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Aviation Maintenance Technician Handbook – General

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Aviation Maintenance Technician Handbook–General

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Preface

The *Aviation Maintenance Technician Handbook–General (FAA-H-8083-30B)* was developed as one of a series of three handbooks for persons preparing for mechanic certification with airframe or powerplant ratings, or both. It is intended that this handbook will provide basic information on principles, fundamentals, and technical procedures in the subject matter areas common to both the airframe and powerplant ratings. Emphasis in this volume is on theory and methods of application.

The handbook is designed to aid students enrolled in a formal course of instruction preparing for FAA certification as a maintenance technician as well as for current technicians who wish to improve their knowledge. This volume contains information on mathematics, aircraft drawings, weight and balance, aircraft materials, processes and tools, physics, electricity, inspection, ground operations, and FAA regulations governing the certification and work of maintenance technicians. New to this volume is a section addressing how successful aviation maintenance technicians incorporate knowledge and awareness of ethics, professionalism and human factors in the field.

Because there are so many different types of airframes and powerplants in use today, it is reasonable to expect that differences exist in the components and systems of each. To avoid undue repetition, the practice of using representative systems and units is implemented throughout the handbook. Subject matter treatment is from a generalized point of view, and should be supplemented by reference to manufacturers' manuals or other publications if more detail is desired. This handbook is not intended to replace, substitute for, or supersede official regulations or the manufacturers' instructions.

The companion handbooks to *Aviation Maintenance Technician Handbook–General (FAA-H-8083-30B)* are the *Aviation Maintenance Technician Handbook–Airframe (FAA-H-8083-31 (as amended))*, and the *Aviation Maintenance Technician Handbook–Powerplant (FAA-H-8083-32 (as amended))*.

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Chapter 1
Safety, Ground Operations, & Servicing

Aviation maintenance technicians (AMTs) devote a portion of their aviation career to ground handling and operating aircraft. Technicians also need to be proficient in operating ground support equipment. The complexity of support equipment and the hazards involved in the ground handling of aircraft require that maintenance technicians possess a detailed knowledge of safety procedures used in aircraft servicing, taxiing, run-up, and in the use of ground support equipment. The information provided in this chapter is intended as a general guide for safely servicing and operating aircraft.

Introducing human factors to aircraft maintenance personnel makes them aware of how it affects maintenance performance. Although there are many human factors involved when dealing with maintenance performance, several areas can be considered. Some of these include fatigue, deadline pressure, stress, distractions, poor communication skills, complacency, and lack of information. Maintenance technicians need to understand how human factors can impact their performance and safety while completing maintenance tasks.

Shop Safety

Keeping the shop, hangars, and flight line clean is essential to safety and efficient maintenance. The highest standards of orderly work arrangements and cleanliness must be observed during the maintenance of aircraft. Where continuous work shifts are established, the outgoing shift removes and properly stores personal tools, rollaway boxes, work stands, maintenance stands, hoses, electrical cords, hoists, crates, and boxes that were needed for the work to be accomplished.

Signs are posted to indicate dangerous equipment or hazardous conditions. Additionally, there are signs that provide the location of first aid and fire equipment. Safety lanes, pedestrian walkways, and fire lanes are painted around the perimeter inside the hangars. This is a safety measure to prevent accidents and to keep pedestrian traffic out of work areas.

Safety is everyone's business. However, technicians and supervisors must watch for their own safety and for the safety of others working around them. Communication is key to ensuring everyone's safety. If other personnel are conducting their actions in an unsafe manner, communicate with them, reminding them of their safety and that of others around them.

Electrical Safety

Physiological Safety

Working with electrical equipment poses certain physiological safety hazards. When electricity is applied to the human body, it can create severe burns in the area of entrance and at the point of exit from the body. In addition, the nervous system is affected and can be damaged or destroyed. To safely deal with electricity, the technician must have a working knowledge of the principles of electricity and a healthy respect for its capability to do both work and damage.

Wearing or use of proper safety equipment can provide a psychological assurance and physically protect the user at the same time. The use of rubber gloves, safety glasses, rubber or grounded safety mats, and other safety equipment contributes to the overall safety of the technician working on or with electrical equipment.

Two factors that affect safety when dealing with electricity are fear and overconfidence. These two factors are major causes of accidents involving electricity. While a certain amount of respect for electrical equipment is healthy and a certain level of confidence is necessary, extremes of either can be deadly.

Lack of respect is often due to lack of knowledge. Personnel who attempt to work with electrical equipment and have no knowledge of the principles of electricity lack the skills to deal with electrical equipment safely. Overconfidence leads to risk taking. The technician who does not respect the capabilities of electricity will, sooner or later, become a victim of electricity's power.

Fire Safety

Anytime current flows, whether during generation or transmission, a by-product 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. That in turn 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 that can damage the wire. Never place wires or cords where they may 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 Compressed Gases

Compressed air, like electricity, is an excellent tool when it is under control. A typical nitrogen bottle set is shown in *Figure 1-1*. The following "dos and don'ts" apply when working with or around compressed gases:

- Inspect air hoses frequently for breaks and worn spots. Unsafe hoses must be replaced immediately.
- Keep all connections in a "no-leak condition."
- Maintain in-line oilers, if installed, in operating condition.
- Ensure the system has water sumps installed and drained at regular intervals.
- Filter air used for paint spraying to remove oil and water.
- Never use compressed air to clean hands or clothing. Pressure can force debris into the flesh leading to infection.
- Never spray compressed air in the area of other personnel.
- Straighten, coil, and properly store air hoses when not in use.
- Many accidents involving compressed gases occur during aircraft tire mounting. To prevent possible personal injury, use tire dollies and other appropriate devices to mount or remove heavy aircraft tires.

When inflating tires on any type of aircraft wheels, always use tire cage guards. Extreme caution is required to avoid over inflation of high-pressure tires because of possible personal injury. Use pressure regulators on high-pressure air bottles to eliminate the possibility of over inflation of tires. Tire cages are not required when adjusting pressure in tires installed on an aircraft.

Safety Around Hazardous Materials

Material safety diamonds are important with regard to shop safety. These diamond-shaped labels are a simple and quick way to determine the risk of hazardous material within the associated container and, if used properly with the tags, indicate what personal safety equipment to use.

The most observable portion of the Safety Data Sheets (SDSs) (formerly known as Material Safety Data Sheet (MSDS)) label is the risk diamond. It is a four-color segmented diamond that represents flammability (red), reactivity (yellow), health (blue), and special hazard (white). In the flammability, reactivity, and health blocks, there is a number from 0 to 4. Zero represents little or no hazard to the user, while 4 means that the material is very hazardous. The special hazard segment contains a word or abbreviation to represent the specific hazard. Some examples are RAD for radiation, ALK for alkali materials, Acid for acidic materials, and CARC for carcinogenic materials. The letter W with a line through it stands for high reactivity to water. *[Figure 1-2]*

The SDS is a more detailed version of the chemical safety issues. These forms have the detailed breakdown of the chemicals, including formulas and action to take if personnel come in contact with the chemicals. All sheets have the same information requirements; however, the exact location of the information on the sheet may vary depending on the SDS manufacturer. These forms are necessary for a safe shop that meets all the requirements of the governing safety body, the U.S. Department of Labor Occupational Safety and Health Administration (OSHA).

