fuel system for a multiengine airplane must be arranged so that, in at least one system configuration, the failure of any one component (other than a fuel tank) does not result in the loss of power of more than one engine or require immediate action by the pilot to prevent the loss of power of more than one engine.

Fuel System Lightning Protection

The fuel system must be designed and arranged to prevent the ignition of fuel vapor within the system by direct lightning strikes or swept lightning strokes (where highly probable). Swept strokes occur when the lightning strike is deformed by interaction with aerodynamic forces and propagates in a unique manner due to the material and shape of the airframe surfaces. Corona and stream ring must also be inhibited at fuel vent outlets since they may ignite the fuel-air mixture. A corona is a luminous discharge that occurs as a result of an electrical potential difference between the aircraft and the surrounding area. Stream ring is a branch-like ionized path that occurs in the presence of a direct stroke or under conditions when lightning strokes are imminent.

Fuel Tanks

Each fuel tank must be able to withstand, without failure, the vibration, inertia, fluid, and structural loads to which it may be subjected in operation. Fuel tanks with flexible liners must demonstrate that the liner is suitable for the particular application. The total usable capacity of any tank(s) must be enough for at least 30 minutes of operation at maximum continuous power. Each integral fuel tank must have adequate facilities for interior inspection and repair. Additionally, each fuel quantity indicator must be adjusted to account for the unusable fuel supply

Fuel System Components

Fuel system components in an engine nacelle or in the fuselage must be protected from damage that could result in spillage of enough fuel to constitute a fire hazard as a result of a wheels-up landing on a paved runway.

Fuel System Repair

The integrity of an aircraft fuel system is critical and should not be compromised. Any evidence of malfunction or leak should be addressed before the aircraft is released for flight. The danger of fire, explosion, or fuel starvation in flight makes it imperative that fuel system irregularities be given top priority. Each manufacturer's maintenance and operation instructions must be used to guide the technician in maintaining the fuel system in airworthy condition. Follow the manufacturer's instructions at all times. Component manufacturers and STC holder instructions should be used when applicable. Some general instructions for fuel system

Troubleshooting the Fuel System

Knowledge of the fuel system and how it operates is essential when troubleshooting. manufacturers produce diagrams and descriptions in their maintenance manuals to aid the technician. Study these for insight. Many manuals have troubleshooting charts or flow diagrams that can be followed. As with all troubleshooting, a logical sequence of steps to narrow the problem to a specific component or location should be followed. Defects within the system can often be maintenance and repair are given in the following sections located by tracing the fuel flow from the tank through the system to the engine. Each component must be functioning as designed and the cause of the defect symptom must be ruled out sequentially.

Location of Leaks and Defects

Close visual inspection is required whenever a leak or defect is suspected in a fuel system. Leaks can often be traced to the connection point of two fuel lines or a fuel line and a component. Occasionally, the component itself may have an internal leak. Fuel leaks also occur in fuel tanks and are discussed below.

Leaking fuel produces a mark where it travels. It can also cause a stronger than normal odor. Gasoline may collect enough of its dye for it to be visible or an area clean of dirt may form. Jet fuel is difficult to detect at first, but it has a slow evaporation rate. Dirt and dust eventually settle into it, which makes it more visible

Fuel Leak Classification

Four basic classifications are used to describe aircraft fuel leaks: stain, seep, heavy seep, and running leak. In 30 minutes, the surface area of the collected fuel from a leak is a certain size. This is used as the classification standard. When the area is less than ¾ inch in diameter, the leak is said to be a stain. From ¾ to 1½ inches in diameter, the leak is classified as a seep. Heavy seeps form an area from 1½ inches to 4 inches in diameter. Running leaks pool and actually drip from the aircraft. They may follow the contour of the aircraft for a long distance.

Replacement of Gaskets, Seals, and Packing

A leak can often be repaired by replacing a gasket or seal. When this occurs or a component is replaced or reassembled after a maintenance operation, a new gasket, seal, or packing must be installed. Do not use the old one(s). Always be sure to use the correct replacement as identified by part number. Also, most gaskets, seals, and packing have a limited shelf life. They should be used only if they are within the service life stamped on the package.

Fuel Tank Repair

Whether rigid removable, bladder-type, or integral, all fuel tanks have the potential to develop leaks. Repair a tank according to the manufacturer's instructions. Some general notes for repair of each tank type follow. Note that at the time a tank is repaired, a thorough inspection should be made. Corrosion, such as that caused by water and microbes, should be identified and treated at this time, even if it is not the cause of the leak. Rigid removable fuel tanks can be riveted, elded, or soldered together. A leak can develop at any of these types of seams or can be elsewhere on the tank. Generally, the repair must match the construction in technique.

Fire Safety

Fuel vapor, air, and a source of ignition are the requirements for a fuel fire. Whenever working with fuel or a fuel system component, the technician must be vigilant to prevent these elements from coming together to cause a fire or explosion. A source of ignition is often the most controllable. In addition to removing all sources of ignition from the work area, care must be exercised to guard against static electricity. Static electricity can easily ignite fuel vapor, and its potential for igniting fuel vapor may not be as obvious as a flame or an operating electrical device. The action of fuel flowing through a fuel line can cause a static buildup as can many other situations in which one object moves past another. Always assess the work area and take steps to remove any potential static electricity ignition sources.

Fuel System Servicing

Maintaining aircraft fuel systems in acceptable condition to deliver clean fuel to the engine(s) is a major safety factor in aviation. Personnel handling fuel or maintaining fuel systems should be properly trained and use best practices to ensure that the fuel, or fuel system, are not the cause of an incident or accident.

Ice Control Systems

Rain, snow, and ice are transportation's longtime enemies. Flying has added a new dimension, particularly with respect to ice. Under certain atmospheric conditions, ice can build rapidly on airfoils and air inlets. On days when there is visible moisture in the air, ice can form on aircraft leading edge surfaces at altitudes where freezing temperatures start. Water droplets in the air can be super cooled to below freezing without actually turning into ice unless they are disturbed in some manner. This unusual occurrence is partly due to the surface tension of the water droplet not allowing the droplet to expand and freeze. However, when aircraft surfaces disturb these droplets, they immediately turn to ice on the aircraft surfaces.

The two types of ice encountered during flight are clear and rime. Clear ice forms when the remaining liquid portion of the water drop flows out over the aircraft surface, gradually freezing as a smooth sheet of solid ice. Formation occurs when droplets are large, such as in rain or in cumuliform clouds. Clear ice is hard, heavy, and tenacious. Its removal by deicing equipment is especially difficult.

Ice or frost forming on aircraft creates two basic hazards:

1. The resulting malformation of the airfoil that could decrease the amount of lift.

2. The additional weight and unequal formation of the ice that could cause unbalancing of the aircraft, making it hard to control.

Icing Effects

Ice buildup increases drag and reduces lift. It causes destructive vibration and hampers true instrument readings. Control surfaces become unbalanced or frozen. Fixed slots are filled and movable slots jammed. Radio reception is hampered and engine performance is affected. Ice, snow, and slush have a direct impact on the safety of flight. Not only because of degraded lift, reduced takeoff performance, and/ or maneuverability of the aircraft, but when chunks break off, they can also cause engine failures and structural damage. Fuselage aft-mounted engines are particularly susceptible to this foreign object damage (FOD) phenomenon. Wing mounted engines are not excluded however. Ice can be present on any part of the aircraft and, when it breaks off, there is some probability that it could go into an engine. The worst case is that ice on the wing breaks off during takeoff due to the flexing of the wing and goes directly into the engine, leading to surge, vibration, and complete thrust loss. Light snow that is loose on the wing surfaces and the fuselage can also cause engine damage leading to surge, vibration, and thrust loss.

