

CHAPTER 9. AIRCRAFT SYSTEMS AND COMPONENTS

SECTION 1. INSPECTION AND MAINTENANCE OF LANDING GEAR

9-1. GENERAL.

a. 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.

b. 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.

9-2. 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.

9-3. 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, bellcranks, 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.

To obtain proper lubrication of the main support bushings, it may be necessary to jack the aircraft.

NOTE: Any time the aircraft is on jacks, check the landing gear main support bushings for wear. Consult the aircraft manufacturer's overhaul manual for specific wear tolerances.

During winter operation, excess grease may congeal and cause increased loads on the gear retraction system, electric motors, and hydraulic pumps. This condition can lead to component malfunctions; therefore, it is recommended that cleanliness be stressed during and after lubrication.

9-4. 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 an-

nual 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.

a. 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.

b. 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.

TABLE 9-1. Bungee cord color codes.

YEARS ENDING WITH	COLOR	QUARTER	COLOR
0 or 5	Black	1st	Red
1 or 6	Green	2nd	Blue
2 or 7	Red	3rd	Green
3 or 8	Blue	4th	Yellow
4 or 9	Yellow	1st	Red

c. 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.

d. 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 bro-

ken. The piston section of the strut should be free of nicks, cuts, and rust.

e. Air-oil struts should undergo an inspection similar to that recommended for spring-oleo struts. In addition, the extension of the strut should be checked to see that it conforms to the distance specified by the manufacturer. If an air-oil strut “bottoms”—that is, it is collapsed—the gas charge and hydraulic fluid has been lost from the air chamber. This is probably due to a loose or defective air valve or to defective O-ring seals.

CAUTION: Before an air-oil strut is removed or disassembled, the air valve should be opened to make sure that all air pressure is removed. Severe injury and/or damage can occur as the result of disassembling a strut when even a small amount of air pressure is still in the air chamber.

f. The method for checking the fluid level of an air-oil strut is given in the manufacturer’s maintenance manual. An alternate means of servicing an oil strut is to jack up the aircraft, remove the strut’s valve cap, release the air charge in the strut by depressing the valve core, remove the strut’s valve core, attach a clean two-foot rubber or plastic hose to the threaded portion that houses the valve core, and secure with a hose clamp. Put the other end of the hose into a clean two quart container filled with the correct hydraulic fluid for the strut. Cover the container with a clean rag to prevent spillage. Now, slowly raise the gear/strut assembly either manually or with another jack under the strut. This will drive the remaining air out of the strut into the container of hydraulic fluid. Once the gear is fully retracted, slowly lower the gear. The hydraulic fluid in the can will be sucked into the strut. Repeat this procedure until you cannot hear any more air bubbles in the container when the wheel strut is fully retracted. With the strut

fully retracted, remove the hose, insert the valve core, lower the gear, and service the strut with nitrogen to get the proper strut extension.

g. The entire structure of the landing gear should be closely examined for cracks, nicks, cuts, corrosion damage, or any other condition that can cause stress concentrations and eventual failure. The exposed lower end of the air-oleo piston is especially susceptible to damage and corrosion, which can lead to seal damage, because the strut is compressed and the piston moves past the strut lower seal, causing the seal to leak fluid and air. Small nicks or cuts can be filed and burnished to a smooth contour, eliminating the point of stress concentration. If a crack is found in a landing-gear member, the part must be replaced.

h. All bolts and fittings should be checked for security and condition. Bolts in the torque links and shimmy damper tend to wear and become loose due to the operational loads placed on them. The nose-wheel shimmy damper should be checked for proper operation and any evidence of leaking. All required servicing should be performed in accordance with the aircraft service manual.

9-5. 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.

a. 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.

b. 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.

c. The proper operation of the anti-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.

9-6. EMERGENCY SYSTEMS. Exercise emergency landing gear systems periodically to ensure proper operation and to prevent inactivity, dirt, and corrosion from rendering the system inoperative when needed. Most emer-

gency systems employ either mechanical, pressure-bottle, or free-fall extension capabilities. Check for the proper safeties on triggering mechanisms, and for the presence of required placards, and necessary accessories such as cranks, levers, handles, etc. Emergency blow-down bottles should be checked for corrosion damage, and then weighed to see if the bottle is still retaining the charge.

9-7. LANDING GEAR COMPONENTS.

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

a. 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.

(1) When assembling shock-struts, use the correct type and number of new "O"-rings, Chevron seals, and backup rings. Use only the correct filler valve core assembly, and follow the manufacturer's instructions when servicing with fluid and air. Either too much or too little air or oil will affect aircraft handling characteristics during taxi, takeoff, and landing, and can cause structural overloads.

(2) Shock cords and rubber discs deteriorate with age and exposure. When this type of shock absorber is used, inspect for general condition; i.e., cleanliness, stretching, fraying, and broken strands. These components should be kept free of petroleum products as they accelerate deterioration of the rubber.

b. 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.

(1) Towing of some aircraft with the rudder locks installed, may cause damage to the steering linkage and rudder control system. Exceeding the steering or towing stop limits should be followed by a close inspection of the entire nose steering assembly. A broken steering stop will allow turning beyond the design limit, transmitting excessive loads to structures, and to the rudder control system. It is recommended that the nose steering arc limits be painted on the steering collar or fuselage.

(2) Inspect shimmy dampers for leakage around the piston shaft and at fluid line connections, and for abnormal wear or looseness around the pivot points. Also check for proper rigging, "bottoming" of the piston in the cylinder, and the condition of the external stops on the steering collar.

c. 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.

d. 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. This condition could also result in the loss of the door during flight. In addition, check for proper safetying of the hinge pins and for distorted, sheared, loose, or cracked hinge rivets. Inspect the wheel wells for improper location or rout-

ing of components and related tubing or wiring. This could interfere with the travel of the gear door actuating mechanisms.

e. 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. When bolting wheel halves together, tighten the nuts to the proper torque value. Periodically accomplish an inspection to ensure the nuts are tight and that there is no movement between the two halves of the wheel. Maintain grease retaining felts in the wheel assembly in a soft, absorbent condition. If any have become hardened, wash them with a petroleum-base cleaning agent; if this fails to soften them, they should be replaced.

(1) Corrosion of wheels. Remove all corrosion from the wheel half, and inspect it to ensure that the wheel halves are serviceable. Apply corrosion prevention treatments as applicable. Prime with a zinc chromate primer or equivalent, and apply at least two finish coats.

(2) Dented or distorted wheels. Replace wheels which wobble excessively due to deformation resulting from a severe side-load impact. In questionable cases, consult the local representative of the FAA concerning the airworthiness of the wheels. Minor dents do not affect the serviceability of a wheel.

(3) Wheel bearings. When inspecting wheel bearings for condition, replace damaged

or excessively worn parts. Maintain bearings and races as matched sets. Pack bearings only with the grease type called for in the manufacturer's maintenance manual prior to their installation. Avoid pre-loading the wheel bearing when installing it on the aircraft by tightening the axle nut just enough to prevent wheel drag or side play.

f. 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.

g. 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.

h. Micro-Switches. Inspect micro-switches for security of attachment, cleanliness, general condition, and proper operation. Check the associated wiring for chafing, proper routing, and to determine that protective covers are installed on wiring terminals, if required. Check the condition of the rubber dust boots which protect the micro-switch plungers from dirt and corrosion.

9-8. FLOATS AND SKIS. Aircraft operated from water may be provided with either a single float or a double float, depending upon the design and construction; however, if an aircraft is an amphibian, it has a hull for flotation and then may need only wingtip floats.

Amphibious aircraft have floats or a hull for operating on water and retractable wheels for land operation.

a. Skis are used for operating on snow and ice. The skis may be made of wood, metal, or composite materials. There are three basic styles of skis. A conventional ski, shown in figure 9-1, replaces the wheel on the axle. The shock cord is used to hold the toe of the ski up when landing. The safety cable and check cable prevent the ski from pivoting through too great an angle during flight.

b. The wheel ski is designed to mount on the aircraft along with the tire. The ski has a portion cut out that allows the tire to extend

slightly below the ski, so that the aircraft can be operated from conventional runways with the wheels or from snow or ice surfaces using the ski. This arrangement has a small wheel mounted on the heel of the ski, so that it does not drag on conventional runways.

c. In retractable wheel-ski arrangements, the ski is mounted on a common axle with the wheel. In this arrangement, the ski can be extended below the level of the wheel for landing on snow or ice. The ski can be retracted above the bottom of the wheel for operations from conventional runways. A hydraulic system is commonly used for the retraction-system operation.

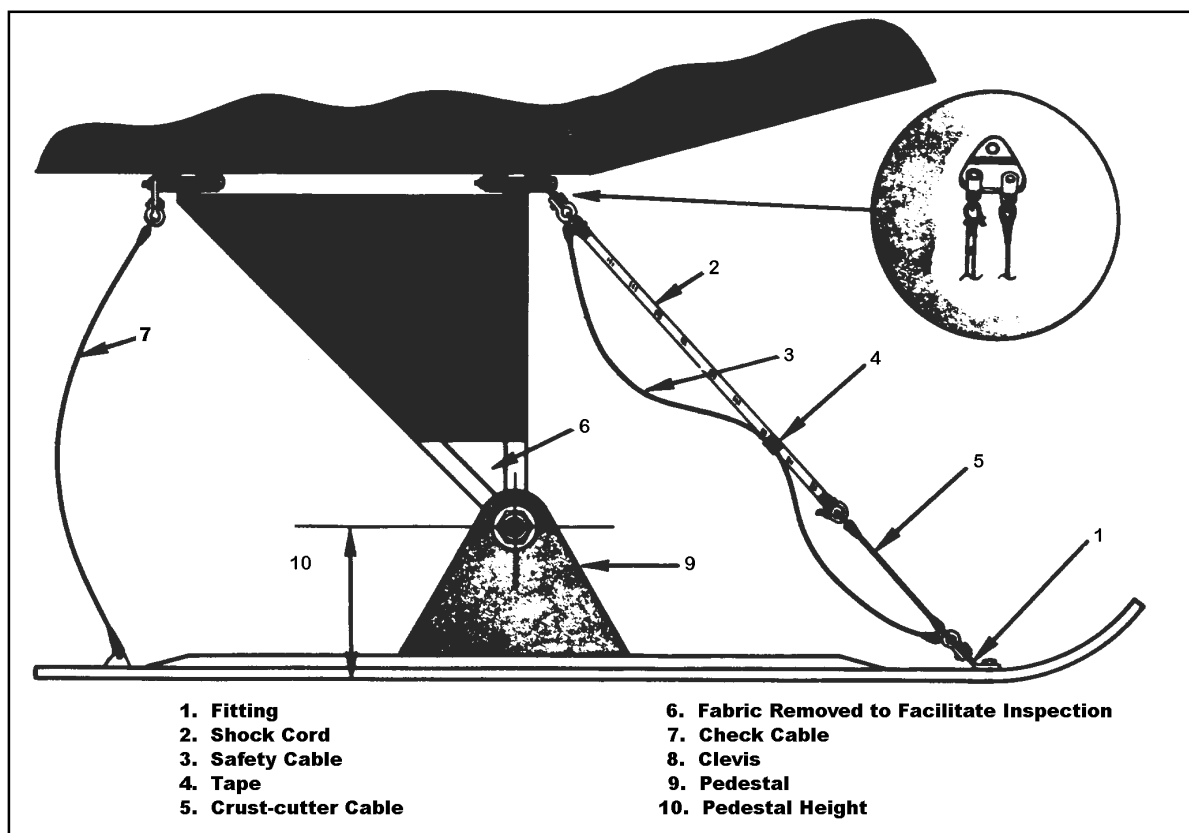


FIGURE 9-1. A typical ski installation.

9-9. INSPECTION AND REPAIR OF FLOATS AND SKIS. Inspection of floats and skis involves examination for damage due to corrosion, collision with other objects, hard landings, and other conditions that may lead to failure. Tubular structures for such gear may be repaired as described in the section covering welded repairs of tubular structures.

a. Floats. To maintain the float in an airworthy condition, periodic and frequent inspections should be made because of the rapidity of corrosion on metal parts, particularly when the aircraft is operated in salt water. Examine metal floats and all metal parts on wooden or fiberglass floats for corrosion, and take corrective action in accordance with the procedures described in Chapter 6, Corrosion, Inspection & Protection. Chapter 4, Metal Structure, Welding, and Brazing, outlines methods for repairing damage to metal floats of aluminum and aluminum alloy structures.