Safety Around Machine Tools

Hazards in a shop increase when the operation of lathes, drill presses, grinders, and other types of machines are used. Each machine has its own set of safety practices. The following discussions are necessary to avoid injury.

The drill press can be used to bore and ream holes, to do facing, milling, and other similar types of operations. The following precautions can reduce the chance of injury:

- Wear eye protection.
- Securely clamp all work.
- Set the proper revolutions per minute (rpm) for the material used.
- Do not allow the spindle to feed beyond its limit of travel while drilling.
- Stop the machine before adjusting work or attempting to remove jammed work.
- Clean the area when finished.

Lathes are used in turning work of a cylindrical nature. This work may be performed on the inside or outside of the cylinder. The work is secured in the chuck to provide the rotary motion, and the forming is done by contact with a

Figure 1-1. *A typical nitrogen bottle.*

securely mounted tool. The following precautions can reduce the chance of injury:

- Wear eye protection.
- Use sharp cutting tools.
- Allow the chuck to stop on its own. Do not attempt to stop the chuck by hand pressure.
- Examine tools and work for cracks or defects before starting the work.
- Do not set tools on the lathe. Tools may be caught by the work and thrown.
- Before measuring the work, allow it to stop in the lathe.

Milling machines are used to shape or dress; cut gear teeth, slots, or key ways; and similar work. The following precautions can reduce the chance of injury:

- Wear eye protection.
- Clean the work bed prior to work.
- Secure the work to the bed to prevent movement during milling.
- Select the proper tools for the job.
- Do not change the feed speed while working.
- Lower the table before moving under or away from the work.
- Ensure all clamps and bolts are passable under the arbor.

Grinders are used to sharpen tools, dress metal, and perform other operations involving the removal of small amounts of metal. The following precautions can reduce the chance of injury:

- Wear eye protection, even if the grinder has a shield.
- Inspect the grinding wheel for defects prior to use.
- Do not force grinding wheels onto the spindle. They fit snugly but do not require force to install them. Placing side pressure on a wheel could cause it to explode.
- Check the wheel flanges and compression washer. They should be one-third the diameter of the wheel.
- Do not stand in the arc of the grinding wheel while operating in case the wheel explodes.

Welding must be performed only in designated areas. Any part that is to be welded must be removed from the aircraft, if possible. Repair would then be accomplished in a controlled environment, such as a welding shop. A welding shop must be equipped with proper tables, ventilation, tool storage, and fire prevention and extinguishing equipment.

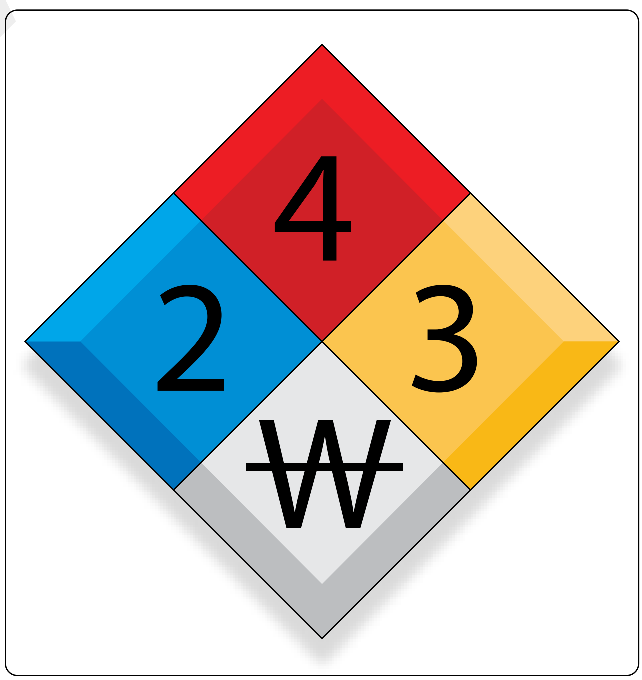

Figure 1-2. *A risk diamond.*

Welding on an aircraft should be performed outside, if possible. If welding in the hangar is necessary, observe these precautions:

- During welding operations, open fuel tanks and work on fuel systems are not permitted.
- Painting is not permitted.
- No aircraft are to be within 35 feet of the welding operation.
- No flammable material is permitted in the area around the welding operation.
- Only qualified welders are permitted to do the work.
- The welding area is to be roped off and placarded.
- Fire extinguishing equipment of a minimum rating of 20B must be in the immediate area with 80B rated equipment as a backup.
- Trained fire watches are to be present in the area around the welding operation.
- The aircraft being welded must be in a towable condition, with a tug attached, and the aircraft parking brakes released. A qualified operator must be on the tug and mechanics available to assist in the towing operation should it become necessary to tow the aircraft. If the aircraft is in the hangar, the hangar doors are to be open.

Flight Line Safety

Hearing Protection

The flight line is a place of dangerous activity. Technicians who perform maintenance on the flight line must constantly be aware of what is going on around them. The noise on a flight line comes from many places. Aircraft are only one source of noise. There are auxiliary power units (APUs), fuel trucks, baggage handling equipment, and so forth. Each has its own frequency of sound. Combined all together, the noise on the ramp or flight line can cause hearing loss.

There are many types of hearing protection available. Hearing protection can be external or internal. Earmuffs or headphones are considered external protection. The internal type of hearing protection fits into the auditory canal. Both types reduce the sound level reaching the eardrum and reduce the chances of hearing loss.

Hearing protection is essential when working with pneumatic drills, rivet guns, or other loud tools. Even short duration exposure to these sounds can cause hearing loss because of their high frequency. Continued exposure will cause hearing loss.

Foreign Object Damage (FOD)

Foreign object damage (FOD) is any damage to aircraft, personnel, or equipment caused by any loose object. These loose objects can be anything, such as broken runway concrete, shop towels, safety wire, etc. To control FOD, keep ramp and operation areas clean, have a tool control program, and provide convenient receptacles for used hardware, shop towels, and other consumables.

Never leave tools or other items around the intake of a turbine engine. The modern gas turbine engine creates a low-pressure area in front of the engine that causes any loose object to be drawn into the engine. The exhaust of these engines can propel loose objects great distances with enough force to damage anything that is hit. The importance of a FOD program cannot be overstressed when a technician considers the cost of engines, components, or a human life.