The ice and rain protection systems used on aircraft keep ice from forming on the following airplane components:

- Wing leading edges
- Horizontal and vertical stabilizer leading edges
- Engine cowl leading edges
- Propellers

Ice Detector System

Ice can be detected visually, but most modern aircraft have one or more ice detector sensors that warn the flight crew of icing conditions. An enunciator light comes on to alert the flight crew. In some aircraft models, multiple ice detectors are used, and the ice detection system automatically turns on the WAI systems when icing is detected.

Ice Prevention

Several means to prevent or control ice formation are used in aircraft today:

1. Heating surfaces with hot air
2. Heating by electrical elements
3. Breaking up ice formations, usually by inflatable boots
4. Chemical application

Equipment is designed for anti-icing or for deicing. Anti-icing equipment is turned on before entering icing conditions and is designed to prevent ice from forming. A surface may be anti-iced by keeping it dry, by heating to a temperature that evaporates water upon impingement, or by heating the surface just enough to prevent freezing, maintaining it running wet. Deicing equipment is designed to remove ice after it begins to accumulate typically on the wings and stabilizer leading edges.

Thermal Electric Anti-Icing

Electricity is used to heat various components on an aircraft so that ice does not form. This type of anti-ice is typically limited to small components due to high amperage draw. Effective thermal electric anti-ice is used on most air data probes, such as pitot tubes, static air ports, TAT and AOA probes, ice detectors, and engine P2/T2 sensors. Water lines, waste water drains, and some turboprop inlet cowls are also heated with electricity to prevent ice from forming. Transport category and high performance aircraft use thermal electric anti-icing in windshields.

Chemical Anti-Icing

Chemical anti-icing is used in some aircraft to anti-ice the leading edges of the wing, stabilizers, windshields, and propellers. The wing and stabilizer systems are often called weeping wing systems or are known by their trade name of TKS™ systems. Ice protection is based upon the freezing point depressant concept. An antifreeze solution is pumped from a reservoir through a mesh screen embedded in the leading edges of the wings and stabilizers. Activated by a switch in the cockpit, the liquid flows over the wing and tail surfaces, preventing the formation of ice as it flows.

The solution mixes with the super cooled water in the cloud, depresses its freezing point, and allows the mixture to flow off of the aircraft without freezing. The system is designed to anti-ice, but it is also capable of deicing an aircraft as well. When ice has accumulated on the leading edges, the antifreeze solution chemically breaks down the bond between the ice and airframe.

This allows aerodynamic forces to carry the ice away. Thus, the system clears the airframe of accumulated ice before transitioning to anti-ice protection.

Wing and Stabilizer Deicing Systems

GA aircraft and turboprop commuter-type aircraft often use a pneumatic deicing system to break off ice after it has formed on the leading edge surfaces. The leading edges of the wings and stabilizers have inflatable boots attached to them. The boots expand when inflated by pneumatic pressure, which breaks away ice accumulated on the boot. Most boots are inflated for 6 to 8 seconds. They are deflated by vacuum suction. The vacuum is continuously applied to hold the boots tightly against the aircraft while not in use.

Deicing System Components

Several components are used to construct all deice boot systems. The components may differ slightly in name and location within the system depending on the aircraft. Components may also combine functions to save space and weight. The basic functions of filtering, pressure regulation, distribution, and attachment to a vacuum when boots are not in use must all be present. Check valves must also be installed to prevent back flow in the system. Manifolds are common on multiengine aircraft to allow sourcing of low pressure air from both engine pumps. Note that air-pump pressure is typically expelled overboard when not needed. Bleed air is shut off by a valve when not needed for deice boot operation on turbine engine aircraft. A timer, or control unit with an automatic mode, exists on many aircraft to repeat the deice cycle periodically.

Inspection, Maintenance, and Troubleshooting of Rubber Deicer Boot Systems

Maintenance on pneumatic deicing systems varies with each aircraft model. The instructions of the airframe or system components manufacturer should be followed in all cases. Depending on the aircraft, maintenance usually consists of operational checks, adjustments, troubleshooting, and inspection.

Troubleshooting

Not all troubles that occur in a deicer system can be corrected by adjusting system components. Some troubles must be corrected by repair or replacement of system components or by tightening loose connections. Note the probable causes and the remedy of each trouble listed in the chart. In addition to using troubleshooting charts, operational checks are sometimes necessary to determine the possible cause of trouble.

Inspection

During each preflight and scheduled inspection, check the deicer boots for cuts, tears, deterioration, punctures, and security; during periodic inspections, go a little further and check deicer components and lines for cracks. If weather cracking of rubber is noted, apply a coating of conductive cement. The cement, in addition to sealing the boots against weather, dissipates static electricity so that it does not puncture the boots by arcing to the metal surfaces.

Deice Boot Maintenance

The life of the deicers can be greatly extended by storing them when they are not needed and by observing these rules when they are in service:Do not drag gasoline hoses over the deicers.

1. Keep deicers free of gasoline, oil, grease, dirt, and other deteriorating substances.
2. Do not lay tools on or lean maintenance equipment against the deicers.
3. Promptly repair or resurface the deicers when abrasion or deterioration is noted.
4. Wrap deice boots in paper or canvas when storing.

Deicing and Anti-icing of Transport Type Aircraft

Deicing Fluid

The deicing fluid must be accepted according to its type for holdover times, aerodynamic performance, and material compatibility. The coloring of these fluids is also standardized. In general, glycol is colorless, Type-I fluids are orange, Type-II fluids are white/pale yellow, and Type- IV fluids are green. The color for Type-III fluid has not yet been determined.

When aircraft surfaces are contaminated by frozen moisture, they must be deiced prior to dispatch. When freezing precipitation exists, and there is a risk of contamination of the surface at the time of dispatch, aircraft surfaces must be anti-iced. If both deicing and anti-icing are enquired, the procedure may be performed in one or two steps. The selection of a one- or two-step process depends upon weather conditions, available equipment, available fluids, and the holdover time to be achieved.

Aircraft Oxygen Systems

The negative effects of reduced atmospheric pressure at flight altitudes, forcing less oxygen into the blood, can be overcome. There are two ways this is commonly done: increase the pressure of the oxygen or increase the quantity of oxygen in the air mixture. Large transport-category and high performance passenger aircraft pressurize the air in the cabin. This serves to push more of the normal 21 percent oxygen found in the air into the blood for saturation. Techniques for pressurization are discussed later in this chapter. When utilized, the percentage of oxygen available for breathing remains the same; only the pressure is increased.

Forms of Oxygen and Characteristics Gaseous Oxygen

Oxygen is a colorless, odorless, and tasteless gas at normal atmospheric temperatures and pressures. It transforms into a liquid at –183 °C (its boiling point). Oxygen combines readily with most elements and numerous compounds. This combining is called oxidation. Typically, oxidation produces heat. When something burns, it is actually rapidly combining with oxygen. Oxygen itself does not burn because it does not combine with itself, except to form oxygen or ozone. But, pure oxygen combines violently with petroleum products creating a significant hazard when handling these materials in close proximity to each other. Nevertheless, oxygen and various petroleum fuels combine to create the energy produced in internal combustion engines.

Pure gaseous oxygen, or nearly pure gaseous oxygen, is stored and transported in high-pressure cylinders that are typically painted green. Technicians should be cautious to keep pure oxygen away from fuel, oil, and grease to prevent unwanted combustion. Not all oxygen in containers is the same. Aviator's breathing oxygen is tested for the presence of water. This is done to avoid the possibility of it freezing in the small passage ways of valves and regulators. Ice could prevent delivery of the oxygen when needed. Aircraft often operate in subzero temperatures, increasing the possibility of icing. The water level should be a maximum of .02ml per liter of oxygen. The words ―Aviator's Breathing Oxygen‖ should be marked clearly on any cylinders containing oxygen for this purpose.

Oxygen Systems and Components

Built-in and portable oxygen systems are used in civilian aviation. They use gaseous or solid oxygen (oxygen generators) as suits the purpose and aircraft. LOX systems and molecular sieve oxygen systems are not discussed, as current applications on civilian aircraft are limited.