Note: Blind rivets should not be used on floats or amphibian hulls below the water line.

In the case of wooden floats, make repairs in accordance with general procedures outlined in Chapter 1, Wood Structure. Repair fiberglass floats in accordance with the manufacturer's instructions.

(1) If small blisters are noticed on the paint, either inside or outside the float, the paint should be removed and the area examined. If corrosion is found, the area should be cleaned thoroughly, and a coat of corrosion-inhibiting material applied. If the corrosion penetrates the metal to an appreciable depth, replace the metal. Special attention should be given to brace wire fittings and water rudder-control systems.

(2) If the hull or floats have retractable landing gear, a retraction check should be performed along with the other recommendations

mentioned for retractable landing-gear systems. Sheet-metal floats should be repaired using approved practices; however, the seams between sections of sheet metal should be waterproofed with suitable fabric and sealing compound. A float that has undergone hull repairs should be tested by filling it with water and allowing it to stand for at least 24 hours to see if any leaks develop.

b. Skis and Ski Installation. Skis should be inspected for general condition of the skis, cables, bungees, and fuselage attachments. If retractable skis are used, checks in accordance with the general practices for retractable gear should be followed. Ski manufacturers usually furnish acceptable repair procedures. It is advisable to examine ski installations frequently to keep them maintained in airworthy condition. If shock cord is used to keep the ski runner in proper trim, periodically examine to ensure that the cord has enough elasticity to keep the runner in its required attitude and the cord is not becoming loose or badly frayed. Replace old or weak shock cords. When other means of restraint are provided, examine for excessive wear and binding, and replace or repair as required. Examine the points of cable attachment, both on the ski and the aircraft structure, for bent lugs due to excessive loads that have been imposed while taxiing over rugged terrain or by trying to break loose frozen skis. If skis that permit attachment to the wheels and tires are used, maintain proper tire pressure as under-inflated tires may push off the wheels if appreciable side loads are developed in landing or taxiing.

c. Repair of Ski Runners. Repair limits are found in the applicable manufacturer's manual. Fractured wooden ski runners usually require replacement. If a split at the rear end of the runner does not exceed 10 percent of the ski length, it may be repaired by attaching one or more wooden crosspieces across the top of

the runner using glue and bolts. Bent or torn metal runners may be straightened if minor bending has taken place and minor tears may be repaired in accordance with procedures recommended in Chapter 4, Metal Structure, Welding, and Brazing.

d. Ski Pedestals.

(1) Tubular Pedestals. Damaged pedestals made of steel tubing may be repaired by using tube splices as shown in the chapter on welding.

(2) Cast Pedestals. Consult a Federal Aviation Administration (FAA) representative on the repair of cast pedestals.

9-10. TYPES OF LANDING GEAR PROBLEMS.

During inspection and before removing any accumulated dirt, closely observe the area being inspected while the wing-tips 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.

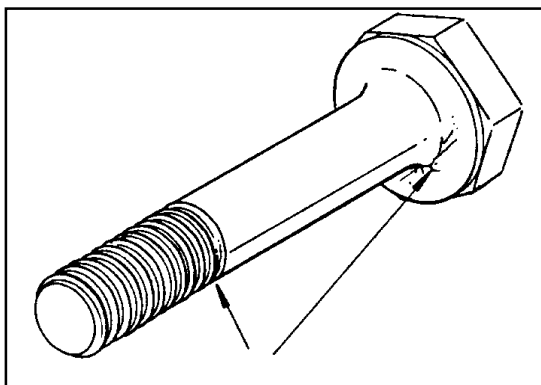


FIGURE 9-2. Typical bolt cracks.

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.

c. **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, as shown in figure 9-2.

e. **Cracks primarily occur** at the edge of bolt holes on the surface and down inside the bore. (See figures 9-3 and 9-4.)

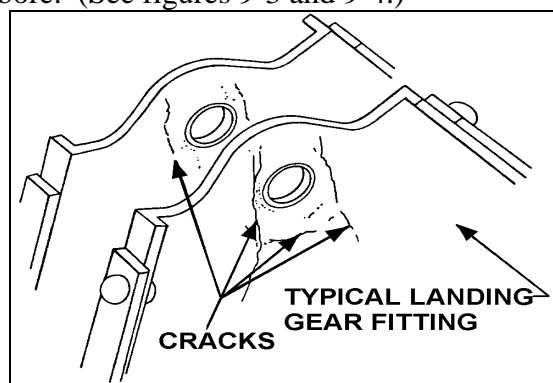


FIGURE 9-3. Typical cracks near bolt holes.

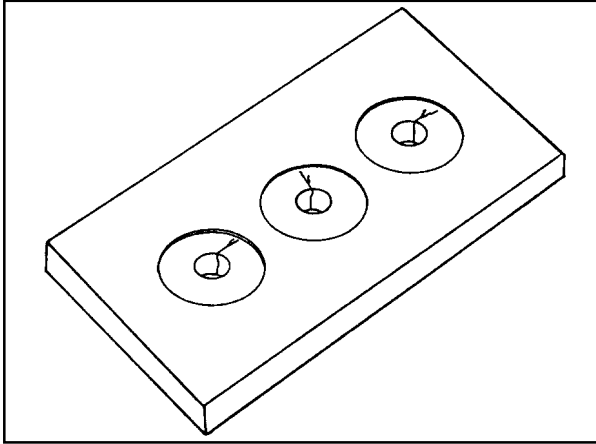


FIGURE 9-4. Typical bolt hole cracks.

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. (See figure 9-5.)

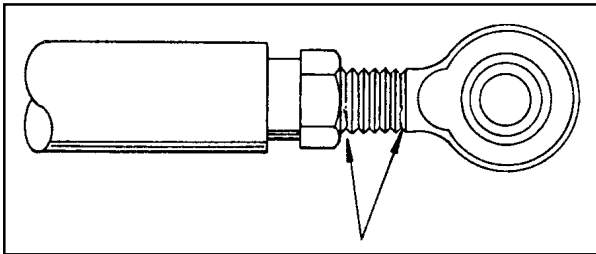


FIGURE 9-5. Typical rod-end cracks.

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. (See figure 9-6.)

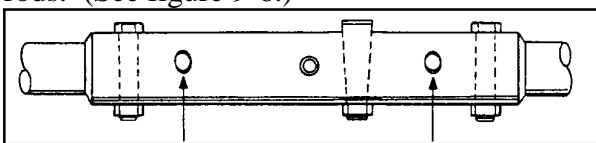


FIGURE 9-6. Typical torque tube bolt hole elongation.

j. 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.

9-11. 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.

9-12. 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.

9-13. TIRE AND TUBE MAINTENANCE. A program of tire maintenance can minimize tire failures and increase tire service life.

a. 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.

9-14. 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 dismantled and turned around, providing there is no exposed fabric. Gear misalignment causing this condition should be corrected.

WARNING: Do not probe cuts or embedded foreign objects while tire is inflated.

c. Tread Cuts. Inspect tread for cuts and other foreign object damage, and mark with crayon or chalk. Remove tires that have the following:

- (1) Any cuts into the carcass ply.

- (2) 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, remove the tire from service.

e. 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.

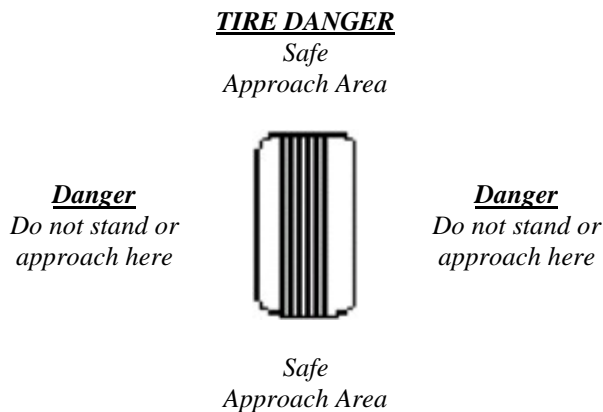
f. Tire Clearance. Look for marks on tires, the gear, and in the wheel wells that might indicate rubbing due to inadequate clearance.

g. Surface Condition. The surface condition of a tire can be inspected with the tire on the aircraft. The tread should be checked for abnormal wear. If the tread is worn in the center of the tire but not on the edges, this indicates that the tire is over-inflated and the operational air pressure should be reduced. On the other hand, a tire worn on the edges, but not in the center, indicates under-inflation. These indications are shown in figure 9-7.

9-15. 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.

9-16. 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. See illustration below:



Personnel should wear protective eye gear to reduce the risk of eye injury due to inflation and deflation of tires.

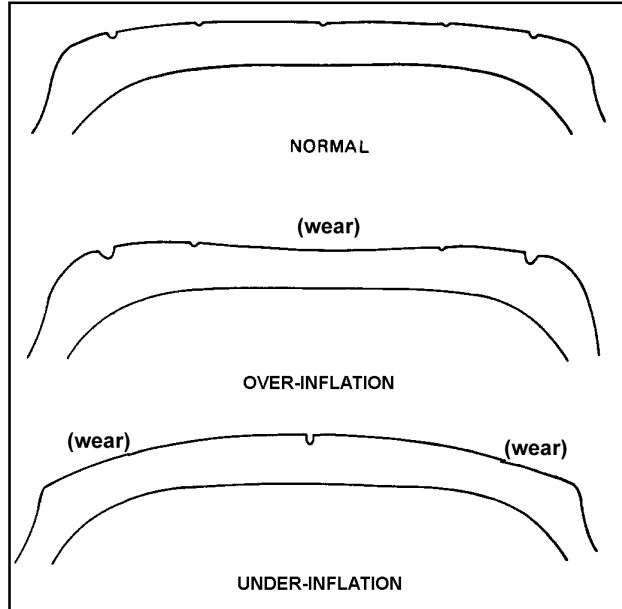


FIGURE 9-7. Examples of tread wear indicating over-inflation and under-inflation.

NOTE: The use of nitrogen to inflate tires is recommended. Do not use oxygen to inflate tires. Deflate tires prior to removing them from the aircraft or when built-up tire assemblies are being shipped.

9-17. 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.

Valve stem, fusible plugs, wheel keys, heat shields, balance weights, and associated hardware should not be removed if demountable flange only is to be removed for tire change.

Fusible plugs and bearing cups should not be removed unless replacement is necessary, if paint is to be stripped, or if a thorough inspection of the wheel is to be made.

When removal and replacement of fusible plugs is required, remove by pressing out with a blunt instrument such as a wooden rod. Exercise caution to ensure wheel sealing surfaces are not damaged.

9-18. 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.

NOTE: It is highly recommended that the tire be placed in a cage so that if the wheel fails, the mechanic is protected from injury.

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.

9-19. 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 a 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.

NOTE: Mechanics should be aware that retread tires can be diametrically bigger than a "new" tire. While this does not pose a problem on fixed landing gear aircraft, it may pose a problem on retractable gear aircraft. Due to a 5 to 8 percent expansion of the tire caused by the ambient temperature, if a retread tire is installed on a retractable gear aircraft, it is strongly recommended that a retraction test be performed. This is to ensure the tire will not become wedged in the wheel well during take-off and landing operation.

9-20. WHEEL INSPECTION. Check wheels for damage. Wheels that are cracked or damaged must be taken out of service for repair or replacement in accordance with the manufacturer's instruction manual.

9-21. 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.

9-22.—9.24. [RESERVED.]

SECTION 2. HYDRAULIC SYSTEMS

9-25. GENERAL. 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. To achieve the necessary redundancy and reliability, the system may consist of several subsystems. 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. Generally, the larger the aircraft, the more mechanical work is required to control the aircraft's various functions. Consequently, the system operating pressure increases accordingly. Primarily, hydraulic power is generated by either engine driven or electric motor driven pumps. The majority of hydraulic pumps are pressure compensated to provide a constant output pressure at a flow-rate demanded by the system. Some constant displacement pumps with a relief valve are used on the smaller aircraft.

9-26. PURPOSES OF HYDRAULIC SYSTEMS. Hydraulic systems make possible the transmission of pressure and energy at the best weight per horsepower ratio.