Safety Around Airplanes

As with the previously mentioned items, it is important to be aware of propellers. Technicians cannot assume the pilot of a taxiing aircraft can see them and must stay within the pilot's view while on the ramp area. Turbine engine intakes and exhaust can also be very hazardous areas. Smoking or open flames are not permitted anywhere near an aircraft in operation. Be aware of aircraft fluids that can be detrimental to skin. When operating support equipment around aircraft, be sure to allow space between it and the aircraft, and secure it so it cannot roll into the aircraft. All items in the area of operating aircraft must be stowed properly.

Safety Around Helicopters

Every type of helicopter has different features. These differences must be learned to avoid damaging the helicopter or injuring the technician. When approaching a helicopter while the blades are turning, adhere to the following guidelines to ensure safety.

- Observe the rotor head and blades to see if they are level. This allows maximum clearance when approaching the helicopter.
- Approach the helicopter in view of the pilot.
- Never approach a helicopter carrying anything with a vertical height that the blades could hit. This could cause blade damage and injury to the individual.
- Never approach a single-rotor helicopter from the rear. The tail rotor is invisible when operating.
- Never go from one side of the helicopter to the other by going around the tail. Always go around the nose of the helicopter.

When securing the rotor on helicopters with elastomeric bearings, check the maintenance manual for the proper method. Using the wrong method could damage the bearing.

Fire Safety

Performing maintenance on aircraft and their components requires the use of electrical tools that can produce sparks, heat-producing tools and equipment, flammable and explosive liquids, and gases. As a result, a high potential exists for fire to occur. Measures must be taken to prevent a fire from occurring and to have a plan for extinguishing it.

The key to fire safety is knowledge of what causes a fire, how to prevent it, and how to put it out. This knowledge must be instilled in each technician, emphasized by their supervisors through sound safety programs, and occasionally practiced. Airport or other local fire departments can normally be called upon to assist in training personnel and helping to establish fire safety programs for the hangar, shops, and flight line.

Fire Protection

Requirements for Fire to Occur

Three things are required for a fire. Remove any one of these things and the fire extinguishes:

1. Fuel—combines with oxygen in the presence of heat, releasing more heat. As a result, it reduces itself to other chemical compounds.
2. Heat—accelerates the combining of oxygen with fuel, in turn releasing more heat.
3. Oxygen—the element that 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. *[Figure 1-3]*

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 involve ordinary combustible materials, such as wood, cloth, paper, upholstery materials, and so forth.
2. Class B fires involve flammable petroleum products or other flammable or combustible liquids, greases, solvents, paints, and so forth.
3. Class C fires involve energized electrical wiring and equipment.

A fourth class of fire, the Class D fire, involves flammable metal. Class D fires are not commercially considered by the NFPA to be a basic type of fire since they are caused by a Class A, B, or C fire. Usually Class D fires involve magnesium in the shop, or in aircraft wheels and brakes, or are the result of improper welding operations.

Any one of these fires can occur during maintenance on or around, or operations involving aircraft. There is a particular type of extinguisher that is most effective for each type of fire.

Types and Operation of Shop and Flight Line Fire Extinguishers

Water extinguishers are the best type to use on Class A fires. Water has two effects on fire. It deprives fire of oxygen and cools the material being burned.

Since most petroleum products float on water, water-type fire extinguishers are not recommended for Class B fires. Extreme caution must be used when fighting electrical fires (Class C) with water-type extinguishers. All electrical power must be removed or shut off to the burning area. Additionally, residual electricity in capacitors, coils, and so forth must be considered to prevent severe injury or possibly death from electrical shock.

Never use water-type fire extinguishers on Class D fires. The cooling effect of water causes an explosive expansion of the metal, because metals burn at extremely high temperatures.

Water fire extinguishers are operated in a variety of ways. Some are hand pumped, while others are pressurized. The pressurized types of extinguishers may have a gas charge stored in the container with the water, or it may contain a "soda-acid" container where acid is spilled into a container of soda inside the extinguisher. The chemical reaction of the soda and the acid causes pressure to build inside the fire extinguisher, forcing the water out.

Carbon dioxide (CO_2) extinguishers are used for Class A, B, and C fires, extinguishing the fire by depriving it of oxygen. *[Figure 1-4]* Additionally, like water-type extinguishers, CO_2 cools the burning material. Never use CO_2 on Class D fires. As with water extinguishers, the cooling effect of CO_2 on the hot metal can cause explosive expansion of the metal.

When using CO_2 fire extinguishers, all parts of the extinguisher can become extremely cold, and remain so for a short time after operation. Wear protective equipment or take other precautions to prevent cold injury, such as frostbite. Extreme caution must be used when operating CO_2 fire extinguishers in closed or confined areas. Not only can the fire be deprived of oxygen, but so too can the operator.

CO_2 fire extinguishers generally use the self-expelling method of operation. This means that the CO_2 has sufficient pressure at normal operating pressure to expel itself. This

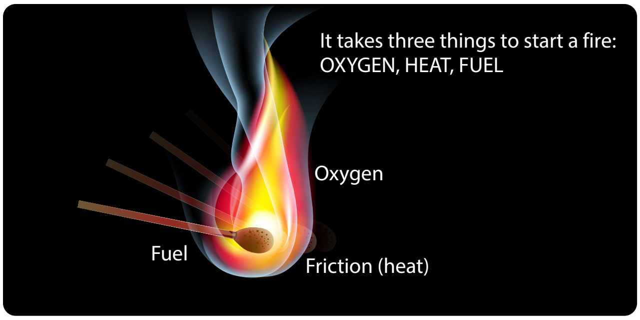

Figure 1-3. *Three elements of fire.*

pressure is held inside the container by some type of seal or frangible disk that is broken or punctured by a firing mechanism, usually a pin. This means that once the seal or disk is broken, pressure in the container is released and the fire extinguisher is spent, requiring replacement. *[Figure 1-5]*

Halogenated hydrocarbon extinguishers are most effective on Class B and C fires. They can be used on Class A and D fires, but they are less effective. Halogenated hydrocarbon, commonly called Freon™ by the industry, are numbered according to chemical formulas with Halon™ numbers.

Carbon tetrachloride (Halon 104), chemical formula CCl_4, has an Underwriters Laboratory (UL) toxicity rating of 3. As such, it is extremely toxic. *[Figure 1-6]* Hydrochloric acid vapor, chlorine, and phosgene gas are produced whenever carbon tetrachloride is used on ordinary fires. The amount of phosgene gas is increased whenever carbon tetrachloride is brought in direct contact with hot metal, certain chemicals, or continuing electrical arcs. It is not approved for any fire extinguishing use. Old containers of Halon 104 found in or around shops or hangars should be disposed of in accordance with Environmental Protection Agency (EPA) regulations and local laws and ordinances.