Oxygen Systems and Regulators

The design of the various oxygen systems used in aircraft depends largely on the type of aircraft, its operational requirements, and whether the aircraft has a pressurization system. Systems are often characterized by the type of regulator used to dispense the oxygen: continuous-flow and demand flow. In some aircraft, a continuous-flow oxygen system is installed for both passengers and crew. The pressure demand system is widely used as a crew system, especially on the larger transport aircraft. Many aircraft have a combination of both systems that may be augmented by portable equipment.

Oxygen System Servicing

Servicing Gaseous Oxygen

Gaseous oxygen systems are prevalent in general, corporate, and airline aviation. The use of light weight aluminum and composite storage cylinders has improved these simple and reliable life support systems. All gaseous oxygen systems require servicing and maintenance. Various procedures and requirements to perform these functions are covered in this section.

Leak Testing Gaseous Oxygen Systems

Leaks in a continuous-flow oxygen system may be difficult to detect because the system is open at the user end. Blocking the flow of oxygen allows pressure to build and leak check procedures can be followed that are similar to those used in the high pressure sections of the systems. detection of leaks should be performed with oxygen-safe leak check fluid. This is a soapy liquid free from elements that might react with pure oxygen or contaminate the system. As with leak detection on an inflated tire or tube assembly, the oxygen leak detection solution is applied to the outside of fittings and mating surfaces. The formation of bubbles indicates a leak.

Filling an Oxygen System

Filling procedures for oxygen systems vary. Many general aviation aircraft are set up to simply replace an empty cylinder with one that is fully charged. This is also the case with a portable oxygen system. High performance and air transport category aircraft often have built-in oxygen systems that contain plumbing designed to refill gaseous oxygen cylinders while they are in place.

Draining an Oxygen System

The biggest factor in draining an oxygen system is safety. The oxygen must be released into the atmosphere without causing a fire, explosion, or hazard. Draining outside is highly recommended. The exact method of draining can vary. The basic procedure involves establishing a continuous flow in a safe area until the system is empty.

The following is a list of steps to safely fill an aircraft oxygen system from a typical oxygen refill cart.

1. Check hydrostatic dates on all cylinders, especially those that are to be filled on the aircraft. If a cylinder is out of date, remove and replace it with a specified unit that is serviceable.

2. Check pressures on all cylinders on the cart and in the aircraft. If pressure is below 50 psi, replace the cylinder(s). On the aircraft, this may require purging the system with oxygen when completed. Best practices dictate that any low-pressure or empty cylinder(s) on the cart should also be removed and replaced when discovered.

3. Take all oxygen handling precautions to ensure a safe environment around the aircraft.
4. Ground the refill cart to the aircraft.

5. Connect the cart hose from the cart manifold to the aircraft fill port. Purge the air from the refill hose with oxygen before opening the refill valve on the aircraft. Some hoses are equipped with purge valves to do this while the hose is securely attached to the aircraft. Others hoses need to be purged while attached to the refill fitting but not fully tightened.

6. Observe the pressure on the aircraft bottle to be filled. Open it. On the refill cart, open the cylinder with the closest pressure to the aircraft cylinder that exceeds it.

7. Open the aircraft oxygen system refill valve. Oxygen will flow from cart cylinder (manifold) into the aircraft cylinder.

Inspection of Masks and Hoses

The wide varieties of oxygen masks used in aviation require periodic inspection. Mask and hose integrity ensure effective delivery of oxygen to the user when it is needed. Sometimes this is in an emergency situation. Leaks, holes, and tears are not acceptable. Most discrepancies of this type are remedied by replacement of the damaged unit. Some continuous-flow masks are designed for disposal after use. Be sure there is a mask for each potential user on board the aircraft. Masks designed to be reused should be clean, as well as functional. This reduces the danger of infection and prolongs the life of the mask. Various mild cleaners and antiseptics that are free of petroleum products can be used. A supply of individually wrapped alcohol swabs are often kept in the cockpit.

Oxygen System Inspection and Maintenance

When working around oxygen and oxygen systems, cleanliness enhances safety. Clean, grease-free hands, clothes, and tools are essential. A good practice is to use only tools dedicated for work on oxygen systems. There should be absolutely no smoking or open flames within a minimum of 50 feet of the work area. Always use protective caps and plugs when working with oxygen cylinders, system components, or plumbing. Do not use any kind of adhesive tape. Oxygen cylinders should be stored in a designated, cool, ventilated area in the hanger away from petroleum products or heat sources.

Aircraft Pressurization Systems Pressure of the Atmosphere

The gases of the atmosphere (air), although invisible, have weight. A one square inch column of air stretching from sea level into space weighs 14.7 pounds. Therefore, it can be stated that the pressure of the atmosphere, or atmospheric pressure, at sea level is 14.7 psi. Atmospheric pressure is also known as barometric pressure and is measured with a barometer. Expressed

in various ways, such as in inches of mercury or millimeters of mercury, these measurements come from observing the height of mercury in a column when air pressure is exerted on a reservoir of mercury into which the column is set. The column must be evacuated so air inside does not act against the mercury rising. A column of mercury 29.92 inches high weighs the same as a column of air that extends from sea level to the top of the atmosphere and has the same cross-section as the column of mercury.

Temperature and Altitude

Temperature variations in the atmosphere are of concern to aviators. Weather systems produce changes in temperature near the earth's surface. Temperature also changes as altitude is increased. The troposphere is the lowest layer of the atmosphere. On average, it ranges from the earth's surface to about 38,000 feet above it. Over the poles, the troposphere extends to only 25,000–30,000 feet and, at the equator, it may extend to around 60,000 feet. This oblong nature of the troposphere is illustrated. Most civilian aviation takes place in the troposphere in which temperature decreases as altitude increases. The rate of change is somewhat constant at about –2 °C or –3.5 °F for every 1,000 feet of increase in altitude. The upper boundary of the troposphere is the tropopause. It is characterized as a zone of relatively constant temperature of –57 °C or –69 °F.

Pressurization Terms

The following terms should be understood for the discussion of pressurization and cabin environmental systems that follows:

1. Cabin altitude—given the air pressure inside the cabin, the altitude on a standard day that has the same pressure as that in the cabin. Rather than saying the pressure inside the cabin is 10.92 psi, it can be said that the cabin altitude is 8,000 feet (MSL).

2. Cabin differential pressure—the difference between the air pressure inside the cabin and the air pressure outside the cabin. Cabin pressure (psi) – ambient pressure (psi) = cabin differential pressure (psid or psi).

3. Cabin rate of climb—the rate of change of air pressure inside the cabin, expressed in feet per minute (fpm) of cabin altitude change.

Pressurization Issues

Pressurizing an aircraft cabin assists in making flight possible in the hostile environment of the upper atmosphere. The degree of pressurization and the operating altitude of any aircraft are limited by critical design factors. A cabin pressurization system must accomplish several functions if it is to ensure adequate passenger comfort and safety. It must be capable of maintaining a cabin pressure altitude of approximately 8,000 feet or lower regardless of the cruising altitude of the aircraft. This is to ensure that passengers and crew have enough oxygen present at sufficient pressure to facilitate full blood saturation.

A pressurization system must also be designed to prevent rapid changes of cabin pressure, which can be uncomfortable or injurious to passengers and crew. Additionally, a pressurization system should circulate air from inside the cabin to the outside at a rate that quickly eliminates odors and to remove stale air. Cabin air must also be heated or cooled on pressurized aircraft. Typically, these functions are incorporated into the pressurization source

Sources of Pressurized Air

The source of air to pressurize an aircraft varies mainly with engine type. Reciprocating aircraft have pressurization sources different from those of turbine-powered aircraft. Note that the compression of air raises its temperature. A means for keeping pressurization air cool enough is built into most pressurization systems. It may be in the form of a heat exchanger, using cold ambient air to modify the temperature of the air from the pressurization source. A full air cycle air conditioning system with expansion turbine may also be used.