9-27. TYPES OF HYDRAULIC FLUID. There are three principal categories of hydraulic fluids; mineral base fluids, polyalphaolefin base, and phosphate ester base fluids. When servicing a hydraulic system, the technician must be certain to use the correct category of replacement fluid. Hydraulic fluids are not necessarily compatible. For example, contamination of the fire-resistant fluid

MIL-H-83282 with MIL-H-5606 may render the MIL-H-83282 non fire-resistant.

a. 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. MIL-H-6083 is simply a rust-inhibited version of MIL-H-5606. They are completely interchangeable. Suppliers generally ship hydraulic components with MIL-H-6083.

b. 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. It is generally limited to -40 °F. However, it can be used in the same system and with the same seals, gaskets, and hoses as MIL-H-5606. MIL-H-46170 is the rust-inhibited version of MIL-H-83282. Small aircraft predominantly use MIL-H-5606 but some have switched to MIL-H-83282, if they can accommodate the high viscosity at low temperature.

c. 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. The earliest generation of these fluids was developed after World War II as a result of the growing number of aircraft hydraulic brake fires which drew the collective concern of the commercial aviation industry.

(1) Progressive development of these fluids occurred as a result of performance requirements of newer aircraft designs. The

airframe manufacturers dubbed these new generations of hydraulic fluid as “types” based on their performance. Today, types IV and V fluids are used. Two distinct classes of type IV fluids exist based on their density: class I fluids are low density and class II are standard density. The class I fluids provide weight savings advantages versus class II. Monsanto and Exxon are the suppliers of the type IV phosphate ester-based aviation hydraulic fluids.

(2) In addition to the type IV fluids that are currently in use, type V fluids are being developed in response to industry demands for a more thermally stable fluid at higher operating temperatures. Type V fluids will be more resistant to hydrolytic and oxidative degradation at high temperature than the type IV fluids.

d. 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.

(1) Phosphate ester-based hydraulic fluids have good solvency properties and may act as plasticizer for certain polymers. Care should be taken in handling to keep the fluid from spilling on plastic materials and paint finishes.

(2) If a small amount of the fluid is spilled during handling, it must be cleaned up immediately with a dry cloth. When larger quantities are spilled, an absorbent sweeping compound is recommended. A final cleaning with an approved solvent or detergent should remove any traces of fluid.

9-28. 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.

f. The hydrocarbon-based hydraulic fluids are, in general, safe to handle. To work with these fluids, reasonable handling procedures must always be followed. Take precaution to avoid fluid getting in the eyes. If fluid contacts the eye, wash immediately with water.

g. When handling Skydrol/Hyjet hydraulic fluids, gloves that are impervious to the fluid must be worn. If skin contact occurs, wash with soap and water.

h. When handling phosphate ester-based fluid use eye protection. If the eye is exposed to fluid, severe eye pain will occur.

i. When Skydrol/Hyjet mist or vapor exposure is possible, a respirator capable of removing organic vapors and mists must be worn.

j. Ingestion of any hydraulic fluid should be avoided. Although small amounts do not appear to be highly hazardous, any significant amount should be tested in accordance with manufacturer's direction, followed with hospital supervised stomach treatment.

9-29. 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.

a. 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. Hydraulic fluid type can be identified by color and smell; however, it is good practice to take fluid from the original marked container and then to check the fluid by color and smell for verification. Fluid containers should always be closed, except when fluid is being removed.

b. Contamination Control. Contamination, both particulate and chemical, is detrimental to the performance and life of components in the aircraft hydraulic system. Con-

tamination 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. The replacement interval of these filters is established by the manufacturer and is included in the maintenance manual. However, in the absence of specific replacement instructions, a recommended service life of the filter elements is:

Pressure filters—3000 hrs.

Return Filters—1500 hrs.

Case drain filters—600 hrs.

(1) When replacing filter elements, be sure that there is no pressure on the filter bowl. Protective clothing and a face shield must be used to prevent fluid from contacting the eye. Replace the element with one that has the proper rating. After the filter element has been replaced, the system must be pressure tested to ensure that the sealing element in the filter assembly is intact.

(2) In the event of a major component failure, such as a pump, consideration must be given to replacing the system filter elements, as well as the failed component. System filters may also be equipped with differential pressure (ΔP) indicators. These indicators are designed to "pop-up" when the pressure drop across the element reaches a predetermined value caused by contamination held by the element. The indicators are designed to prevent false indications due to cold start, pump ripple, and shock loads. Consequently, a filter whose indicator has been activated must be replaced. In fact, some indicator designs are

such that the indicator cannot be reset, unless the filter bowl is removed and the element replaced.

c. 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. (Note: A visual inspection of hydraulic filters is not always effective.)

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

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

d. Inspections. Hydraulic and pneumatic systems are inspected for leakage, worn or damaged tubing, worn or damaged hoses, wear of moving parts, security of mounting for all units, safetying, 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. (See figure 9.9.)

(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.

(4) Accumulators must be checked for leakage, air or gas preload, and position. If the accumulator is equipped with a pressure gauge, the preload can be read directly.

(5) An operational check of the system can be performed using the engine-driven pump, an electrically-operated auxiliary pump (if such a pump is included in the system), or a ground test unit. The entire system and each subsystem should be checked for smooth operation, unusual noises, and speed of operation for each unit. The pressure section of the system should be checked with no subsystems to see that pressure holds for the required time without the pump supplying the system. System pressure should be observed during operation of each subsystem to ensure that the engine-driven pump maintains the required pressure.

e. 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, packings, and other parts, and to apply proper torque in connecting fittings. When installing fittings, valves, etc. always lubricate the threads with hydraulic fluid.

(7) Overhaul of hydraulic and pneumatic units is usually accomplished in approved repair facilities; however, replacement of seals and packings may be done from time to time by technicians in the field. When a unit is disassembled, all O-ring and Chevron seals should be removed and replaced with new seals. The new seals must be of the same material as the original and must carry the correct manufacturer’s part number. No seal should be installed unless it is positively identified as the correct part and the shelf life has not expired.

(8) When installing seals, care should be exercised to ensure that the seal is not scratched, cut, or otherwise damaged. When it is necessary to install a seal over sharp edges, the edges must be covered with shim stock, plastic sheet, or electrical tape.

(9) The replacement of hydraulic units and tubing usually involves the spillage of some hydraulic fluid. Care should be taken to ensure that the spillage of fluid is kept to a minimum by closing valves, if available, and by plugging lines immediately after they are disconnected. All openings in hydraulic systems should be capped or plugged to prevent contamination of the system.

(10) The importance of the proper torque applied to all nuts and fittings in a system cannot be over-emphasized. Too much torque will damage metal and seals, and too little torque will result in leaks and loose parts. The proper torque wrenches with the appropriate range should be used in assembling system units.

f. 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.

9-30. HYDRAULIC LINES AND FITTINGS. Carefully inspect all lines and fittings at regular intervals to ensure airworthiness. Investigate any evidence of fluid loss or leaks. Check metal lines for leaks, loose anchorage, scratches, kinks, or other damage. Inspect fittings and connections for leakage, looseness, cracks, burrs, or other damage. Replace or repair defective elements. Make sure the lines and hoses do not chafe against one another and are correctly secured and clamped.

a. Replacement of Metal Lines. When inspection shows a line to be damaged or defective, replace the entire line or, if the damaged section is localized, a repair section may be inserted. In replacing lines, always use tubing of the same size and material as the original line. Use the old tubing as a template in bending the new line, unless it is too greatly damaged, in which case a template can be made from soft iron wire. Soft aluminum tubing (1100, 3003, or 5052) under 1/4-inch outside diameter may be bent by hand.. For all other tubing use an acceptable hand or power tube-bending tool. Bend tubing carefully to avoid excessive flattening, kinking, or wrinkling. Minimum bend radii values are shown in table 9-2. A small amount of flattening in bends is acceptable, but do not exceed 75 percent of the original outside diameter. Excessive flattening will cause fatigue failure of the tube. When installing the replacement tubing, line it up correctly with the mating part so that it is not forced into alignment by tightening of the coupling nuts.

b. Tube Connections. Many tube connections are made using flared tube ends with

standard connection fittings: AN-818 (MS 20818) nut and AN-819 (MS 20819) sleeve. In forming flares, cut the tube ends square, file smooth, remove all burrs and sharp edges, and thoroughly clean. The tubing is then flared using the correct 37-degree aviation flare forming tool for the size of tubing and type of fitting. A double flare is used on soft aluminum tubing 3/8-inch outside diameter and under, and a single flare on all other tubing. In making the connections, use hydraulic fluid as a lubricant and then tighten. Over-tightening will damage the tube or fitting, which may cause a failure. Under-tightening may cause leakage which could result in a system failure.

CAUTION: Mistaken use of 45-degree automotive flare forming tools may result in improper tubing flare shape and angle; causing misfit, stress and strain, and probable system failure.

c. Repair of Metal Tube Lines. Minor dents and scratches in tubing may be repaired. Scratches or nicks not deeper than 10 percent of the wall thickness in aluminum alloy tubing, that are not in the heel of a bend, may be repaired by burnishing with hand tools. Replace lines with severe die marks, seams, or splits in the tube. Any crack or deformity in a flare is unacceptable and cause for rejection. A dent less than 20 percent of the tube diameter is not objectionable unless it is in the heel of a bend. A severely-damaged line should be replaced; however, it may be repaired by cutting out the damaged section and inserting a tube section of the same size and material. Flare both ends of the undamaged and replacement tube sections and make the connection by using standard unions, sleeves, and tube nuts. If the damaged portion is short enough, omit the insert tube and repair by using one union and two sets of connection fittings.

TABLE 9-2. Tube data.

Dash Nos. Ref.	Tubing OD inches	Wrench torque for tightening AN-818 Nut (pound inch)						Minimum bend radii measured to tubing centerline. Dimension in inches.	
		Aluminum-alloy tubing		Steel tubing		Aluminum-alloy tubing (Flare MS33583) for use on oxygen lines only			
		Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Alum. Alloy	Steel
-2	1/8	20	30	75	85	--	--	3/8	--
-3	3/16	25	35	95	105	--	--	7/16	21/32
-4	1/4	50	65	135	150	--	--	9/16	7/8
-5	5/16	70	90	170	200	100	125	3/4	1-1/8
-6	3/8	110	130	270	300	200	250	15/16	1-5/16
-8	1/2	230	260	450	500	300	400	1-1/4	1-3/4
-10	5/8	330	360	650	700	--	--	1-1/2	2-3/16
-12	3/4	460	500	900	1000	--	--	1-3/4	2-5/8
-16	1	500	700	1200	1400	--	--	3	3-1/2
-20	1-1/4	800	900	1520	1680	--	--	3-3/4	4-3/8
-24	1-1/2	800	900	1900	2100	--	--	5	5-1/4
-28	1-3/4	--	--	--	--	--	--	--	--
-32	2	1800	2000	2660	2940	--	--	8	7

d. Replacement of Flexible Lines. When replacement of a flexible line is necessary, use the same type, size, part number, and length of hose as the line to be replaced. Check TSO requirements. If the replacement of a hose with a swaged-end type fitting is necessary, obtain a new hose assembly of the correct size and composition. Certain synthetic oils require a specially compounded synthetic rubber hose, which is compatible. Refer to the aircraft manufacturer's service information for the correct part number for the replacement hose. If the fittings on each end are of the correct type or sleeve type, a replacement may be fabricated as shown in figure 9-8. Before cutting new flexible wire braided hose to the proper size, tape the hose tightly with masking tape and cut in the center of the masking tape to prevent fraying. The use of a mandrel will prevent cutting the inside of the hose when inserting the fittings. Typical aircraft hose specifications and their uses are shown in table 9-3. Install hose assemblies without twisting. (See figure 9-9.) A hose should not be stretched tight between two fittings as this will result in overstressing and eventual failure. The length of hose should be sufficient to provide about 5 to 8 percent slack. Avoid tight bends in flex lines as they may result in

failure. Never exceed the minimum bend radii as indicated in figure 9-10.