Methyl bromide (Halon 1001), chemical formula CH_3Br, is a liquefied gas with a UL toxicity rating of 2. It is very toxic and corrosive to aluminum alloys, magnesium, and zinc. Halon 1001 is not recommended for aircraft use. Chlorobromomethane (Halon 1011), chemical formula CH_2ClBr, is a liquefied gas with a UL toxicity rating of 3. Like methyl bromide, Halon 1011 is not recommended for aircraft use. Dibromodifluoromethane (Halon 1202), chemical formula CBr_2F_2, has a UL toxicity rating of 4. Halon 1202 is not recommended for aircraft use.

Bromochlorodifluoromethane (Halon 1211), chemical formula $CBrClF_2$, is a liquefied gas with a UL toxicity rating of 5. It is colorless, noncorrosive, and evaporates rapidly leaving no residue. It does not freeze or cause cold burns and does not harm fabrics, metals, or other materials it contacts. Halon 1211 acts rapidly on fires by producing a heavy blanketing mist that eliminates oxygen from the fire source. More importantly, it interferes chemically with the combustion process of the fire. Furthermore, it has outstanding properties in preventing re-flash after the fire has been extinguished.

Bromotrifluoromethane (Halon 1301), chemical formula CF_3Br, is also a liquefied gas and has a UL toxicity rating of 6. It has all the characteristics of Halon 1211. The significant difference between the two is Halon 1211 forms a spray similar to CO_2, while Halon 1301 has a vapor spray that is more difficult to direct.

Note: The EPA has restricted Halon to its 1986 production level due to its effect on the ozone layer.

Dry powder extinguishers, while effective on Class B and C fires, are best for use on Class D fires. The method of operation of dry powder fire extinguishers varies from gas cartridge charges, stored pressure within the container that forces the powder charge out of the container, to scooping pails or buckets of the powder from large containers or barrels to toss on the fire.

Figure 1-4. *Carbon dioxide fire extinguisher.*

Dry powder is not recommended for aircraft use, except on metal fires, as a fire extinguisher. The leftover chemical residues and dust often make cleanup difficult and can damage electronic or other delicate equipment.

Inspection of Fire Extinguishers

Fire extinguishers need to be checked periodically utilizing a checklist. If a checklist is unavailable, check the following as a minimum:

- Proper location of appropriate extinguisher
- Safety seals unbroken
- All external dirt and rust removed
- Gauge or indicator in operable range
- Proper weight
- No nozzle obstruction
- No obvious damage

Airport or other local fire departments can usually help in preparing or providing extinguisher checklists. In addition, these fire departments can be helpful in answering questions

Extinguishing Materials	Classes of Fire				Self-Generating	Self-Expelling	Cartridge of N_2 Cylinder	Stored Pressure	Pump	Hand
	A	B	C	D						
Water and antifreeze	X						X	X	X	X
Soda-acid (water)	X				X					
Wetting agent	X						X			
Foam	X	X			X					
Loaded stream	X	X+					X	X		
Multipurpose dry chemical	X+	X	X				X	X		
Carbon dioxide		X+	X			X				
Dry chemical		X	X				X	X		
Bromotrifluoromethane — Halon 1301		X	X			X				
Bromochlorodifluoromethane — Halon 1211		X	X					X		
Dry powder (metal fires)				X			X			X

+ Smaller sizes of these extinguishers are not recognized for use on these classes of fire.

Figure 1-5. *Extinguisher operation and methods of expelling.*

Group	Definition	Examples
6 (Least toxic)	Gases or vapors in concentrations up to 20% by volume, for durations of exposure of up to approximately 2 hours, do not appear to produce injury.	Bromotrifluoromethane (Halon 1301)
5a	Gases or vapors much less toxic than Group 4, but more toxic than Group 6.	Carbon dioxide
4	Gases or vapors in concentrations of the order of 2 to 2 ½%, for durations of exposure of up to approximately 2 hours are lethal or produce serious injury.	Dibromodifluormethane (Halon 1202)
3	Gases or vapors in concentrations of the order of 2 to 2 ½%, for durations of exposure of the order of 1 hour are lethal or produce serious injury.	Bromochloromethane (Halon 1011) Carbon tetrachloride (Halon 104)
2	Gases or vapors in concentrations of approximately ½ to 1%, for durations of exposure of up to approximately ½ hour are lethal or produce serious injury.	Methyl bromide (Halon 1001)

Figure 1-6. *Toxicity table.*

and assisting in obtaining repairs to or replacement of fire extinguishers.

Identifying Fire Extinguishers

Fire extinguishers are marked to indicate suitability for a particular class of fire. The markings on *Figure 1-7* must be placed on the fire extinguisher and in a conspicuous place in the vicinity of the fire extinguisher. When the location is marked, however, take extreme care to ensure that the fire extinguisher kept at that location is in fact the type depicted by the marking. In other words, if a location is marked for a Class B fire extinguisher, ensure that the fire extinguisher in that location is in fact suitable for Class B fires.

Markings must be applied by decalcomanias (decals), painting, or similar methods. They are to be legible and as durable as necessary for the location. For example, markings used outside need to be more durable than those in the hangar or office spaces.

When markings are applied to the extinguisher, they are placed on the front of the shell, if one is installed, above or below the extinguisher nameplate. Markings must be large enough and in a form that is easily seen and identifiable by the average person with average eyesight at a distance of at least 3 feet.

When markings are applied to wall panels, and so forth, in the vicinity of extinguishers, they must be large enough and in a form that is easily seen and identifiable by the average person with average eyesight at a distance of at least 25 feet. *[Figure 1-8]*

Using Fire Extinguishers

When using a fire extinguisher, ensure the correct type is used for the fire. Most extinguishers have a pin to pull that allows the handle to activate the agent. Stand back 8 feet and aim at the base of the fire or flames. Squeeze the lever and sweep side to side until the fire is extinguished.

Tie-Down Procedures

Preparation of Aircraft

Aircraft are to be tied down after each flight to prevent damage from sudden storms. The direction that aircraft are to be parked and tied down is determined by prevailing or forecast wind direction.

Aircraft are to be headed into the wind, depending on the locations of the parking area's fixed tie-down points. Spacing of tie-downs need to allow for ample wingtip clearance. *[Figure 1-9]* After the aircraft is properly located, lock the nosewheel or the tail wheel in the fore-and-aft position.

Tie-Down Procedures for Land Planes

Securing Light Aircraft

Light aircraft are most often secured with ropes tied only at the aircraft tie-down rings provided for securing purposes. Rope is never to be tied to a lift strut, since this practice can bend a strut if the rope slips to a point where there is no slack. Since manila rope shrinks when wet, about 1 inch (1") of slack needs to be provided for movement. Too much slack, however, allows the aircraft to jerk against the ropes. Tight tie-down ropes put inverted flight stresses on the aircraft and many are not designed to take such loads.

A tie-down rope holds no better than the knot. Anti-slip knots, such as the bowline, are quickly tied and are easy to untie. *[Figure 1-10]* Aircraft not equipped with tie-down fittings must be secured in accordance with the manufacturer's instructions. Ropes are to be tied to outer ends of struts on high-wing monoplanes and suitable rings provided where structural conditions permit, if the manufacturer has not already provided them.