Control of Cabin Pressure Pressurization Modes

Aircraft cabin pressurization can be controlled via two different modes of operation. The first is the isobaric mode, which works to maintain cabin altitude at a single pressure despite the changing altitude of the aircraft. For example, the flight crew may select to maintain a cabin altitude of 8,000 feet (10.92 psi). In the isobaric mode, the cabin pressure is established at the 8,000 foot level and remains at this level, even as the altitude of the aircraft fluctuates.

Cabin Pressure Controller

The cabin pressure controller is the device used to control the cabin air pressure. Older aircraft use strictly pneumatic means for controlling cabin pressure. Selections for the desired cabin altitude, rate of cabin altitude change, and barometric pressure setting are all made directly to the pressure controller from pressurization panel in the cockpit

Pressurization Gauges

While all pressurization systems differ slightly, usually three cockpit indications, in concert with various warning lights and alerts, advise the crew of pressurization variables. They are the cabin altimeter, the cabin rate of climb or vertical speed indicator, and the cabin differential pressure indicator. These can be separate gauges or combined into one or two gauges. All are typically located on the pressurization panel, although sometimes they are elsewhere on the instrument panel. Outflow valve position indicator(s) are also common

Cabin Pressurization Troubleshooting

While pressurization systems on different aircraft operate similarly with similar components, it cannot be assumed that they are the same. Even those systems constructed by a single manufacturer likely have differences when installed on different aircraft. It is important to check the aircraft manufacture's service information when troubleshooting the pressurization system. A fault, such as failure to pressurize or failure to maintain pressurization, can have many different causes. Adherence to the steps in a manufacturer's troubleshooting procedures is highly recommended to sequentially evaluate possible causes. Pressurization system test kits are available, or the aircraft can be pressurized by its normal sources during troubleshooting. A test flight may be required after maintenance.

Air Conditioning Systems

There are two types of air conditioning systems commonly used on aircraft. Air cycle air conditioning is used on most turbine-powered aircraft. It makes use of engine bleed air or

APU pneumatic air during the conditioning process. Vapor cycle air conditioning systems are often used on reciprocating aircraft. This type system is similar to that found in homes and automobiles. Note that some turbine-powered aircraft also use vapor cycle air conditioning.

Air Cycle Air Conditioning

Air cycle air conditioning prepares engine bleed air to pressurize the aircraft cabin. The temperature and quantity of the air must be controlled to maintain a comfortable cabin environment at all altitudes and on the ground. The air cycle system is often called the air conditioning package or pack. It is usually located in the lower half of the fuselage or in the tail section of turbine-powered aircraft.

System Servicing

Vapor cycle air conditioning systems can give many hours of reliable, maintenance-free service. Periodic visual inspections, tests, and refrigerant level and oil level checks may be all that is required for some time. Follow the manufacturer's instructions for inspection criteria and intervals.

Visual Inspection

All components of any vapor cycle system should be checked to ensure they are secure. Be vigilant for any damage, misalignment, or visual signs of leakage. The evaporator and condenser fins should be checked to ensure they are clean, unobstructed, and not folded over from an impact. Dirt and inhibited airflow through the fins can prevent effective heat exchange to and from the refrigerant. Occasionally, these units can be washed.

Leak Test

As mentioned under the leak detector section above, leaks in a vapor cycle air conditioning system must be discovered and repaired. The most obvious sign of a possible leak is a low refrigerant level. Bubbles present in the sight glass of the receiver dryer while the system is operating indicate more refrigerant is needed. A system check for a leak may be in order. Note that vapor cycle systems normally lose a small amount of refrigerant each year. No action is needed if this amount is within limits.

Fire Protection Systems

Because fire is one of the most dangerous threats to an aircraft, the potential fire zones of modern multiengine aircraft are protected by a fixed fire protection system. A fire zone is an area, or region, of an aircraft designed by the manufacturer to require fire detection and/or fire extinguishing equipment and a high degree of inherent fire resistance. The term ―fixed‖ describes a permanently installed system in contrast to any type of portable fire extinguishing equipment, such as a hand-held Halon or water fire extinguisher. A complete fire protection system on modern aircraft, and on many older aircraft, includes a fire detection system and a fire extinguishing system.

Typical zones on aircraft that have a fixed fire detection and/or fire extinguisher system are:

1. Engines and auxiliary power unit (APU)
2. Cargo and baggage compartments
3. Lavatories on transport aircraft
4. Electronic bays
5. Wheel wells
6. Bleed air ducts

To detect fires or overheat conditions, detectors are placed in the various zones to be monitored. Fires are detected in reciprocating engine and small turboprop aircraft using one or more of the following:

1. Overheat detectors
2. Rate-of-temperature-rise detectors3. Flame detectors4. Observation by rewmembersFir

The complete aircraft fire protection systems of most large turbine-engine aircraft incorporate several of these different detection methods.

1. Rate-of-temperature-rise detectors
2. Radiation sensing detectors
3. Smoke detectors
4. Overheat detectors
5. Carbon monoxide detectors
6. Combustible mixture detectors
7. Optical detectors
8. Observation of crew or passing

Classes of Fires

The following classes of fires that are likely to occur onboard aircraft, as defined in the U.S. National Fire Protection Association (NFPA) Standard 10, Standard for Portable Fire Extinguishers, 2007 Edition, are:

1. Class A—fires involving ordinary combustible materials, such as wood, cloth, paper, rubber, and plastics.

2. Class B—fires involving flammable liquids, petroleum oils, greases, tars, oil-based paints, lacquers, solvents, alcohols, and flammable gases.

Requirements for Overheat and Fire Protection Systems

Fire protection systems on current-production aircraft do not rely on observation by crew members as a primary method of fire detection. An ideal fire detector system includes as

many of the following features as possible:

1. No false warnings under any flight or ground condition.
2. Rapid indication of a fire and accurate location of the fire.
3. Accurate indication that a fire is out.
4. Indication that a fire has re-ignited.
5. Continuous indication for duration of a fire.
6. Means for electrically testing the detector system from the aircraft cockpit.
7. Resists damage from exposure to oil, water, vibration, extreme temperatures, or handling.
8. Light in weight and easily adaptable to any mounting position.
9. Circuitry that operates directly from the aircraft power system without inverters.
10. Minimum electrical current requirements when not indicating a fire.
11. Cockpit light that illuminates, indicating the location of the fire, and with an audible alarm system.
12. A separate detector system for each engine.

Fire Detection/Overheat Systems

A fire detection system should signal the presence of a fire. Units of the system are installed in locations where there are greater possibilities of a fire. Three detector system types in common use are the thermal switch, thermocouple, and the continuous loop.P

Smoke**, Flame, and Carbon Monoxide**

Detection Systems

Smoke Detectors

A smoke detection system monitors the lavatories and cargo baggage compartments for the presence of smoke, which is indicative of a fire condition. Smoke detection instruments that collect air for sampling are mounted in the compartments in strategic locations. A smoke detection system is used where the type of fire anticipated is expected to generate a substantial amount of smoke before temperature changes are sufficient to actuate a heat detection system.

Two common types used are light refraction and ionization.

Light Refraction Type

The light refraction type of smoke detector contains a photoelectric cell that detects light refracted by smoke particles. Smoke particles refract the light to the photoelectric cell and, when it senses enough of this light, it creates an electrical current that sets off a light.

Ionization Type

Some aircraft use an ionization type smoke detector. The system generates an alarm signal (both horn and indicator) by detecting a change in ion density due to smoke in the cabin. The system is connected to the 28 volt DC electrical power supplied from the aircraft. Alarm output and sensor sensitive checks are performed simply with the test switch on the control panel.