(1) Teflon hose is used in many aircraft systems because it has superior qualities for certain applications. Teflon is compounded from tetrafluoroethylene resin which is unaffected by fluids normally used in aircraft. It has an operating range of -65°F to 450 °F. For these reasons, Teflon is used in hydraulic and engine lubricating systems where temperatures and pressures preclude the use of rubber hose. Although Teflon hose has excellent performance qualities, it also has peculiar characteristics that require extra care in handling. It tends to assume a permanent set when exposed to high pressure or temperature. Do not attempt to straighten a hose that has been in service. Any excessive bending or twisting may cause kinking or weakening of the tubing wall. Replace any hose that shows signs of leakage, abrasion, or kinking. Any hose suspected of kinking may be checked with a steel ball of proper size. Table 9-4 shows hose and ball sizes. The ball will not pass through if the hose is distorted beyond limits.

(2) If the hose fittings are of the reusable type, a replacement hose may be

fabricated as described in figure 9-8. Refer to figure 9-10 for minimum bend radii. When a hose assembly is removed, the ends should be tied as shown in figure 9-11, so that the pre-formed shape will be maintained. Refer to figure 9-12 for minimum bend radii for teflon hose.

(3) All flexible hose installations should be supported at least every 24 inches. Closer supports are preferred. They should be carefully routed and securely clamped to avoid abrasion, kinking, or excessive flexing. Excessive flexing may cause weakening of the hose or loosening at the fittings.

e. O-Ring Seals. An understanding of O-ring seal applications is necessary to determine when replacement should be made. The simplest application is where the O-ring merely serves as a gasket when it is compressed within a recessed area by applying pressure with a packing nut or screw cap. Leakage is not normally acceptable in this type of installation. In other installations, the O-ring seals depend primarily upon their resiliency to accomplish their sealing action. When moving parts are involved, minor seepage may be normal and acceptable. A moist surface found on moving parts of hydraulic units is an indication the seal is being properly lubricated. In pneumatic systems, seal lubrication is provided by the installation of a grease-impregnated felt wiper ring. When systems are static, seepage past the seals is not normally acceptable.

f. Storage of replacement seals.

(1) Store O-ring seals where temperature does not exceed 120° F.

(2) Keep seals packaged to avoid exposure to ambient air and light, particularly sunlight.

g. 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?

h. Do's and Don'ts that apply to O-ring seals.

(a) Correct all leaks from static seal installations.

(b) Don't retighten packing gland nuts; retightening will, in most cases, increase rather than decrease the leak.

(c) Never reuse O-ring seals because they tend to swell from exposure to fluids, and become set from being under pressure. They may have minor cuts or abrasions that are not readily discernible by visual inspection.

(d) Avoid using tools that might damage the seal or the sealing surface.

(e) Do not depend upon color-coding. Coding may vary with manufacturer

(f) Be sure that part number is correct

(g) Retain replacement seals in their package until ready for use. This provides proper identification and protects the seal from damage and contamination.

(h) Assure that the sealing surfaces are clean and free of nicks or scratches before installing seal.

(i) Protect the seal from any sharp surfaces that it may pass over during installation. Use an installation bullet or cover the sharp surfaces with tape.

(j) Lubricate the seal so it will slide into place smoothly.

(k) Be sure the seal has not twisted during installation.

i. Hydraulic System Pressure Test.

When a flexible hose has been repaired or overhauled using existing hardware and new hose material, before the hose is installed on

the aircraft it is recommended that the hose is tested to at least 1.5 system pressure. A new hose can be operationally checked after it is installed in the aircraft using system pressure.

j. Hydraulic Components. Hydraulic components such as pumps, actuating cylinders, selector valves, relief valves, etc., should be repaired or adjusted following the airplane and component manufacturer's instructions. Inspect hydraulic filter elements at frequent intervals and replace as necessary.

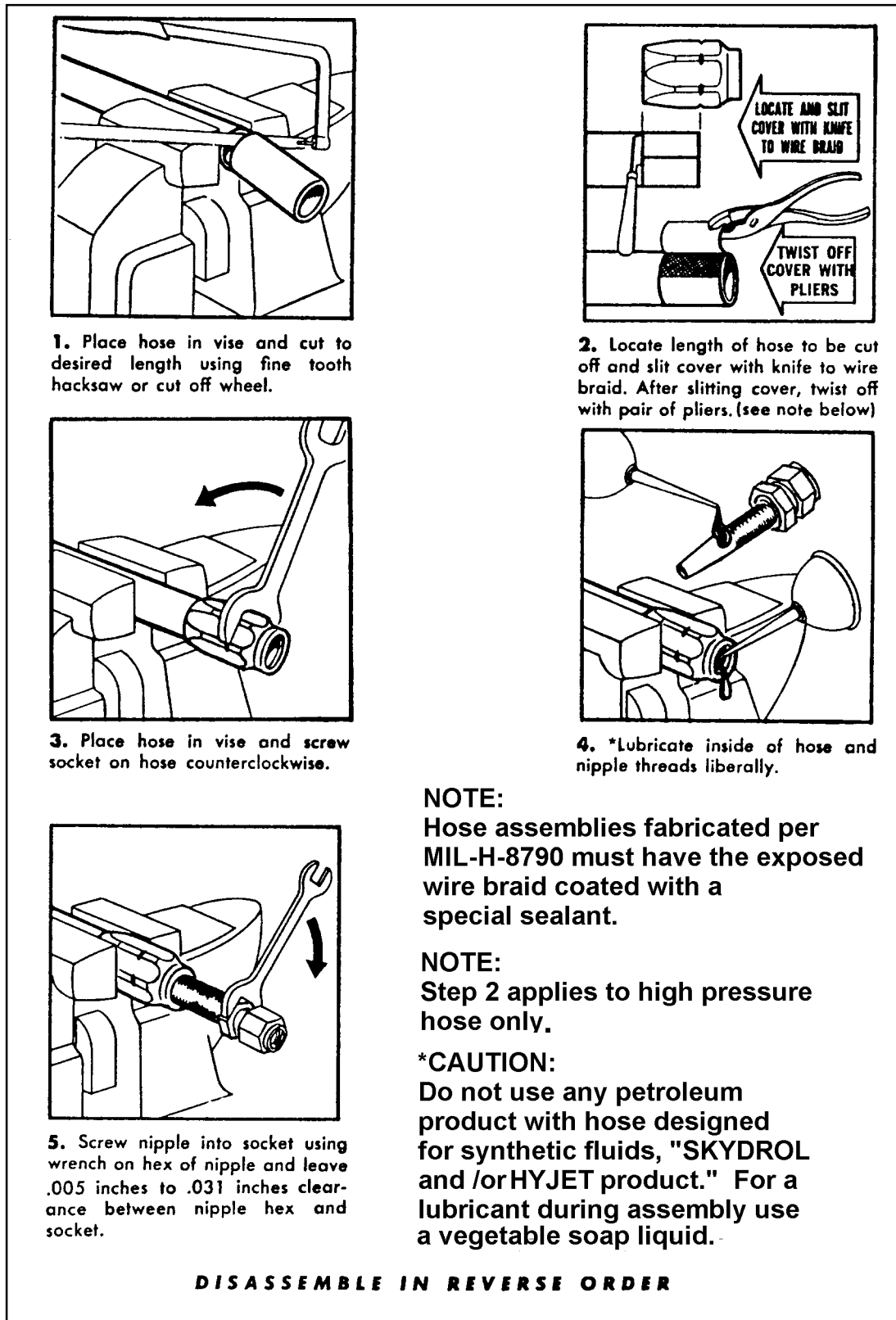


FIGURE 9-8. Hose assembly instructions (can be used for low pressure hydraulic fluid, and oil line applications).

TABLE 9-3. Aircraft hose specifications.

SINGLE WIRE BRAID FABRIC COVERED

MIL. PART NO.	TUBE SIZE O.D.	HOSE SIZE I.D.	HOSE SIZE O.D.	RECOMM. OPER. PRESS.	MIN. BURST PRESS.	MAX. PROOF PRESS.	MIN BEND RADIUS
MIL-H-8794- 3-L	3/16	1/8	.45	3,000	12,000	6,000	3.00
MIL-H-8794- 4-L	1/4	3/16	.52	3,000	12,000	6,000	3.00
MIL-H-8794- 5-L	5/16	1/4	.58	3,000	10,000	5,000	3.38
MIL-H-8794- 6-L	3/8	5/16	.67	2,000	9,000	4,500	4.00
MIL-H-8794- 8-L	1/2	13/32	.77	2,000	8,000	4,000	4.63
MIL-H-8794-10-L	5/8	1/2	.92	1,750	7,000	3,500	5.50
MIL-H-8794-12-L	3/4	5/8	1.08	1,750	6,000	3,000	6.50
MIL-H-8794-16-L	1	7/8	1.23	800	3,200	1,600	7.38
MIL-H-8794-20-L	1 1/4	1 1/8	1.50	600	2,500	1,250	9.00
MIL-H-8794-24-L	1 1/2	1 3/8	1.75	500	2,000	1,000	11.00
MIL-H-8794-32-L	2	1 13/16	2.22	350	1,400	700	13.25
MIL-H-8794-40-L	2 1/2	2 3/8	2.88	200	1,000	300	24.00
MIL-H-8794-48-L	3	3	3.56	200	800	300	33.00

Construction: Seamless synthetic rubber inner tube reinforced with one fiber braid, one braid of high tensile steel wire and covered with an oil resistant rubber impregnated fiber braid.

Identification: Hose is identified by specification number, size number, quarter year and year, hose manufacturer's identification.

Uses: Hose is approved for use in aircraft hydraulic, pneumatic, coolant, fuel and oil systems.

Operating Temperatures:
 Sizes-3 through 12: Minus 65 °F. to plus 250 °F.

Sizes - 16 through 48: Minus 40 °F. to plus 275 °F.

Note: Maximum temperatures and pressures should not be used simultaneously.

MULTIPLE WIRE BRAID RUBBER COVERED

MIL PAR NO.	TUBE SIZE O.D.	HOSE SIZE I.D.	HOSE SIZE O.D.	RECOMM. OPER. PRESS.	MIN. BURST PRESS.	MIN. PROOF PRESS.	MIN. BEND RADIUS
MIL-H-8788- 4-L	1/4	7/32	0.63	3,000	16,000	8,000	3.00
MIL-H-8788- 5-L	5/16	9/32	0.70	3,000	14,000	7,000	3.38
MIL-H-8788- 6-L	3/8	11/32	0.77	3,000	14,000	7,000	5.00
MIL-H-8788- 8-L	1/2	7/16	0.86	3,000	14,000	7,000	5.75
MIL-H-8788-10-L	5/8	9/16	1.03	3,000	12,000	6,000	6.50
MIL-H-8788-12-L	3/4	11/16	1.22	3,000	12,000	6,000	7.75
MIL-H-8788-16-L	1	7/8	1.50	3,000	10,000	5,000	9.63

Hose Construction: Seamless synthetic rubber inner tube reinforced with one fabric braid, two or more steel wire braids, and covered with a synthetic rubber cover (for gas applications request perforated cover).

Identification: Hose is identified by specification number, size number, quarter year and year, hose manufacturer's identification.

Uses: High pressure hydraulic, pneumatic, coolant, fuel and oil.

Operating Temperatures:
 Minus 65 °F. to plus 200 °F.

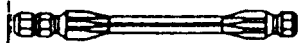
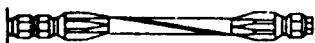
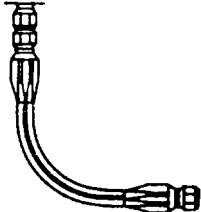
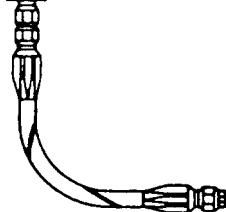
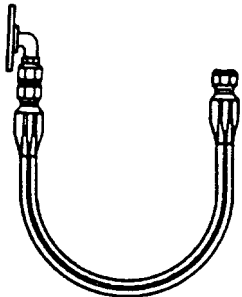
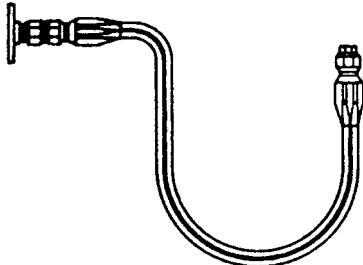
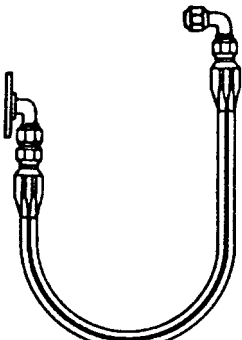
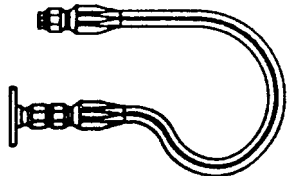
RIGHT WAY	WRONG WAY	
		<p>Do not bend or twist the hose as illustrated.</p>
		<p>Allow enough slack in the hose line to provide for changes in length when pressure is applied. The hose will change in length from + 2% to - 4%.</p>
		<p>Metal end fittings cannot be considered as part of the flexible portion of the assembly.</p>
		<p>The use of elbows and adapters will ensure easier installation and in many installations will remove the strain from the hose line and greatly increase service life.</p> <p>At all times keep the minimum bend radii of the hose as large as possible to avoid tube collapsing.</p>

FIGURE 9-9. Proper hose installations.