Securing Heavy Aircraft

The normal tie-down procedure for heavy aircraft can be accomplished with rope or cable tie-down. The number of tie-downs are governed by anticipated weather conditions.

Most heavy aircraft are equipped with surface control locks that are engaged or installed when the aircraft is secured. Since the method of locking controls vary on different types of aircraft, check the manufacturer's instructions for proper installation or engaging procedures. If high winds are anticipated, control surface battens can also be installed to prevent damage. *Figure 1-11* illustrates four common tie-down points on heavy aircraft.

The normal tie-down procedure for heavy aircraft includes the following:

1. Head aircraft into prevailing wind whenever possible.
2. Install control locks, all covers, and guards.
3. Chock all wheels fore and aft. *[Figure 1-12]*
4. Attach tie-down reels to aircraft tie-down loops, tie-down anchors, or tie-down stakes. Use tie-down stakes for temporary tie-down only. If tie-down reels are not available, ¼" wire cable or 1½" manila line may be used.

Tie-Down Procedures for Seaplanes

Seaplanes can be moored to a buoy, weather permitting, or tied to a dock. Weather causes wave action, and waves cause the seaplane to bob and roll. This bobbing and rolling while

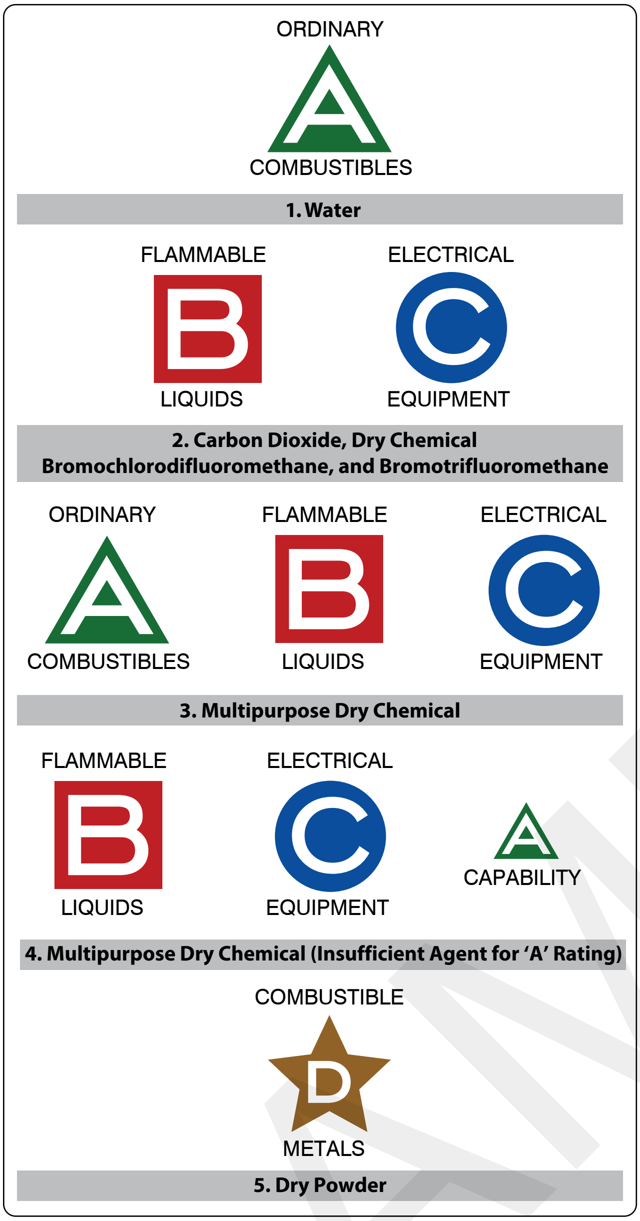

Figure 1-7. *Typical extinguisher markings.*

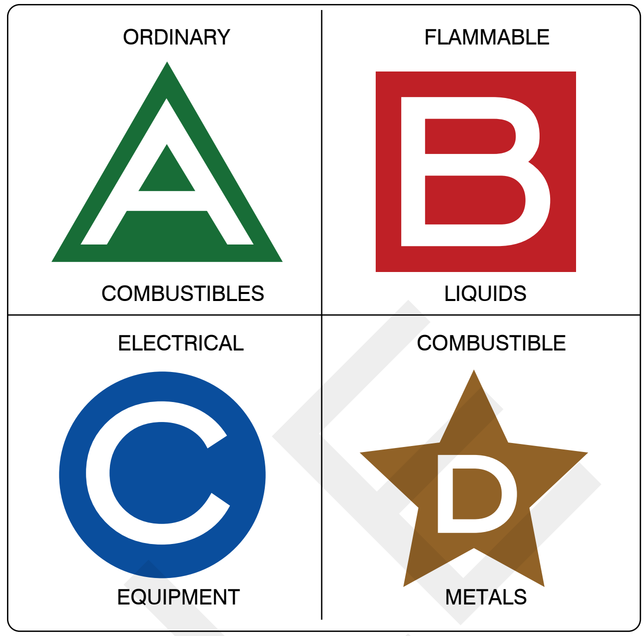

Figure 1-8. *Identification of fire extinguisher type location.*

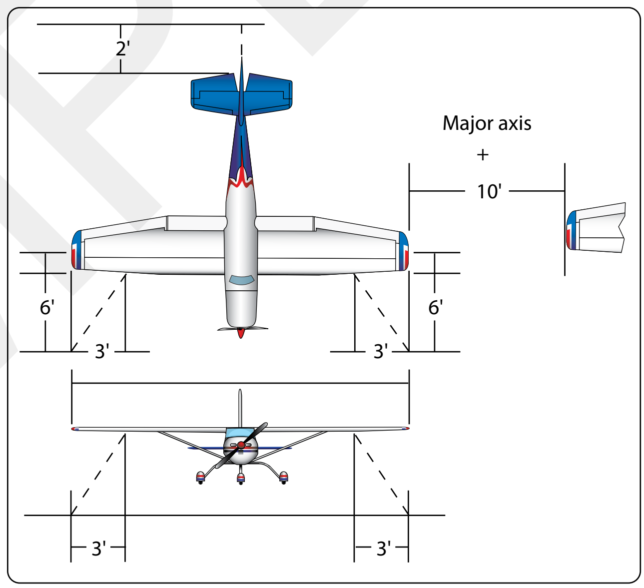

Figure 1-9. *Diagram of tiedown dimensions.*

tied to a dock can cause damage.

When warning of an impending storm is received and it is not possible to fly the aircraft out of the storm area, some compartments of the seaplane can be flooded, partially sinking the aircraft. Tie down the aircraft securely to anchors. Seaplanes tied down on land have been saved from high-wind damage by filling the floats with water in addition to tying the aircraft down in the usual manner. During heavy weather, if possible, remove the seaplane from the water and tie down in the same manner as a land plane. If this is not possible, the seaplane could be anchored in a sheltered area away from the wind and waves.