Reinstalled Fire Extinguishing Systems

Transport aircraft have fixed fire extinguishing systems installed in:

1. Turbine engine compartments
3. APU compartments Cargo and baggage compartments
4. Lavatories

CO2 Fire Extinguishing Systems

Older aircraft with reciprocating engines used CO2 as an extinguishing agent, but all newer aircraft designs with turbine engines use Halon or equivalent extinguishing agent, such as halocarbon clean agents.

Fire Detection System Maintenance

Fire detector sensing elements are located in many high activity areas around aircraft engines. Their location, together with their small size, increases the chance of damage to the sensing elements during maintenance. An inspection and maintenance program for all types of continuous-loop systems should include the following visual checks. Note: These procedures are examples and should not be used to replace the applicable manufacturer's instructions. Sensing elements of a continuous-loop system should be inspected for the following:

1. Cracked or broken sections caused by crushing or squeezing between inspection plates, cowl panels, or engine components.

2. Abrasion caused by rubbing of the element on cowling, accessories, or structural embers.

3. Pieces of safety wire, or other metal particles, that may short the spot-detector terminals.

4. Condition of rubber grommets in mounting clamps that may be softened from exposure to oils or hardened from excessive heat.

5. Dents and kinks in sensing element sections. Limits on the element diameter, acceptable dents and kinks, and degree of smoothness of tubing contour are specified by manufacturers. No attempt should be made to straighten any acceptable dent or kink, since stresses may be set up that could cause tubing failure.

Fire Detection System Troubleshooting

The following troubleshooting procedures represent the most common difficulties encountered in engine fire detection systems:

1. Intermittent alarms are most often caused by an intermittent short in the detector system wiring. Such shorts may be caused by a loose wire that occasionally touches a nearby terminal, a frayed wire brushing against a structure, or a sensing element rubbing against a structural member long enough to weary through the insulation. Intermittent faults often can be located by moving wires to recreate the short.

2. Fire alarms and warning lights can occur when no engine fire or overheat condition exists. Such false alarms can be most easily located by disconnecting the engine sensing loop connections from the control unit. If the false alarm ceases when the engine sensing loop is disconnected, the fault is in the disconnected sensing loop, which should be examined for areas that have been bent into contact with hot parts of the engine. If no bent element can be found, the shorted section can be located by isolating the connecting elements consecutively around the entire loop.

3. Kinks and sharp bends in the sensing element can cause an internal wire to short intermittently to the outer tubing. The fault can be located by checking the sensing element with an ohm meter while tapping the element in the suspected areas to produce the short. 4. Moisture in the detection system seldom causes a false fire alarm. If, however, moisture does cause an alarm, the warning persists until the contamination is removed, or boils away, and the resistance of the loop returns to its normal value.

5. Failure to obtain an alarm signal when the test switch is actuated may be caused by a defective test switch or control unit, the lack of electrical power, inoperative indicator light, or an openingin the sensing element or connecting wiring. When the test switch fails to provide an alarm, the continuity of a two-wire sensing loop can be determined by opening the loop and measuring the resistance. In a single-wire, continuous loop system, the center conductor should be grounded.

UNIT V FLIGHT SAFETY

Ground Support Equipments

Electric Ground Power Units

Ground support electrical auxiliary power units vary widely in size and type. However, they can be generally classified by towed, stationary, or self-propelled items of equipment. Some units are mainly for in-hangar use during maintenance. Others are designed for use on the flight line either at a stationary gate area or towed from aircraft to aircraft. The stationary type can be powered from the electrical service of the facility. The movable type ground power unit (GPU) generally has an onboard engine that turns a generator to produce power. Some smaller units use a series of batteries.

The towed power units vary in size and range of available power.

The smallest units are simply high-capacity batteries used to start light aircraft. These units are normally mounted on wheels or skids and are equipped with an extra-long electrical line terminated in a suitable
plug-in adapter.

Hydraulic Ground Power Units

Portable hydraulic test stands are manufactured in many sizes and cost ranges. [Figure 11-29] Some have a limited range of operation, while others can be used to perform all the system tests that fixed shop test stands are designed to perform. Hydraulic power units, sometimes called a hydraulic mule, provide hydraulic pressure to operate the aircraft systems during maintenance.

They can be used to:

• Drain the aircraft hydraulic systems.
• Filter the aircraft system hydraulic fluid.
• Refill the aircraft system with clean fluid.
• Check the aircraft hydraulic systems for operation and leaks.

This type of portable hydraulic test unit is usually an electrically powered unit. It uses a hydraulic system capable of delivering a variable volume of fluid from zero to approximately 24 gallons per minute at variable pressures up to 3,000 psi.

Ground Support Air Units

Air carts are used to provide low pressure (up to 50 psi high volume flow) air which can be used for tarting the engines, and heating and cooling the aircraft on the ground (using the onboard aircraft systems). It generally consists of an APU built into the cart that provides bleed air from the APU’s compressor for operating aircraft systems or starting engines.

Ground Air Heating and Air Conditioning

Most airport gates have facilities that can provide heated or cooled air. The units that cool or heat the air are permanent installations, which connect to the aircraft by a large hose that connects to the aircraft’s ventilation system. Portable heating and air conditioning units can also be moved close to the aircraft and connected by a duct, which provides air to keep the cabin temperature comfortable.

Fueling and Defueling Procedures

Maintenance technicians are often asked to fuel or defuel aircraft. Fueling procedure can vary from aircraft to aircraft. Tanks may need to be fueled in a prescribed sequence to prevent structural damage to the airframe. The proper procedure should be confirmed before fueling an unfamiliar aircraft.

Fueling

Always fuel aircraft outside, not in a hangar where fuel vapors may accumulate and increase the risk and severity of an accident. Generally, there are two types of fueling process: over-the-wing refueling and pressure refueling. Over-the wing refueling is accomplished by opening the fuel tank cap on the upper surface of the wing or fuselage, if equipped with fuselage tanks. The fueling nozzle is carefully inserted into the fill opening and fuel is pumped into the tank. This process is similar to the process used to refuel an automobile gas tank. When finished, the cap is secured and subsequent tanks are opened and refilled until the aircraft has the desired fuel load onboard. Pressure refueling occurs at the bottom, front, or rear of the fuel tank. A pressure refueling nozzle locks onto the fueling port at the aircraft fueling station. Fuel is pumped into the aircraft through this secured and sealed connection. Gauges are monitored to ascertain when the tanks are properly loaded. An automatic shutoff system may be part of the aircraft system. It closes the fueling valve when the tanks are full.

Precautions should be used with either type of fueling. First and foremost, it is absolutely essential that the correct fuel be put in the aircraft. The type of fuel to be used is placarded near the fill port on over-the-wing systems and at the fueling station on pressure refueled aircraft. If there is any question about which fuel to use, the pilot in command, other knowledgeable personnel, or the manufacturer’s maintenance/operations manual should be consulted before proceeding. Note that an over-the-wing refueling nozzle for turbine engine fuel should be too large to fit into the fill opening on an aircraft utilizing gasoline. Clean the area adjacent to the fill port when refueling over the wing. Ensure the fuel nozzle is also clean. Aviation fuel nozzles are equipped with static bonding wires that must be attached to the aircraft before the fuel cap is opened

Open the cap only when ready to dispense the fuel. Insert the nozzle into the opening with care. The aircraft structure is much more delicate than the fuel nozzle, which could easily damage the aircraft. Do not insert the neck of the nozzle deeply enough to hit bottom. This could dent the tank, or the aircraft skin, if it is an integral tank. Exercise caution to avoid damage to the surface of the airframe by the heavy fuel hose. Lay the hose over your shoulder or use a refueling mat to protect the paint.