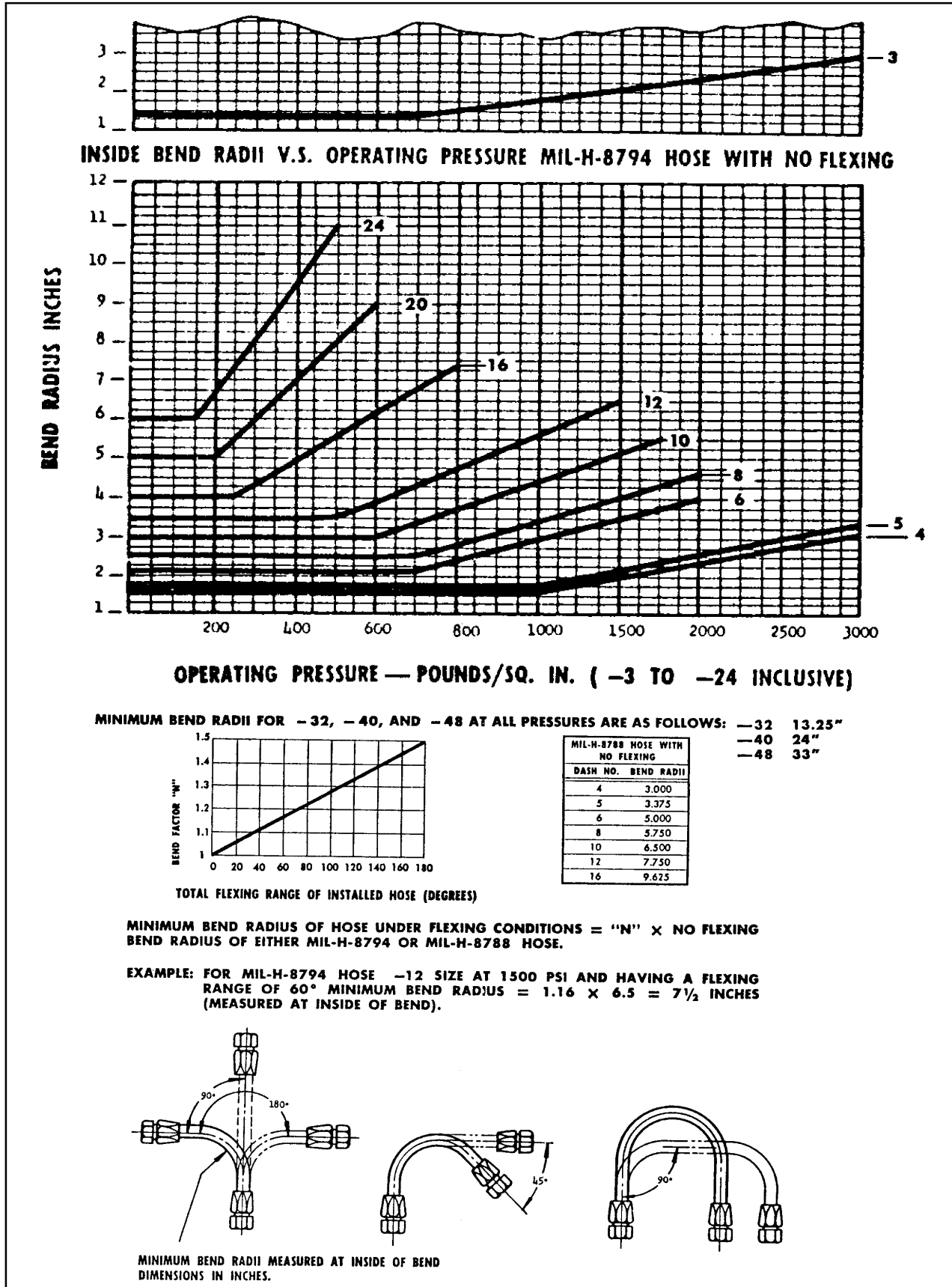


FIGURE 9-10. Minimum bend radii.

TABLE 9-4. Ball diameters for testing hose restrictions or kinking.

HOSE SIZE	BALL SIZE
-4	5/64
-5	9/64
-6	13/64
-8	9/32
-10	3/8
-12	1/2
-16	47/64
-20	61/64

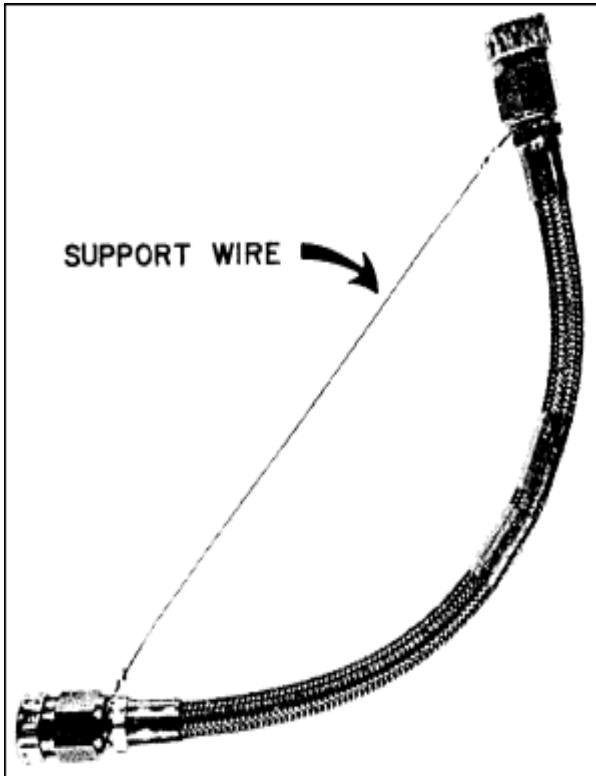


FIGURE 9-11. Suggested handling of preformed hose.

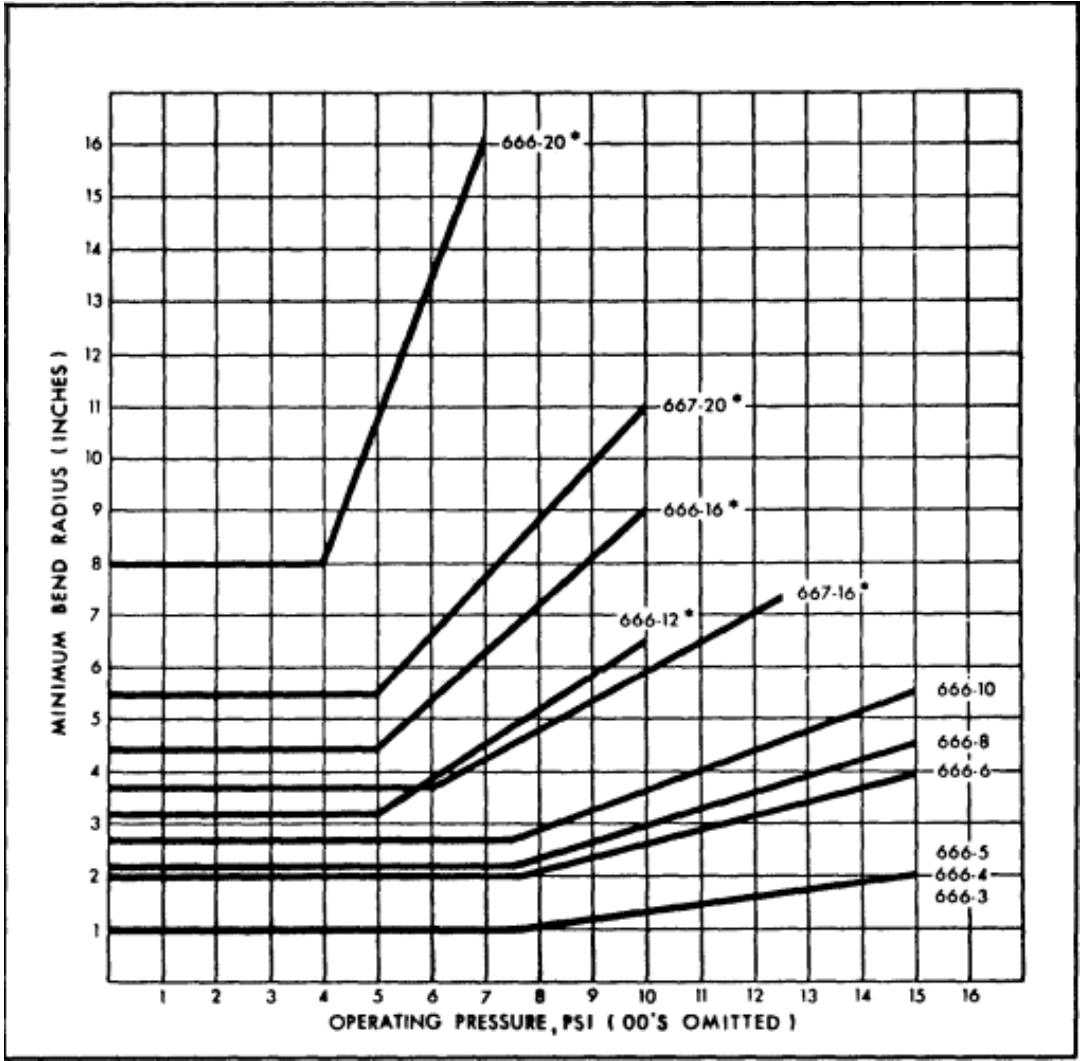


Figure 9-12. Minimum bend radii—Teflon hose.

9.31.—9.36 [RESERVED.]

SECTION 3. EMERGENCY EQUIPMENT

9-37. LIFE RAFTS. Inflatable life rafts are subject to general deterioration due to aging. Experience has indicated that such equipment may be in need of replacement at the end of 5 years due to porosity of the rubber-coated material. Wear of such equipment is accelerated when stowed on board aircraft because of vibration which causes chafing of the rubberized fabric. This ultimately results in localized leakage. Leakage is also likely to occur where the fabric is folded because sharp corners are formed. When these corners are in contact with the carrying cases or with adjacent parts of the rubberized fabric, they tend to wear through due to vibration (Ref: TSO-C70a).

a. When accomplishing maintenance, repair, and inspection of unpacked rafts, personnel should not step on any part of the raft or flotation tubes while wearing shoes. Rafts should not be thrown or dropped, since damage to the raft or accessories may result. Particular care should be exercised at all times to prevent snagging, cutting, and contact with gasoline, acids, oils, and grease. High standards of performance for proper maintenance, inspection, and repair cannot be overemphasized, since the lives of passengers could be involved.

b. Inspection and inflation tests, when applicable, will be accomplished during storage and after installation in an aircraft in accordance with the manufacturer's specifications and/or FAA-approved procedures. Accessory items will be installed during these inspections. A raft knife will be attached by a 24-inch nylon lanyard to the mooring eye located above the CO₂ cylinder case to enable rapid cutting of the mooring line.

9-38. LIFE RAFT INSPECTIONS. Inspection of life rafts should be performed in accordance with the manufacturer's

specifications. General inspection procedures to be performed on most life rafts are as follows.