Tie-Down Procedures for Ski Planes

Ski planes are tied down, if the securing means are available, in the same manner as land planes. Ski-equipped airplanes can be secured on ice or in snow by using a device called a dead-man. A dead-man is any item at hand, such as a piece of pipe, log, and so forth, that a rope is attached to and buried in a snow or ice trench. Using caution to keep the free end of the rope dry and unfrozen, snow is packed in the trench. If available, pour water into the trench; when it is frozen, tie down the aircraft with the free end of the rope.

Operators of ski-equipped aircraft sometimes pack soft snow around the skis, pour water on the snow, and permit the skis to freeze to the ice. This, in addition to the usual tie-down procedures, aids in preventing damage from windstorms. Caution must be used when moving an aircraft that has been secured in this manner to ensure that a ski is not still frozen to the ground. Otherwise, damage to the aircraft or skis can occur.

Tie-Down Procedures for Helicopters

Helicopters, like other aircraft are secured to prevent structural damage that can occur from high-velocity surface winds. Helicopters are to be secured in hangars, when possible. If not, they must be tied down securely. Helicopters that are tied down can usually sustain winds up to approximately 65 mph. If at all possible, helicopters are evacuated to a safe area if tornadoes or hurricanes are anticipated. For added protection, helicopters can be moved to a clear area so that they are not damaged by flying objects or falling limbs from surrounding trees.

If high winds are anticipated with the helicopter parked in the open, tie down the main rotor blades. Detailed instructions for securing and mooring each type of helicopter can be found in the applicable maintenance manual. *[Figure 1-13]* Methods of securing helicopters vary with weather conditions, the

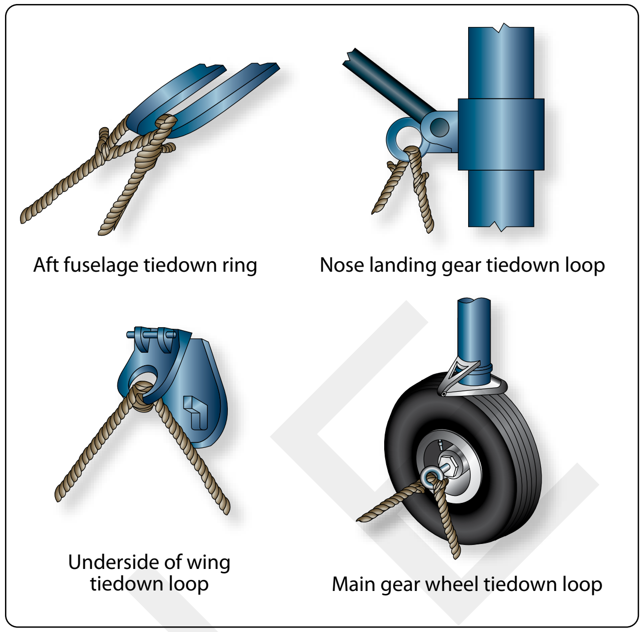

Figure 1-11. *Common tie-down points.*

length of time the aircraft is expected to remain on the ground, and location and characteristics of the aircraft. Wheel chocks, control locks, rope tie-downs, mooring covers, tip socks, tie-

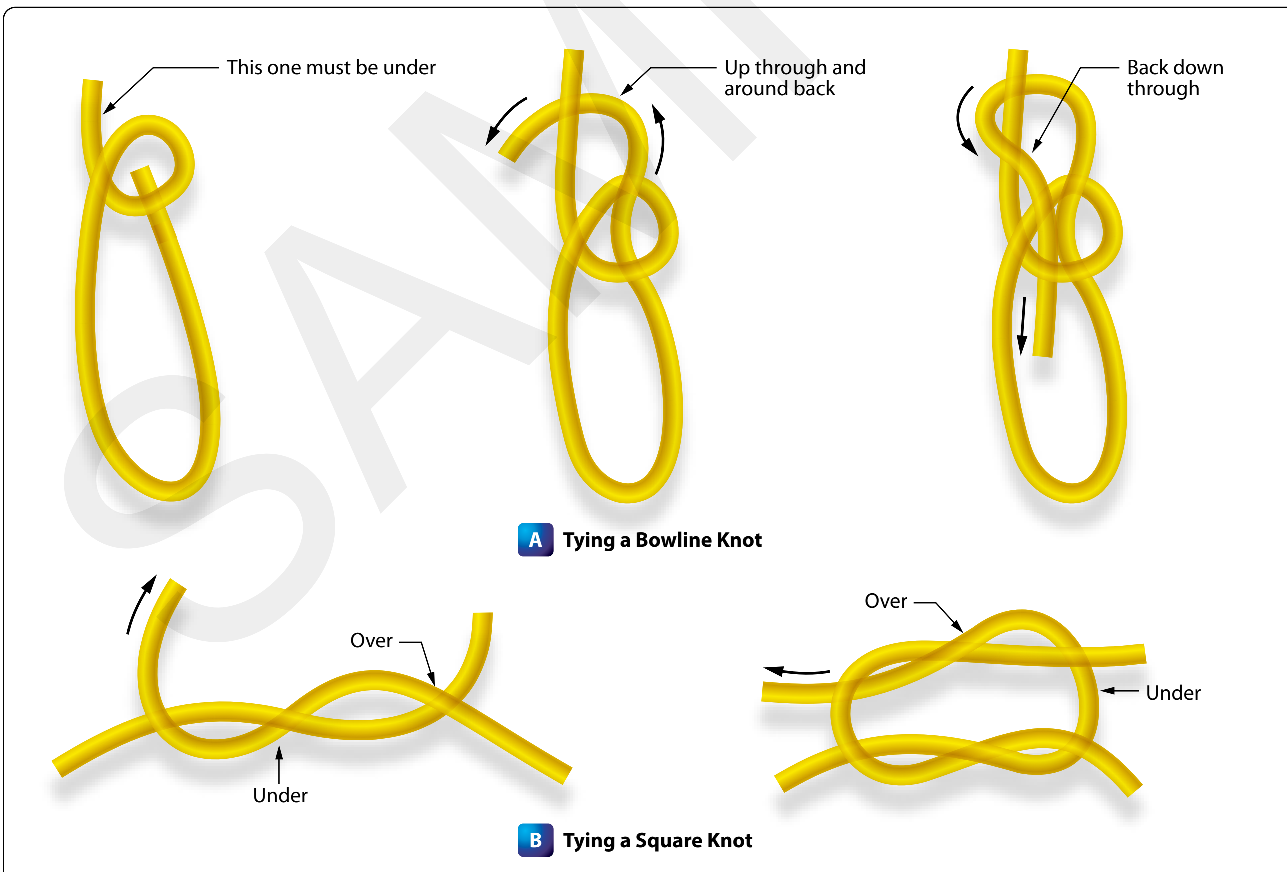

Figure 1-10. *Knots commonly used for aircraft tie-down.*

down assemblies, parking brakes, and rotor brakes are used

Figure 1-12. *Wheels chocked fore and aft.*

to secure helicopters.
Typical mooring procedures are as follows:

1. Face the helicopter in the direction that the highest forecast wind or gusts are anticipated.
2. Spot the helicopter slightly more than one rotor span distance from other aircraft.
3. Place wheel chocks ahead of and behind all wheels (where applicable). On helicopters equipped with skids, retract the ground handling wheels, lower the helicopter to rest on the skids, and install wheel position lock pins or remove the ground-handling wheels. Secure ground-handling wheels inside the aircraft or inside the hangar or storage buildings. Do not leave them unsecured on the flight line.
4. Align the blades and install tie-down assemblies as prescribed by the helicopter manufacturer. *[Figure 1-14]* Tie straps snugly without strain, and during wet weather, provide some slack to avoid the possibility of the straps shrinking, causing undue stress on the aircraft and/or its rotor system(s).
5. Fasten the tie-down ropes or cables to the forward and aft landing gear cross tubes and secure to ground stakes or tie-down rings.

Procedures for Securing Weight-Shift-Control

There are many types of weight-shift-controlled aircraft—engine powered and non-powered. These types of aircraft are very susceptible to wind damage. The wings can be secured in a similar manner as a conventional aircraft in light winds. In high winds, the mast can be disconnected from the wing and the wing placed close to the ground and secured. This type of aircraft can also be partially disassembled or moved into a hangar for protection.

Procedures for Securing Powered Parachutes

When securing powered parachutes, pack the parachute in a bag to prevent the chute from filling with air from the wind and dragging the seat and engine. The engine and seat can also be secured if needed.

Ground Movement of Aircraft

Engine Starting and Operation

The following instructions cover the starting procedures for reciprocating, turboprop, turbofan, and APU. These procedures are presented only as a general guide for familiarization with typical procedures and methods. Detailed instructions for starting a specific type of engine can be found in the manufacturer's instruction book.

Before starting an aircraft engine:

1. Position the aircraft to head into the prevailing wind to ensure adequate airflow over the engine for cooling purposes.
2. Make sure that no property damage or personal injury occurs from the propeller blast or jet exhaust.
3. If external electrical power is used for starting, ensure that it can be removed safely, and it is sufficient for the total starting sequence.
4. During any and all starting procedures, a "fireguard" equipped with a suitable fire extinguisher shall be stationed in an appropriate place. A fireguard is someone familiar with aircraft starting procedures. The fire extinguisher should be a CO_2 extinguisher of at least 5-pound capacity. The appropriate place is adjacent to the outboard side of the engine, in view of the pilot, and also where they can observe the engine/aircraft for indication of starting problems.
5. If the aircraft is turbine-engine powered, the area in front of the jet inlet must be kept clear of personnel, property, and/or debris (FOD).
6. These "before starting" procedures apply to all aircraft powerplants.
7. Follow manufacturer's checklists for start procedures and shutdown procedures.

Reciprocating Engines

The following procedures are typical of those used to start reciprocating engines. There are, however, wide variations in the procedures for the many reciprocating engines. Do not attempt to use the methods presented here for actually starting an engine. Instead, always refer to the procedures contained in the applicable manufacturer's instructions. Reciprocating engines are capable of starting in fairly low temperatures

Figure 1-13. *Example of mooring of a helicopter.*

without the use of engine heating or oil dilution, depending on the grade of oil used.

The various covers (wing, tail, flight deck, wheel, and so forth) protecting the aircraft must be removed before attempting to turn the engine. Use external sources of electrical power when starting engines equipped with electric starters, if possible or needed. This eliminates an excessive burden on the aircraft battery. Leave all unnecessary electrical equipment off until the generators are furnishing electrical power to the aircraft power bus.

Before starting a radial engine that has been shut down for more than 30 minutes, check the ignition switch for off. Turn the propeller three or four complete revolutions by hand to detect a hydraulic lock, if one is present. Any liquid present in a cylinder is indicated by the abnormal effort required to rotate the propeller or by the propeller stopping abruptly during rotation. Never use force to turn the propeller when a hydraulic lock is detected. Sufficient force can be exerted on the crankshaft to bend or break a connecting rod if a lock is present.

To eliminate a lock, remove either the front or rear spark plug from the lower cylinders and pull the propeller through. Never attempt to clear the hydraulic lock by pulling the propeller through in the direction opposite to normal rotation. This tends to inject the liquid from the cylinder into the intake pipe. The liquid is drawn back into the cylinder with the possibility of complete or partial lock occurring on the subsequent start.

To start the engine, proceed as follows:

1. Turn the auxiliary fuel pump on, if the aircraft is so equipped.
2. Place the mixture control to the position recommended for the engine and carburetor combination being started. As a general rule, put the mixture control in the "idle cut-off" position for fuel injection and in the