There are other miscellaneous good practices that should be employed when refueling an aircraft. A ladder should be used if the refuel point is not accessible while standing on the ground. Climbing on an expensive aircraft to access the fueling ports is possible but does not give the stability of a ladder and may not be appreciated by the aircraft owner. If it is necessary to walk on the wings of the aircraft, do so only in designated areas, which are safe

Defueling

Removing the fuel contained in aircraft fuel tanks is sometimes required. This can occur for maintenance, inspection, or due to contamination. Occasionally, a change in flight plan may require defueling. Safety procedures for defueling are the same as those for fueling. Always defuel outside. Fire extinguishers should be on hand. Bonding cables should be attached to guard against static electricity buildup. Defueling should be performed by experienced personnel, and inexperienced personnel must be checked out before doing so without assistance. Remember that there may be a sequence in defueling an aircraft’s fuel tanks just as there is when fueling to avoid structural damage. Consult the manufacturer’s maintenance operations manual(s) if in doubt.

Pressure fueled aircraft normally defuel through the pressure fueling port. The aircraft's in-tank boost pumps can be used to pump the fuel out. The pump on a fuel truck can also be used to draw fuel out. These tanks can also be drained through the tank sump drains, but the large size of the tanks usually makes this impractical. Aircraft fueled over the wing are normally drained through the tank sump drains. Follow the manufacturer's procedure for defueling the aircraft.

Good fuel removed from an aircraft must be handled with all precautions used when handling any fuel. It must only be put into clean tanks and efforts must be made to keep it clean.

It may be put back in the aircraft or another aircraft if the manufacturer allows. Large aircraft can often transfer fuel from a tank requiring maintenance to another tank to avoid the defueling process.

Fire Hazards When Fueling or Defueling

Due to the combustible nature of AVGAS and turbine engine fuel, the potential for fire while fueling and defueling aircraft must be addressed. Always fuel and defuel outside, not in a hangar that serves as an enclosed area for vapors to build up to a combustible level. lothing worn by refueling personnel should not promote static electricity buildup. Synthetics, such as nylon, should be avoided. Cotton has proved to be safe for fuel handling attire.

As previously mentioned, the most controllable of the three ingredients required for fire is the source of ignition. It is absolutely necessary to prevent a source of ignition anywhere near the aircraft during fueling or refueling. Any open flame, such as a lit cigarette, must be extinguished. Operation of any electrical devices must be avoided. Radio and radar use is prohibited. It is important to note that fuel vapors proliferate well beyond the actual fuel tank opening and a simple spark, even one caused by static electricity, could be enough for ignition. Any potential for sparks must be nullified.

Spilled fuel poses an additional fire hazard. A thin layer of fuel vaporizes quickly. Small spills should be wiped up immediately. Larger spills can be flooded with water to dissipate the fuel and the potential for ignition. Do not sweep fuel that has spilled onto the ramp.

Class B fire extinguishers need to be charged and accessible nearby during the fueling and defueling processes. Fueling personnel must know exactly where they are and how to use them. In case of an emergency, the fuel truck, if used, may need to be quickly driven away from the area. For this reason alone, it should be positioned correctly on the ramp relative to the aircraft.

Fire Protection

Requirements for Fire to occur three things are required for a fire:

(1) fuel — something that will, in the presence of heat, combine with oxygen, thereby releasing more heat and as a result reduces itself to other chemical compounds;

(2) heat — accelerates the combining of oxygen with fuel, in turn releasing more heat; and

(3) Oxygen — the element which combines chemically with another substance through the process of oxidation. Rapid oxidation, accompanied by a noticeable release of heat and light, is called combustion or burning. Remove any one of these things and the fire extinguishers.

Classification of Fires

For commercial purposes, the National Fire Protection Association (NFPA) has classified fires into three basic types: Class A, Class B, and Class C.

1. Class A fires occur in ordinary combustible materials, such as wood, cloth, paper, upholstery materials, and so forth.

2. Class B fires occur in flammable petroleum products of other flammable or combustible liquids, greases, solvents, paints, and so forth.

3. Class C fires occur involve energized electrical wiring and equipment.

Fire Safety

Anytime current flows, whether during generation or transmission, a byproduct of that flow is heat. The greater the current flow, the greater the amount of heat created. When this heat becomes too great, protective coatings on wiring and other electrical devices can melt, causing shorting, which leads to more current flow and greater heat. This heat can become so great that metals can melt, liquids vaporize, and flammable substances ignite.

An important factor in preventing electrical fires is to keep the area around electrical work or electrical equipment clean, uncluttered, and free of all unnecessary flammable substances. Ensure that all power cords, wires, and lines are free of kinks and bends which can damage the wire. Never place wires or cords where they will be walked on or run over by other equipment. When several wires inside a power cord are broken, the current passing through the remaining wires increases. This generates more heat than the insulation coatings on the wire are designed to withstand and can lead to a fire. Closely monitor the condition of electrical equipment. Repair or replace damaged equipment before further use.

Safety around Hazardous Materials

Material safety diamonds are very important with regard to shop safety. These forms and labels are a simple and quick way to determine the risk and, if used properly with the tags, will indicate what personal safety equipment to use with the hazardous material

Karpagam Academy of Higher Education

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(Established Under Section 3 of UGC Act 1956)

Coimbatore - 641021

Faculty of Engineering
Department of Mechanical Engineering
(Aerospace Engineering)

AIRFRAME MAINTENANCE AND REPAIR

Unit I Online Questions

1. Welding is a process of ____________

   a. permanent joint b. temporary joint c. screwing d. hammering

2. Arc welding is also known as _________

   a. gas welding **b. electric welding** c. submerged welding d. forge welding

3. A hand operated tool which is used to light a gas torch safely is _________

   a. friction lighter b. filler rod c. welding hose d. welding torch

4. Oxyacetylene welding equipment is normally used to weld _____________

   a. sheet metal b. steel tubing c. copper rods d. hard metals

5. MIG Welding stands for ______________

   a. Melting in Gas b. Metal In Gravity **c. Metal Inert Gas** d. Melting Inert Game

6. Welding sparks can cause __________and explosions.

   a. Fire b. Hot air c. Snow d. Foams

7. Which material is hard in nature?

   a. Copper **b. Graphite** c. Aluminium d. Iron

8. Welding do not produce heat or bright light so they can be used to practice safely for real welding.

   a. Machine b. Transformer **c. simulators** d. Rod

9. MMA Welding stands for _______________

   a. Metal Melting Arc **b. Manual Metal Arc**

   c. Metal Moving Arc d. Manual Melting Argon

10. A _____________ is a pointed instrument used to mark or score metal to show where it is to be cut.
    a. scribe b. snip c. hammer d. tongs

11. In TIG Welding we use an INERT gas. Which GAS could this be?
    a. Oxygen b. Air c. Acetylene **d. Argon**

12. ___________ type of sheet metal is user in aircraft skin structures.
    a. Iron b. Copper **c. Aluminum** d. Nickel

13. It is an operation of cutting a required component from sheet metal.
    a. Molding **b. Blanking** c. Punching d. Wire drawing

14. Welding rods in stick welding are covered in a FLUX that melts to protect the weld. When this cools it is called ________ and it must be chipped off.
    a. ICE b. PAINT c. GLASS **d. SLAG**

15. ________________ is used to measure the sheet metal thickness.
    a. wire gauge b. scale c. meter tape d. ruler

16. All Arc welding processes produce very bright light that can damage your eyes if they are not protected by a
    a. tongs b. mask c. C - Clamp **d. glass**

17. Tick off the material, which is different from the group
    a. Constantan. b.. Manganin c. Nichrome. **d. Brass**.

18. Magnetic particle testing is used to detect cracks which are ______________
    a. Invisible b. visible c. hidden d. surfaced

19. Magnetic particle testing uses the effects of__________________
    a. magnets b. fluid c. gas d. volatility

20. _______________also known as metal inert gas.
    a. metal arc welding **b. gas metal arc welding** c. flux-cored arc welding d. forge welding