CAUTION: Areas where life rafts are inspected or tested must be smooth, free of splinters, sharp projections, and oil stains. Floors with abrasive characteristics, such as concrete or rough wood, will be covered with untreated tarpaulins or heavy clean paper.

a. Inspect life rafts for cuts, tears, or other damage to the rubberized material. If the raft is found to be in good condition, remove the CO₂ bottle(s) and inflate the raft with air to a pressure of 2 psi. The air should be introduced at the fitting normally connected to the CO₂ bottle(s). After at least 1 hour, to allow for the air within the raft to adjust itself to the ambient temperature, check pressure and adjust, if necessary, to 2 psi and allow the raft to stand for 24 hours. If, after 24 hours, the pressure is less than 1 psi, examine the raft for leakage by using soapy water. In order to eliminate pressure variations due to temperature differences at the time the initial and final reading are taken, test the raft in a room where the temperature is fairly constant. If the pressure drop is satisfactory, the raft should be considered as being in an airworthy condition and returned to service after being fitted with correctly charged CO₂ bottles as determined by weighing them. Rafts more than 5 years old are likely to be unairworthy due to deterioration. It is suggested that serviceable rafts be marked to indicate the date of inspection and that soapstone be used when folding them preparatory to insertion into the carrying case. Take care to see that all of the raft's required equipment is on board and properly stowed. If the raft lanyard, used to prevent the raft from floating away from the airplane, is in need of

replacement, use a lanyard not less than 20 feet long and having a breaking strength of about 75 pounds.

b. It is recommended that the aforementioned procedure be repeated every 18 months using the CO₂ bottle(s) for inflation. If a single bottle is used for inflating both compartments, it should be noted whether the inflation is proceeding equally to both compartments. Occasionally, the formation of “carbon-dioxide snow” may occur in one passage of the distribution manifold and divert a larger volume of gas to one compartment, which may burst if the mattress valve is not open to relieve the pressure. If the pressure is satisfactory, return the raft to service in accordance with the procedure outlined.

c. Inspect the CO₂ cylinder for evidence of cross-threading or stripping.

d. Inspect the CO₂ bottle inflation valve cable rigging as follows.

(1) Remove the screws that attach the cover plate to the valve and remove the cover plate.

(2) Inspect the firing line cable ball swage for engagement in the correct recess for either “Upward Pull” or “Downward Pull.” The cable will be wrapped around the sheave approximately 270 degrees.

(3) Reposition the cable ball swage as required. (See figure 9-12.)

(4) Replace the cover plate. The green dot on the sheave should be visible through the window in the cover plate, indicating a charged cylinder.

e. Check the CO₂ cylinder release cable and housing for condition and security.

f. Make sure the safety deflector is removed from the cylinder outlet before connecting the cylinder to the raft. (See figure 9-12.)

g. Stencil the life raft’s inspection date on the raft.

9-39. SURVIVAL KIT INSPECTION.

a. Survival Kit Contents. Each raft accommodating passengers or crew members should contain, as a minimum, the following:

- Hand Pump (if required)
- Desalting Kit, First-Aid Kit
- Mirror/Reflector
- Emergency Rations
- Tarpaulins
- Fishing Kit
- Raft Knife
- Compass
- Protective Ointment (Sunburn)
- Oars
- Emergency Water Containers
- Repair Kits
- Signal Flares
- Carrying Case
- Locator Beacon and Battery
- Lines and Anchor
- Police Whistle
- Flashlight
- Thermal Protective Aid
- Light-sticks
- Solar Still Kit
- Survival Manual
- Duct Tape
- Plastic Trash Bags
- Accessory Containers
 - Bailing Bucket
 - Sponge
- Dye Marker

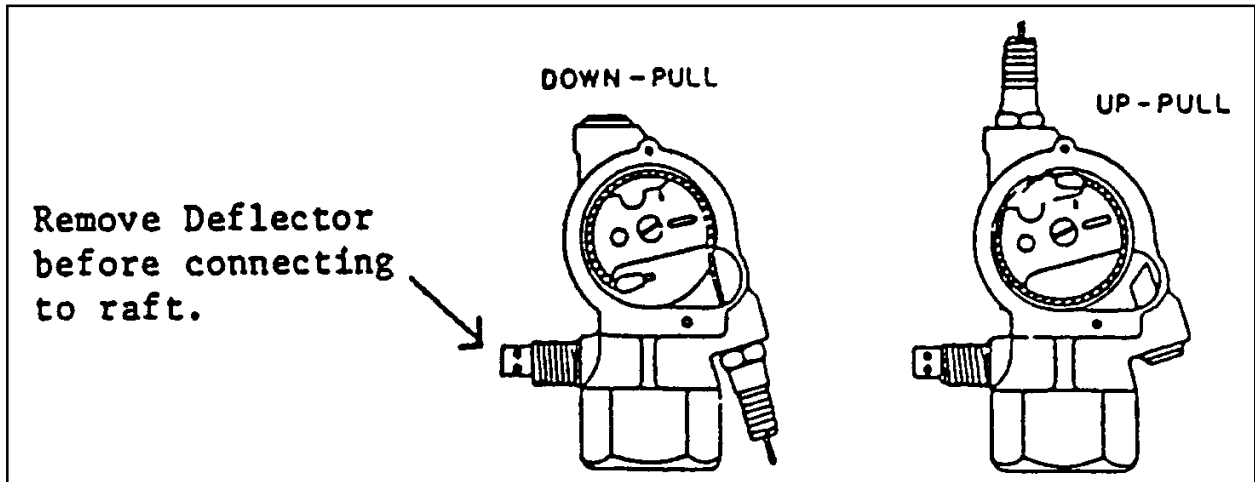


FIGURE 9-12. Inflation valve.

b. Exposure Suits. Quick-donning exposure suits should be provided in sufficient quantity to accommodate the passengers and crew on extended over-water missions whenever any of the following conditions exist.

- (1) The water temperature is 59 °F or below, or
- (2) The Outside Air Temperature (OAT) is 32 °F or below.

c. Physical Inspection. Make a physical inspection of the life raft's accessories and/or contents, in accordance with manufacturer's specifications, to ascertain that all items required are in a serviceable condition.

- (1) Pumps and Hoses.
 - (a) Check the air pump for condition and security.
 - (b) Check the air pump hose and hose fittings for ease of attachment to the pump and mattress valves.

(c) Operate the pump to ensure that it delivers air.

(d) Close the outlet and check the seal of the piston.

(e) Blow into the outlet to determine if the pump check valve will seal.

(2) Desalting Kit.

- (a) Check the desalting kit expiration date, if applicable.
- (b) Replace the severely dented or punctured cans.

NOTE: Type MK-2 desalter kits have an indefinite shelf and service life and do not have to be age-controlled.

(3) First-Aid Kit. Inspect each kit prior to flight to ensure that the seal is intact; the kits have not been tampered with or opened; and check the date when the kit contents should be inspected (120-day interval), and containing the following:

- 1 Case First-Aid Kit, empty;
- 1 Bottle Benzalkonium Chloride Zinc; Tinted, 1:1000 2cc
- 1 Package Sodium Chloride; (Sodium Bicarbonate Mix) 4.5 gm;
- 1 Bandage each, Gauze, & Compress (2 inches x 6 yd);
- 2 Dressings, First-Aid, 4 inches x 7 inches;
- 1 Package Bandages; Absorbent & Adhesive, 3/4-inch x 3 inches;
- 3 Bottles, Snap-On Cap, Plastic Tablet and Capsule, Round, (issued empty; to be used as needed by user);
- 1 Tube Lipstick, Anti-Chap; and
- 1 bottle Water Purification Tablets, Iodine 8 mg (50).

(a) If the seal is found to be broken, or there is evidence of tampering, the kit should be opened and inspected to ensure that all components are included and undamaged. After such inspection, the kit should be resealed.

(b) To reseal the kit, use a wire and lead seal according to the manufacturer's specifications. Pass the wire through grommets or opposite flaps, bend the wire back and force each end through the middle of the lacing cord on each side of the square knot. Pass the ends of the wire through the holes in the lead seal, draw the wire taut, and compress the seal.

(4) Mirror/Reflector. Check the reflector for defective reflection surface and the reflector lanyard for defective conditions and security of attachment.

(5) Emergency Rations. Check the food ration cans for obvious damage, severe dents, and an expiration date. Replace items when severely damaged, dented, or when the date is expired. Ensure that the opening key is attached.

(6) Tarpaulins. Spread out and check for tears, mildew, corroded grommets, and general condition.

(7) Fishing Kit. Check for damaged container or for tampering. Replace if damaged or incomplete.

(8) Raft Knife. Check for corrosion and ease of opening and security of the knife lanyard to the raft.

(9) Compass. Check for proper operation and condition.

(10) Protective Ointment (Sunburn).

(a) Check the sunburn ointment containers for cracks or crushed condition.

(b) Install the ointment in a 6 inch mailing tube and tape the ends to prevent crushing. Stow it where it will be subjected to the least amount of pressure in the kit.

(11) Oars.

(a) Check for serviceability.

(b) Wrap the oars separately in craft paper and seal with tape.

(c) Stencil *inspected* in letters not less than 1/2-inch high on each package.

(12) Emergency Water Containers. Check for open seams, holes, etc. Replace defective containers.

(13) Repair Kit. Check for proper wrapping and missing items. Four plugs are wrapped in a single container. This container and the pliers are wrapped in waterproof paper and sealed with waterproof tape. The package is stenciled *repair plugs and pliers* with letters not less than 1/2-inch high.

(14) Signal Flares. Check the flares for obvious damage and suspended lot numbers. Replace if lot number is over-age or obvious damage exists.

(15) Carrying Case. Check for snags, abrasions, and defective snaps. Repair or replace as necessary.

(16) Locator Beacon and Battery.

(a) Check for corrosion and obvious damage per the manufacturer's manual.

(b) Assemble as an operating unit. Perform an operational test, prepare the beacon for water activation by pulling out the battery switch plug from the end of the transmitter section, and package as instructed on the container.

(17) Lines and Anchor. Check all lines and sea anchors for conditions and security.

(18) Police Whistle. Inspect and test.

(19) Flashlight. Test the flashlight switch for operation; remove old batteries and inspect the case for corrosion and condition; and install new batteries and test momentarily for operation.

(20) Space Blankets. Check space blankets (if required) for rips, tears, and obvious damage.

(21) Light-sticks. Inspect light-sticks for condition and check expiration date.

(22) Solar Still Kit. Check the solar still kit for condition.

(23) Survival Manual. Inspect the survival manual for condition and completeness.

(24) Duct Tape. Check the duct tape for deterioration.

(25) Plastic Trash Bags. Assure that three (each) plastic trash bags are serviceable.

(26) Accessory Containers.

(a) Check the containers for condition and security.

(b) Repack the accessories, secure, and record the inspection data on data cards. Record the Inspection date.

(27) Dye Marker. Check for dents and overall condition.

(28) Shark Chaser. Check for dents and overall condition.

d. After Inspection. Replace accessories in the container, close, and tie securely with tying tapes. Draw a 25-pound breaking strength cord tightly around the center and one approximately 5 inches from each end of the container, tie with square knots, and seal with a lead seal.

e. Folding Life Rafts. Fold the life rafts per the manufacturer's folding diagram using soapstone and secure the raft in its container. Check the container for obvious damage.

9-40. SPECIAL INSPECTIONS. Life rafts in storage or in service shall be unpacked and thoroughly inspected for mildew whenever weather or other conditions warrant. The extent of a special inspection will be determined by the inspector or maintenance chief following a review of the circumstances or conditions to which the life rafts have been subjected. The inspector or maintenance chief may direct a complete overall inspection and inflation test

of the life rafts, regardless of the last date of inspection, if it is considered that another inspection is warranted.

9-41. INSPECTION RECORD. The date the inspection was completed will be stenciled on the flotation tube at the left of the cylinder. The size of lettering will not be less than 1/4-inch or greater than 1/2-inch in height. Previous inspection dates will not be removed or obliterated, but will be arranged in columnar form with the latest date at the top. After the inspection is completed, fill out the raft's inspection record in accordance with part 43 section 43.9, and attach the parts tag to the survival equipment. The date on the tag will reflect the same date as stenciled on the flotation tube and will be used to determine the next due date of inspection and test.

9-42. RAFT REPAIRS.

a. Repairs. The service life for flotation equipment will be determined by condition rather than age. Equipment passing tests and inspections may remain in service indefinitely since the inflation tests and material inspections will identify and condemn equipment having more than minor installation defects. However, the service life for life rafts operating under normal usage and environmental conditions is anticipated by the manufacturers to be 8 to 10 years, and it is appropriate to base life raft's parts replacement programs upon this estimate. It is not considered advisable or economical to perform major repairs on life rafts.

b. Life Rafts. Life rafts with any of the following conditions should be condemned rather than repaired:

(1) Life rafts over 3-1/2 years of age and requiring major repair or more than two minor repairs.