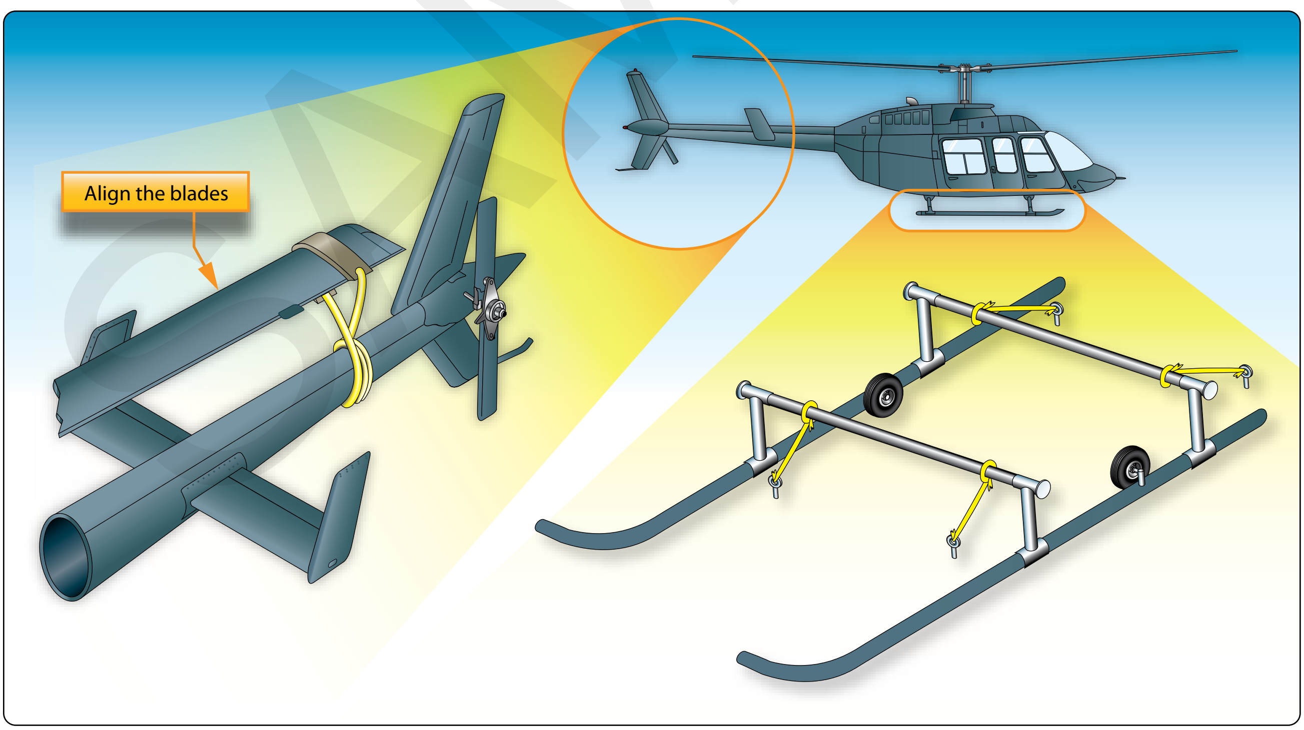

Figure 1-14. *Securing helicopter blades and fuselage.*

"full rich" position for float-type carburetors. Many light aircraft are equipped with a mixture control pull rod that has no detent intermediate positions. When such controls are pushed in flush with the instrument panel, the mixture is set in the "full rich" position. Conversely, when the control rod is pulled all the way out, the carburetor is in the "idle cut-off" or "full lean" position. The operator can select unmarked intermediate positions between these two extremes to achieve any desired mixture setting.

3. Open the throttle to a position that provides 1,000 to 1,200 rpm (approximately ⅛" to ½" from the "closed" position).
4. Leave the pre-heat or alternate air (carburetor air) control in the "cold" position to prevent damage and fire in case of backfire. These auxiliary heating devices are used after the engine warms up. They improve fuel vaporization, prevent fouling of the spark plugs, ice formation, and eliminate icing in the induction system.
5. Move the primer switch to "on" intermittently (press to prime by pushing in on the ignition switch during the starting cycle), or prime with one to three strokes of priming pump, depending on how the aircraft is equipped. The colder the weather, the more priming is needed.
6. Energize the starter and after the propeller has made at least two complete revolutions, turn the ignition switch on. On engines equipped with an induction vibrator (shower of sparks, magneto incorporates a retard breaker assembly), turn the switch to the "both" position and energize the starter by turning the switch to the "start" position. After the engine starts, release the starter switch to the "both" position. When starting an engine that uses an impulse coupling magneto, turn the ignition switch to the "left" position. Place the start switch to the "start" position. When the engine starts, release the start switch. Do not crank the engine continuously with the starter for more than 1 minute. Allow a 3- to 5-minute period for cooling the starter (starter duty cycle) between successive attempts. Otherwise, the starter may be burned out due to overheating.
7. After the engine is operating smoothly, move the mixture control to the "full rich" position if started in the "idle cutoff" position. Carbureted engines are already in the rich mixture position. Check for oil pressure.
8. Instruments for monitoring the engine during operation include a tachometer for rpm, manifold pressure gauge, oil pressure gauge, oil temperature gauge, cylinder head temperature gauge, exhaust gas temperature gauge, and fuel flow gauge.

Hand Cranking Engines

If the aircraft has no self-starter, start the engine by turning the propeller by hand (hand propping the propeller). The person who is turning the propeller calls: "Fuel on, switch off, throttle closed, brakes on." The person operating the engine checks these items and repeats the phrase. The switch and throttle must not be touched again until the person swinging the prop calls "contact." The operator repeats "contact" and then turns on the switch. Never turn on the switch and then call "contact."

A few simple precautions help to avoid accidents when hand propping the engine. While touching a propeller, always assume that the ignition is on. The switches that control the magnetos operate on the principle of short-circuiting the current to turn the ignition off. If the switch is faulty, it can be in the "off" position and still permit current to flow in the magneto primary circuit. This condition could allow the engine to start when the switch is off.

Be sure the ground is firm. Slippery grass, mud, grease, or loose gravel can lead to a fall into or under the propeller. Never allow any portion of your body to get in the way of the propeller. This applies even when the engine is not being cranked.

Stand close enough to the propeller to be able to step away as it is pulled down. Stepping away after cranking is a safeguard in case the brakes fail. Do not stand in a position that requires leaning toward the propeller to reach it. This throws the body off balance and could cause a fall into the blades when the engine starts.

In swinging the prop, always move the blade downward by pushing with the palms of the hands. Do not grip the blade with the fingers curled over the edge, since "kickback" may break them or draw your body in the blade path. Excessive throttle opening after the engine has fired is the principal cause of backfiring during starting. Gradual opening of the throttle, while the engine is cold, reduces the potential for backfiring. Slow, smooth movement of the throttle assures correct engine operation.

Avoid over priming the engine before it is turned over by the starter. This can result in fires, scored or scuffed cylinders and pistons, or engine failures due to hydraulic lock. If the engine is inadvertently flooded or over primed, turn the ignition switch off and move the throttle to the "full open" position. To rid the engine of the excess fuel, turn it over by hand or by the starter. If excessive force is needed to turn over the engine, stop immediately. Do not force rotation of the engine. If in doubt, remove the lower cylinder spark plugs.

Aviation Maintenance Technician Handbook—General

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U.S. Department of Transportation

Federal Aviation Administration

The FAA *Aviation Maintenance Technician Handbook—General* is designed for use by instructors and applicants preparing for the FAA Knowledge Exam and Oral & Practical (O&P) Exams required to obtain an Aviation Mechanic Certificate with Airframe and/or Powerplant Ratings (also called an A&P license). Developed as one in a series of handbooks for this purpose, this is an effective text for both students and instructors and will also serve as an invaluable reference guide for current technicians who wish to improve their knowledge.

This general handbook provides the basic information on principles, fundamentals, and technical procedures in the subject matter areas relating to the aviation mechanic general curriculum. Subjects covered include: safety, ground operations, and servicing; regulations, maintenance forms, records, and publications; mathematics in aviation maintenance; aircraft drawings; physics for aviation; aircraft weight and balance; aircraft materials, hardware, and processes; cleaning and corrosion control; fluid lines and fittings; inspection concepts and techniques; hand tools and measuring devices; fundamentals of electricity and electronics; mechanic privileges and limitations; and human factors.

Reflecting current technologies, equipment, and procedures, this 2023 edition provides guidance to support the FAA *Aviation Mechanic Airman Certification Standards* (ACS) and 14 CFR Part 147 Aviation Maintenance Technician Schools. Illustrated throughout with detailed, full-color drawings and photographs, the handbook also offers a comprehensive glossary and index.

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