21. Anti iceing used for ___________
    a. proper operation **b. proper torque** c. secues mounting d. safting

22. You must wear a welding mask to protect your eyes in all ARC welding processes.
    a. True b. False c. Irrelevant d. High cost

23. Raising the aircraft from ground for maintenance is termed as ______________
    a. Jacking b. Leveling c. Mooring d. Lifting

24. In MMA Welding , the weld pool is shielded by

a. CO_2 gas b. Air **c. Melting Flux** d. Argon Gas

25. Magnetic testing the flaws and cracks are seen as___________________

a. Particles b. Cracklers c. Dracles d. Marks

26. Inspection of raw productes is for _____________

a. corrosion b. machining c. cracking **d. casting**

27. Inspection of llowing secondary processing is for _____________

a. Machining b. Erosion c. Wear d. Forgings

28. Welding Simulators are used because

a. no material and no fumes b. safer to practice c. cheaper to operate **d. All of the given**

29. Penetrant penetrates the ________________

a. body **b. surface** c. layerd. dagger

30. Radiography uses________________

a. X-rays b. Y-rays c. Z-rays d. UV Rays

Unit II Online Questions

1. Composite materials are classified based on:

   a. Type of matrix b. Size-and-shape of reinforcement **c. Both a and b** d. incorrect

2. Usually stronger constituent of a composite is

   a. Matrix **b. Reinforcement** c. Both are of equal strength d. Can't define

3. Composite materials are

   a. made mainly to improve temperature resistance

   b. used for improved optical properties

   c. made with strong fibers embedded in strength better than strength of matrix.

   d. made with strong fibres embedded in strength better than strength of both matrix and filler

4. Pick the composite from the list

   a. Wood b. Steel c. Nylon d. Mica

5. Strong and ductile materials

   a. Polymers b. Ceramics **c. Metals** d. Semiconductors

6. Presently most used metal in the world

   a. Aluminum b. Gold **c. Steel** d. Silver

7. Detrimental property of a materi al for shock load applications

   a. High density **b. Low toughness** c. High strength d. Low hardness

8. Aircraft landing gear struts are made of

   a. Titanium alloys b. Super alloys **c. Aluminum alloys** d. Magnesium Alloys

9. Which of the following is the binding material in cemented carbides

   a. cobalt b. nickel c. vanadium d. iron

10. Chromium in steel

    a. Improves wear resistance, cutting ability and toughness

    b. improves corrosion and heat resistant properties

    c. improves cutting ability and reduces hardenability

    d. makes steel hard

11. Manganese in steel increases its

    a. tensile strength b. hardness **c. ductility** d. fluidity

12. Modern airframes are build on the principle of

    a. stressed skin b. strain skin c. shear skin d. smooth skin

13. The sheet metal covering of the structure which bears the structural loading is called as

    a. ribs b. longerons **c. skin** d. fuselage

14. The basic function of the fuselage is to provide accommodation for the aircrew and the

    a. spare b. ribs c. components **d. passengers**

15. A stressed skin fuselage is usually designed with a cross sectional shape of

    a. square b. triangle **c. oval** d. none of the given

16. The internal structure of fuselage mainly concentrated near the surface of the outer skin is known as

    a. monocoque **b. semi-monocoque** c. partial monocoque d. full monocoque

17. Bulkheads are fitted in certain position within the fuselage structure in the place of

    a. ribs b. spar **c. frames** d. skin

18. Structural bulkheads are often used in construction when we require more

    a. weight **b. strength** c. drag d. shape

19. Which of the following bulkheads are used to carry tail unit loads

    a. structural bulkhead b. pressure bulkhead c. fuel tank bulkhead d. aerodynamic bulkhead

20. The alloy used for the propeller blades of high quality are alluminium

    a. 2225-T6 b. 2345-T6 **c. 2025-T6** d. 2125-T6

21. The engine cowl ring is made from

    a. steel alloy b. iron alloy **c. aluminum alloy** d. copper alloy

22. Chrome molybdenum and mild steel are used for

    a. engine mount b. cowl ring c. compressor d. piston

23. The most complex design of wing structure will be found in

    a. civil aircraft **b. military aircraft** c. Ambulance aircraft d. agriculture aircraft

24. The revited fuel tanks are made from alclad aluminium alloys or

    a. 2025-T4 b. 2024-T5 **c. 2024-T4** d. 2025-T5

25. The leading edge is covered with plywood or sheet metal to maintain

a. perfect weight ratio b. perfect drag **c. perfect contour** d. none of the given

26. Wing flaps especially split type are constructed with aluminium alloy sheet backened by

a. ribs b. spars c. formers **d. stiffeners**

27. Wind shield and cabin encloseres are frequently constructed by one of transparent plastics such as

a. Plexi glass b. 2024-T6 c. 2025-T5 d. chrome molybednum

28. Control stick,torsion tubes,push pull tubes,bell cranks are manufactured from aluminium alloys or

a. Cobalt b. Nickel c. Ferrous **d. Steel**

29. Which of the following is a relatively cheap material.

a. steel alloy b. Aluminum alloys **c. wood** d. Plastics

30. Which of the following is not a wood.

a. ash b. brass c. elm **d. none of the given**

Unit III Online Questions

1. Inspection of raw products is for ____________

   a. casting b. machining c. cracking d. corrosion

2. Inspection of flowing secondary processing is for ____________

   a. Wear b. Erosion **c. Machining** d. Forgings

3. In services Damage Inspection ___________

   a. Heat treating **b. Heat Damage** c. plating d. Extrusions

4. Which is mode of propagation __________

   a. compression wave b. Normal proe c. T\R Probe d. Probe

5. _____________ probe is used to check inclination

   a. Angle b. Shear c. Surface d. Plate

6. Cause for attenuation is _________

   a. Reflection b. Joining c. Groping **d. Scattering**

7. Which is technique ___________ under eddy current testing

   a. Reasonace technique b. pulse generator c. Display system d. Receiver and its amplification

8. ultrasonic flaw detector is __________

   a. Display system b. Reasonance technique c. Pulse echo tech d. Through transmission technique