(2) A rip or tear across an air retaining seam.

(3) Rafts on which oil, grease, or any other foreign substance has caused a deterioration of the rubberized fabric.

(4) Rafts on which a heavy mildew condition has caused deterioration of the rubberized fabric.

(5) Rafts on which porous flotation tubes allow diffusion of air. A porous area is located by a soap test on the inflated raft. Higher diffusion is indicated by the excessive loss of pressure after a soap test has failed to locate a specific area of injury on the raft.

(6) Rafts requiring internal repair or opening of air retaining seams for repair.

(7) Rafts with an excessive number of injuries that would not, in the judgment of competent inspectors, justify repair.

c. Patches. Holes or abrasions which are 2 inches or less, in diameter (in air retaining chambers) will be repaired by the application of an outside patch. Holes exceeding 2 inches in length or diameter, will require an inside patch as well as an outside patch. Inside and outside patches should be round or rectangular and manufactured of fabric (specification MIL-C-6819). Cement should conform to Class 1 of specification MIL-C-5539. Patch as follows:

(1) Outside patches.

(a) With a rubber solvent thoroughly clean the area to be patched.

(b) From the material referenced, fabricate a patch as shown in figure 9-13.

(c) When two fabric surfaces are to be bonded, apply two coats of extra light cement, two coats of light cement, and three coats of heavy cement to each surface. Rubber-coated tape and seam crossover patches with protective backing do not require cement. Each coat of cement should be thoroughly dry to the touch before the next coat is applied. Start the bonding of fabric surfaces while the last coat of cement is slightly tacky. To ensure proper adhesion when bonding two cemented surfaces, the areas to be bonded should remain tacky during application. This is accomplished by brushing the cemented area with a cloth moistened with solvent.

NOTE: If difficulty in the drying of heavy cement is encountered due to atmospheric conditions, six additional coats of light cement may be substituted for the three coats of heavy cement.

(d) After applying the patch, thoroughly roll it with a hand roller, rolling from the center to the outer edge, to ensure that all air pockets are removed and a firm bond is secured.

(e) Thoroughly dust with talc. Allow to cure for 60 hours before performing leak tests and storing.

(2) Inside Patches.

(a) Cut a rectangular patch as shown in figure 9-13, allowing at least 1-1/2 inches to extend beyond the edge of the injury in all directions.

(b) Mark the center line on the side of the patch that is to be attached to the raft. Mark cross lines on each end of the patch 1-1/2 inches from the ends. When the patch is applied to the injury on the inside, the longitudinal edges of the injury will coincide with the

center line, and cross lines on the ends of the patch will coincide with the ends of the injury.

(c) To ensure that the inside surface of the raft is properly powdered in the area of repair, pass a small handful of talc through the opening in the raft and place it approximately 12 inches from the injury. This should be accomplished before the inside area is cemented, exercising care to prevent distribution of the talc prior to completion of the repair.

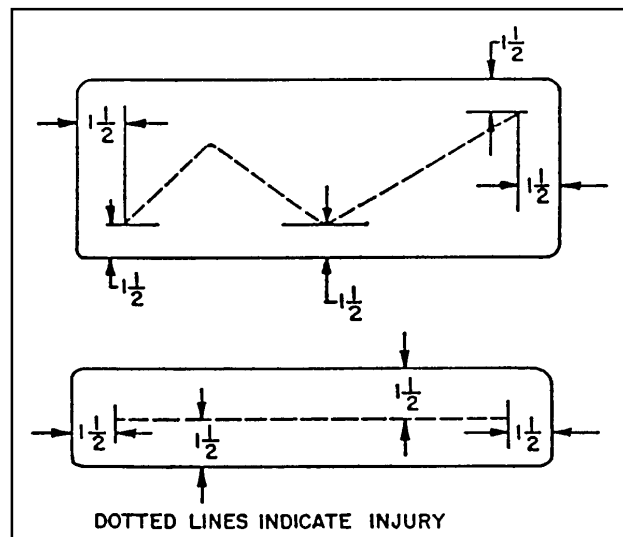


FIGURE 9-13. Repair dimensions.

(d) Using cleaning solvent, cleanse an area on the inside surface of the fabric slightly larger than the patch to be applied. Ensure that the repaired area is thoroughly dry, both inside and outside; apply two coats of extra light cement, two coats of light cement, and three coats of heavy cement (or six additional coats of light cement in lieu of the heavy cement) to the cleansed area, allowing each coat to dry thoroughly before applying successive coats.

NOTE: Since it is impossible for the repairman to visually observe the cementing that is being accomplished on the inside of the raft, exercise care to ensure that each coat of cement completely covers the area to be repaired.

(e) The inside patch should be cemented simultaneously with the application of cement to the inside of the raft. Apply the same number of coats as directed in paragraph 9 42b(2)(d) to the side of the patch that is applied to the injured fabric of the raft. Ensure that each coat is thoroughly dry before applying the next coat.

(f) To aid in adhesion, prior to applying the patch, the inside area to be repaired and cemented surface of the patch should be cleaned with a cloth moistened with rubber solvent. The cement will then become tacky.

(g) Apply the patch. Fold the patch lengthwise in the shape of the letter "U" and insert the patch between the torn edges of the injury on the life rafts. Position the patch so that the fabric at the end of the tear will coincide with a cross line and the center line on the patch follows one edge of the torn fabric. Attach one edge of the torn fabric along the center line on the patch.

(h) Inspect the repair for wrinkles. Working from the attached edge of the fabric to the edge of the patch, remove the wrinkles with a stitcher. Lay the opposite edge of the torn fabric on the patch so that it butts the edge of the torn fabric that has already been applied to the patch. Remove the wrinkles. Thoroughly roll the patch with a 2 inch rubber roller.

NOTE: The surface under the patch should be as smooth as possible so that the torn edge of the fabric may be attached to the patch instead of attempting to attach the patch to the fabric.

(i) Scatter the handful of talc that was placed inside the tube by grasping the sides of the flotation tube and pulling them apart.

(j) Prepare and attach the outside patch as outlined in "OUTSIDE PATCHES," sub-paragraphs 9-42b(1)(a)-(e).

(k) Allow to cure for at least 60 hours before performing leak tests and storing.

(3) Seams and Tapes.

(a) Remove all old or dead cement from the area that will require recementing. Dampen the repair area with a solvent-moistened cloth; then roll or rub off the old cement.

(b) Apply cement to the surface as outlined in "OUTSIDE PATCHES," sub-paragraph 9-42b(1)(a)-(e).

(c) Roll thoroughly with a roller to ensure that all air pockets are removed and a firm bond is secured.

(d) Allow to dry and apply talc over the seam as previously outlined.

(e) Allow to cure for at least 60 hours before performing leak tests and storing.

9-43. LIFE PRESERVERS. Inflatable life preservers are subject to general deterioration due to aging. Experience has indicated that such equipment may be in need of replacement at the end of 5 years due to porosity of the rubber-coated material. Wear of such equipment is accelerated when stowed on board aircraft because of vibration which causes chafing of the rubberized fabric. This ultimately results in localized leakage. Leakage is also likely to occur where the fabric is folded because sharp corners are formed. When these corners are in contact with the carrying cases, or with adjacent parts of the rubberized fabric, they tend to wear through due to vibration.

Life preservers should be inspected in accordance with the manufacturer's specification, unless climate, storage, or operational conditions indicate the need for more frequent inspections (Ref: TSO-C13).

9-44. LIFE PRESERVER INSPECTION.

Life preservers should be inspected at 12-month intervals for cuts, tears, or other damage to the rubberized material. Check the mouth valves and tubing for leakage, corrosion, and deterioration. Remove the CO₂ cylinder and check the discharge mechanism by operating the lever to ascertain that the pin operates freely. Check the gaskets and valve cores of the cylinder container and the pull cord for deterioration. If no defects are found, inflate the preserver with air to a 2 psi pressure and allow to stand for 12 hours. If the preserver still has adequate rigidity at the end of that time, deflate and fit with CO₂ cylinders having weights not less than that indicated on them by the manufacturer. All cylinders made in accordance with joint Army/Navy Specification MIL-C-00601D are so stamped and have a minimum permissible weight stamped on them. The use of such CO₂ cylinders is recommended. Having fitted the preserver with an adequately-charged cylinder, mark the preserver to indicate the date of inspection and patch it to the container. It is recommended that the aforementioned procedure be repeated every 12-month period, utilizing the CO₂ cartridge for inflation. Carbon dioxide permeates the rubberized fabric at a faster rate than air and will indicate if the porosity of the material is excessive. The following checks and inspections should be completed:

a. Check for abrasions, chafing, and soiling across folded cell areas and around metal parts. Condemn the life preserver when unsuitable conditions are found.

b. Check for separation of cell fabric and loose attachments along the edges of patches and sealing tapes. Repair if practicable.

c. Check for deterioration in areas where oil and grease are noted. Condemn deteriorated cells. If deterioration is not noted, clean the areas with mild soap and water and rinse with clear water.

d. Inspect the snaps and/or buckles to ensure proper operation.

e. Inspect the instruction panel for readability.

f. Inspect all stitching for gaps, pulls, and tears.

g. Visually inspect the cell containers for snags, cuts, loose stitching, and oil and grease spots. Repair or replace as necessary.

h. Inspect the hardware for rusted or broken parts and cotter pins for damage. Ensure that pins are smooth and free of burrs.

i. Check the inflator discharge lever for proper operation. Move the inflator discharge lever slowly through a normal cycle of operation to ensure freedom of operation and to make certain that the piercing pin has sufficient movement to discharge the CO₂ cylinder. The point of the pin should move past the surface of the gasket in the inflator. In the unoperated position, the end point should be slightly below the gasket surface.

j. Check the installation of the inflator stem gaskets and check the stem caps for tightness. Ensure that the inflator is centered on the stem.

k. Check rescue light. Inspect and test.

(1) Replace the battery if it shows any signs of encrustation.

(2) Inspect for proper installation and physical condition of the lamp, wire, and battery.

(3) Check the light assembly for proper operation and water insulation and flotation.

(4) Pull the sealing plug (where applicable) from the battery. Let water flow through the open ports. Make sure the battery is activated and power is supplied to the light.

(5) Fill out the inspection record and serviceable parts tag. Attach to the vest.

l. Deflate the life preserver and repack in container and secure.

m. The accessories listed below will be required for all life preservers:

(1) **One Recognition Light:** Remove when returning to serviceable or repairable storage. Remove for replacement of defective light, repair, or salvage of preserver.

(2) **One Recognition Light Battery:** Remove when returning to serviceable or repairable storage.

n. Record the inspection data on data cards.

o. Life preserver inspected and found sea worthy. Include the inspector's signature.

p. Inspection record. Upon completion of 12-month inspection and tests, each flotation cell will be marked to indicate the date the inspection was accomplished. The inspection stencil will consist of 1/8-inch letters and numerals and will be applied to the patches on the cells (example: 4/3/97). To facilitate

determination of the next 12-month inspection period, enter the date it is due in the blank beside the word *inspect* on the inspection data card provided in the inspection data pocket on the cell container. Repack, close, and seal the container.

9-45. REPAIR OF LIFE PRESERVERS.

Leaks may be disclosed by immersion in soapy water. Repair leaks by the use of patches in accordance with the recommendations of the manufacturer. Clean corroded metal parts and replace missing or weakened lanyards. Life preservers which do not retain sufficient rigidity after the 12-hour period, because of general deterioration and porosity of the fabric, are beyond economical repair and should be replaced.

9-46. MISCELLANEOUS EQUIPMENT.

a. Parachutes. With reasonable care, parachutes can remain in service indefinitely. They should not be carelessly tossed about, left in aircraft to become wet, or left where someone may tamper with them. They should not be placed where they may fall on oily floors or be subject to acid fumes from adjacent battery chargers.

(1) When repacking is scheduled, to comply with the 120-day requirement in Title 14 of the Code of Federal Regulation (14 CFR) part 105 section 105.43 a careful inspection of the parachute shall be made by a qualified parachute technician (rigger). If repairs or replacements of parts are necessary to maintain the airworthiness of the parachute assembly, such work must be done by the original parachute manufacturer or by a qualified parachute rigger, certificated in accordance with 14 CFR, part 65.