9. Type of RT in following is __________

   a. X- Ray b. Natural isotropes c. artificial isotropes d. cobalt

10. _____________ is Natural isotropes

    a. Uranium **b. Iridium** c. Cobalt d. Cesium

11. _____________ is artificial isotrope

    a. Cobalt b. Uranium c. Thorium d. Radium

12. Gamma rays are produced by ____________

    a. Radio isotope b. Natural isotopes c. artificial isotopes d. All of the given

13. Thickness of job to be radio raped up-to 75mm is _________

    a. cesium **b. tridium** c. Cesium d. Uranium

14. Thickness of job to be radio graphed between 25 to 225 is

    a. cesium b. Iridium **c. Cobalt** d. Uranium

15. Cesium thickness of Radio graphed is ________

    a. Up to 75mm b. 25-225mm **c. 40-100mm** d. 100-150mm

16. Surface preplaced by _______ cutting for welding shall by uniform and smooth.

    a. Gas b. MIG c.TIG d. Laser

17. Edge prepared and weld fit up shall be verified by __________

    a. BNC **b. WPS** c. T\R Probe d. DB

18. Following which is cable _______

    a. Ba TiO3 b. Pb zro3 c. LiSO4 **d. BNC**

19. Which is advantage of visual testing ________

    a. Less training b. Temporary record c. testing speed is low d. High training

20. Which is hardest component

    a. Gold b. Platinum c. Diamond d. Silver

21. Which engine is more efficiency __________

    a. Petrol engine **b. Diesel engine** c. Gas engine d. Non air to reheating

22. Centrifugal pump is called _______ pump.

    a. Low discharge b. Discharge **c. High discharge** d. No discharge

23. Centrifugal pump is ________ device.

    a. Potential **b. Kinetic** c. Electrical d. Electronic

24. The centrifugal action of the impeller accelerates the liquid to ________

a. High velocity b. Low velocity c. Constant velocity d. No velocity

25. Cavitations mean _______ forming is liquid.

a. Separation **b. Bubbles** c. Turbulent d. Colour change

26. To avoid cavitations to increase the pump size upto ________

a. four-five inch b. two-three inch **c. one-two inch** d. five inch

27. Cavitations will accrue in _________

a. Displacement pump **b. centrifugal pump** c. Reciprocating pump d. screw pump

28. Centrifugal pump is not called as _______ displacement type.

a. Negative b. Non Constant **c. Positive** d. Neutral

29. Entropy decrease with increase in __________

a. Temperature b. Pressure c. Area d. Volume

30. 1 HP = ________

a. 856.2 watt **b. 746.2 watt** c. 672 watt d. 476.2 watt

Unit IV Online Questions

1. Rivets are ____________mechanical fastener

   a. Permanent b. Temporary c. Bad d. Good

2. The original head of the rivet is called the _____________

   a. Factory head b. Shop head c. Buck-tail d. Nose tip

3. The deformed end is called the______________

   a. Factory head **b. Shop head** c. Buck-tail d. Nose tip

4. The shop head is also named as _______________

   a. Factory head b. Shop head **c. Buck-tail** d. Nose tip

5. A bolt is tightened or released by torquing _____________

   a. nut b. top head c. Both a and b d. washer

6. A screw is tightened or released by torquing______________

   a. nut **b. top head** c. Both a and d d. washer

7. A __________is a hardware device that mechanically joins or affixes two or more objects together.

   a. Fastener b. Slower c. Both d and b d. washer

8. The screws are tightened by clockwise rotation is termed________________

   a. Right-hand threadb. Left handed thread c. Both a and d d. Sq.thread

9. A _____________is a metal working tool used to create an accurate sized hole

   a. Drafter **b. Reamer** c. Both a and b d. Fastener

10. The process of creating an accurate sized hole is called_______________

    a. Drafting **b. Reaming** c. Both a and b d. Fastener

11. A drill bit is a ________________tool

    a. Softening b. Joining c. Reaming **d. Cutting**

12. A gear is a _____________ machine

    a. Softening b. Joining **c. Rotating** d. Grinding

13. The ratio of the angular velocity of the input gear to the angular velocity of the output gear is_____________

    a. Velocity ratio b. Angular ratio **c. Gear ratio** d. Pitch dia

14. The gear ratio is also known as ________________

    a. Velocity ratio b. Angular ratio **c. Speed Ratio** d. Pitch dia

15. The torque ratio is also known as_______________

    a. Velocity ratio b. Angular ratio **c. Gear ratio** d. Pitch dia

16. A hand nibbling tools are to remove metal from ________________

    a. Large area **b. smaller area** c. Both a and b d. Mid ratio

17. Small holes may be punched in sheet metal using______________

    a. Drafter b. Reamer **c. Chassis punch** d. Drill press

18. A _______________ Is a bench or floor-mounted machine designed to drill a hole

    a. Drill press b. Drill bit c. Stakes d. Reamer

19. The process of dimpling heavy sheet in highly stressed part of airplane in order to maintain maximum strength of the sheet is called________________

    a. Coin dimpling **b. hot dimpling** c. Cold dimpling d. Both a and b

20. The ______________ is the process wherein the sheet metal is caused to flow to the shape of dies

    a. Coin dimpling b. hot dimpling c. Cold dimpling d. Both a and c

21. Measuring instruments are________________

    a. linear b. stick c. thermometer d. scale

22. Which material is used in strip lock__________________

    a. Aluminum b. Titanium c. Gold d. Berlium

23. ______________ is the process of hard soldring with the composition of copper zinc.

    a. eutectic welding **b. silver soldering** c. sweat soldering d. hard soldering

24. __________________ is used for measuring the diameter of wire and the thickness of sheet metal.

    a. wire gauges b. sheet metal gauges c. hard gauges **d. Both a and b**

25. _________________ is the radial distance between bottom to pitch circle.

    a. dedendum b. addendum c. Both a and b d. pitch circle

26. The distance between the center of two gears knows as________

a. Center distance b. clearances d. pitch circle d. both a and b

27. ______________ is the type which is applied to the outer surface of plywood skin.

a. angler b. radius **c. surface patch** d. thickness

28. A doubeler made up of ___________ in plywood is cut.

a. 1/4. b. 1 / 2. c. 3 / 4. d. 4 / 3.

29. The No. of gears of maleness theeth________________

a. root circle b. circle **c. pitch ratio** d. contact ratio

30. Surface tape is also called as_____________

a. pinked b. finishing tape c. warp d. twist caed

Unit V Online Questions

1. Inspection are visual examinations and manual checks to determine to condition of _____

   a. Aircraft b. structure c. Cockpit d. other

2. Regular inspections increase the aircraft's_______________

   a. malfunctions b. standards c. failures **d. airworthiness**

3. Aircrafts should be regularly_____________

   a. broken **b. checked** c. fixed d. rigged

4. FAR stands for_______________

   a. Federal Aviation Regulations b. Franklin Aviation Rules

   c. Frankfinn Aviation Recruits d. Federal Aviator Rules

5. Aircraft logs is a_________________

   a. handbook b. rulebook c. maintenance book d. data book

6. Power unit mount is required for mounting _______________

   a. turbines b. turbines **c. Engine** d. cracks

7. AW stands for______________

   a. Airworthiness directives b. aircraft wars c. Air wings d. Airport doctor

8. Magnrtic particle testing is used to detect cracks which are ______________

   a. hidden b. visible **c. Invisible** d. surfaced

9. Magnetic particle testing uses the effects of__________________

   a. volatility b. fluid c. gas **d. magnets**

10. Longitudinal magnetization is used for _________________

    a. short parts **b. long parts** c. medium parts d. none

11. visual inspections are checked______________

    a. Visually b. manually c. Automatic d. magnetically

12. Penetrant penetrates the _______________

    a. dagger b. body c. layer **d. surface**

13. Radiography uses_______________

    a. X-rays b. Y-rays c. Z-rays d. UV Rays

14. Latent image is made permanently____________________

a. invisible **b. visible** c. hidden d. hounded

15. Ultrasonic testing uses ________________

a. X-rays b. UV rays **c. pulses** d.Y-rays

16. Radiation from X-rays is destructive to living _________________

a. body b. bone c. skin **d. tissue**

17. Pulse echo methid detects_________________

a. Flaws b. Barges c. Darks d. bitrews

18. Visual inspection is a__________________

a. Nodt **b. NDT** c. Nest d. Butr

19. Penetration penetrates the body_______________

a. with damage **b. without damage** c. cracks d. Determinates

20. Magnetic testing the flaws and cracks are seen as_________________

a. Marks b. Cracklers c. Dracles **d. Particles**

21. Inspection of raw productes is for ___________

a. **corrosion** b. machining c. cracking **d. casting**

22. Inspection of following secondary processing is for ___________

a. Machining b. Erosion c. Wear d. Forgings

23. In services Damage Inspection __________

a. Heat Damage b. Heat treating c. plating d. Extrusions

24. Which is mode of propagation _________

a. compression wave b. Normal proe c. T\R Probe d. Angle Probe

25. ____________ probe is used to chech inclination

a. Angle b. Shear c. Surface d. Plate

26. Cause for attenuation is ________

a. Scattering b. Joining c. Groping d. Reflection

27. Which is technique ___________ under eddy current testing

a. Resonance technique b. pulse generator c. Display system d. Receiver and its amplification

28. ultrasonic flaw detector is __________

a. Display system b. Resonance technique c. Pulse echo tech d. through transmission technique

29. Type of RT in following is __________

a. X- Ray b. Natural isotropes c. Artificial isotropes d. cobalt

30. _____________ is Natural isotropes

a. Uranium b. Iridium c. Cobalt d. Cesium