(2) The lead seal should be inspected periodically to ensure the thread has not been broken. If broken, or broken and retied or

appears to have been tampered with, the parachute must be repacked by a properly certified rigger.

b. Safety Belts shall be of an approved type. All seat belts and restraint systems must conform to standards established by the FAA. These standards are contained in Technical Standard Order TSO C22 for seat belts and TSO C114 for restraint systems.

(1) Safety belts eligible for installation in aircraft must be identified by the proper TSO markings on the belt. Each safety belt must be equipped with an approved metal to metal latching device. Airworthy type-certificated safety belts currently in aircraft may be removed for cleaning and reinstalled. However, when a TSO safety belt is found unairworthy, replacement with a new TSO-approved belt or harness is required.

(2) The webbing of safety belts, even when mildew-proofed, is subject to deterioration due to constant use, cleaning, and the effects of aging. Fraying of belts is an indication of wear, and such belts are likely to be unairworthy because they can no longer hold the minimum required tensile load.

(3) **Safety belts shall be repaired** in accordance with specifications approved by the responsible FAA ACO.

9-47. OXYGEN SYSTEMS. The following instructions are to serve as a guide for the inspection and maintenance of aircraft oxygen systems. The information is applicable to both portable and permanently-installed equipment.

a. Aircraft Gaseous Oxygen Systems. The oxygen in gaseous systems is supplied from one or more high- or low-pressure oxygen cylinders. Since the oxygen is compressed within the cylinder, the amount of pressure indicated on the system gauge bears a direct relationship to the amount of oxygen contained

in the cylinder. The pressure-indicating line connection is normally located between the cylinder and a pressure-reducing valve.

NOTE: Some of the gaseous oxygen systems do not use pressure-reducing valves. The high pressure is reduced to a useable pressure by a regulator. This regulator is located between the high- and low-pressure system.

CAUTION: Oxygen rich environments are dangerous.

b. Portable Oxygen Systems. The three basic types of portable oxygen systems are: demand, pressure demand, and continuous flow. The components of these systems are identical to those of a permanent installation with the exception that some parts are miniaturized as necessary. This is done in order that they may be contained in a case or strapped around a person's shoulder. It is for this portability reason that special attention be given to assuring that any storage or security provision for portable oxygen equipment in the aircraft is adequate, in good condition, and accessible to the user.

NOTE: Check portable equipment including its security provisions frequently, since it is more susceptible to personnel abuse than a permanently-installed system.

9-48. INSPECTION. Hands, clothing, and tools must be free of oil, grease, and dirt when working with oxygen equipment. Traces of these organic materials near compressed oxygen may result in spontaneous combustion, explosions, and/or fire.

a. Oxygen Tanks and Cylinders. Inspect the entire exterior surface of the cylinder for indication of abuse, dents, bulges, and strap chafing.

(1) Examine the neck of cylinder for cracks, distortion, or damaged threads.

(2) Check the cylinder to determine if the markings are legible.

(3) Check the date of the last hydrostatic test. If the periodic retest date is past, do not return the cylinder to service until the test has been accomplished.

(4) Inspect the cylinder mounting bracket, bracket hold-down bolts, and cylinder-holding straps for cracks, deformation, cleanliness, and security of attachment.

(5) In the immediate area where the cylinder is stored or secured, check for evidence of any types of interference, chafing, deformation, or deterioration.

b. Lines and Fittings.

(1) Inspect oxygen lines for chafing, corrosion, flat spots and irregularities, i.e., sharp bends, kinks, and inadequate security.

(2) Check fittings for corrosion around the threaded area where lines are joined. Pressurize the system and check for leaks. (See paragraph 9-49b(2)(d).)

CAUTION: In pressurizing the system, actuate the valve slowly to avoid surging which could rupture the line.

c. Regulators, Valves, and Gauges.

(1) Examine all parts for cracks, nicks, damaged threads or other apparent damage.

(2) Actuate the regulator controls and the valve to check for ease of operation.

(3) Determine if the gauge is functioning properly by observing the pressure build-up and the return to zero when the system oxygen is bled off.

d. Masks and Hoses.

(1) Check the oxygen mask for fabric cracks and rough face seals. If the mask is a full-face model, inspect the glass or plastic for cleanliness and state of repair.

(2) When appropriate, with due regard to hygienic considerations, the sealing qualities of an oxygen mask may be tested by placing a thumb over the connection at the end of the mask tube and inhaling very lightly. Remove the thumb from the disconnect after each continuous inhalation. If there is no leakage, the mask will adhere tightly to the face during inhalation, and definite resistance to inhalation will be noticeable.

(3) Flex the mask hose gently over its entirety and check for evidence of deterioration or dirt.

(4) Examine the mask and hose storage compartment for cleanliness and general condition.

(5) If the mask and hose storage compartment is provided with a cover or release mechanism, thoroughly check the operation of the mechanism.

9-49. MAINTENANCE.

a. Oxygen Tanks, Cylinders, and Hold-Down Brackets.

(1) Remove from service any cylinders that show signs of abuse, dents, bulges, cracks, distortion, damaged thread, or defects which might render them unsafe. Typical examples

of oxygen cylinder damage are shown in figure 9-14.

(2) When replacing an oxygen cylinder, be certain that the replacement cylinder is of the same size and weight as the one removed.

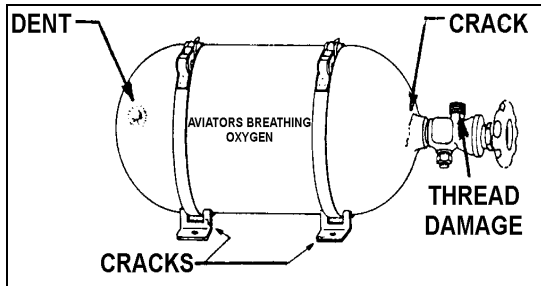


FIGURE 9-14. Oxygen cylinder damage.

NOTE: Cylinders having greater weight or size will require strengthened cylinder mounting brackets and a reevaluation to determine that the larger or heavier cylinder will not interfere with adjacent systems, components, or structural members, and that the strength of attaching structure is adequate and any additional weight will be computed into the aircraft's weight and balance report.

(3) Replace or repair any cylinder mounting brackets that show signs of wear. Visible cracks may be welded in accordance

with manufacturer's standards. Replace the cylinder straps or clamps that show wear or abuse. For typical mounting bracket cracks and failure, see figure 9-15.

b. Lines and Fittings.

(1) Replace any oxygen line that is chafed, rusted, corroded, dented, cracked, or kinked.

(2) Clean oxygen system fittings showing signs of rusting or corrosion in the threaded area. To accomplish this, use a cleaner recommended by manufacturers of oxygen equipment. Replace lines and fittings that cannot be cleaned.

(a) The high-pressure lines which are located between the oxygen bottle (outside the oxygen service filler) and the regulator are normally fabricated from stainless steel or thick-wall, seamless copper alloy tubing. The fittings on high-pressure lines are normally silver brazed.

NOTE: Use silver alloys free of cadmium when silver brazing. The use of silver brazing alloys, which contain cadmium, will emit a poisonous gas when heated to a molten state. This gas is extremely hazardous to health if inhaled.

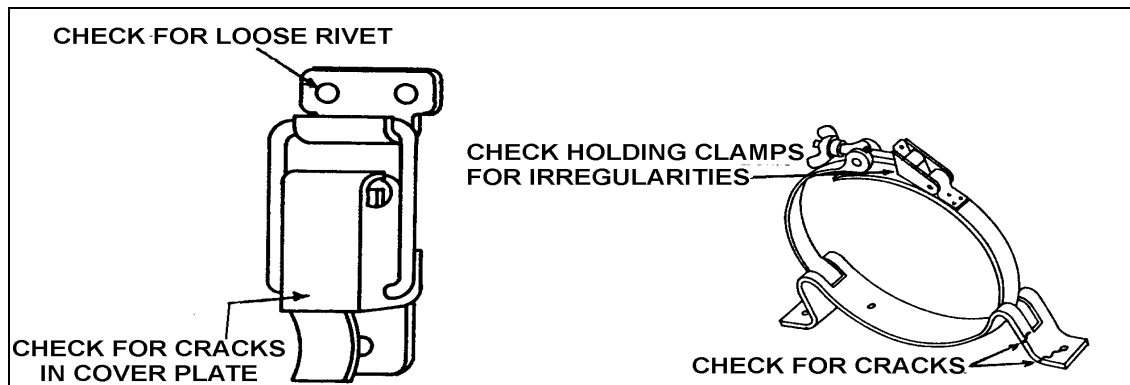


FIGURE 9-15. Cylinder brackets and clamps.

(b) The low-pressure lines extend from the pressure regulator to each passenger and crew oxygen outlet. These lines are fabricated from seamless aluminum alloy, copper, or flexible hose. Normally, flare- or flange-type connections are used.

CAUTION: Do not allow oil, grease, flammable solvent, or other combustibles such as lint or dust to come in contact with threads or any parts that will be exposed to pressurized oxygen.

(c) It is advisable to purge the oxygen system any time work has been accomplished on any of the lines and fittings. Use dry nitrogen or dry air for purging the system. All open lines should be capped immediately after purging.

(d) When oxygen is being lost from a system through leakage, a sequence of steps may be necessary to locate the opening. Leakage may often be detected by listening for the distinct hissing sound of escaping gas. If this check proves negative, it will be necessary to soap-test all lines and connections with a castile soap and water solution or specially compounded leak-test material. Make the solution thick enough to adhere to the contours of the fittings. At the completion of the leakage test, remove all traces of the soap and water.

CAUTION: Do not attempt to tighten any connections while the system is charged.

c. Regulators, Valves, and Gauges. Line maintenance of oxygen regulators, valves, and gauges does not include major repair. These components are precision made and their repair usually requires the attention of a repair station or the manufacturer. Care must be taken when reinstalling these components to

ascertain if the threaded area is free of nicks, burrs, and contaminants that would prevent the connections from sealing properly.

CAUTION: Do not use petroleum lubricants on these components.

d. Masks and Hoses.

(1) Troubleshooting. If a mask assembly is defective (leaks, does not allow breathing, or contains a defective microphone), it is advisable to return the mask assembly to the manufacturer or a repair station.

(2) Maintenance Practice and Cleaning.

(a) Clean and disinfect the mask assemblies after use, as appropriate.

NOTE: Use care to avoid damaging the microphone assembly while cleaning and sterilizing.

(b) Wash the mask with a mild soap solution and rinse it with clear water.

(c) To sterilize, swab the mask thoroughly with a gauze or sponge soaked in a water merthiolate solution. This solution should contain 1/5-teaspoon of merthiolate per 1 quart of water. Wipe the mask with a clean cloth and air dry.

(d) Replace the hose if it shows evidence of deterioration.

(e) Hoses may be cleaned in the same manner as the mask.

(f) Observe that each mask breathing tube end is free of nicks, and that the tube end will slip into the cabin oxygen receptacle with ease and not leak.

9-50. FUNCTIONAL TESTING AFTER REPAIR. Following repair, and before inspection plates, cover plates, or upholstery are replaced, test the entire system.

a. Open the cylinder valve slowly and observe the pressure gauge on a high-pressure system. A pressure of approximately 1,800 psi (at 70 °F) should be indicated on the gauge. (Cylinder pressure will vary considerably with radical temperature changes.)

(1) Check the system by installing one of the mask hose fittings (minus the mask) in each of the cabin wall outlets to determine whether there is a flow. If a demand mask is used, check by breathing through the mask and, if appropriate, clean the mask according to paragraph 9-49d.

(2) Check the complete system for leaks in accordance with the procedure outlined in paragraph 9-49b(2)(d).

(3) If leaks are found, close the cylinder valve and open an outlet to reduce the pressure in the system to zero.

b. The following checks may be made for a pressure drop check of the system.

(1) Open the cylinder valve and pressurize the system. Observe the pressure gauge (a pressure of approximately 1,800 psi at 70 °F should be indicated). For the light weight ICC 3HT 1850 cylinders, pressurize the system to approximately 1,850 psi at 70 °F.

(2) Close the cylinder valve and wait approximately 5 minutes for temperatures to stabilize.

(3) Record the pressure gauge reading and temperature and after 1 hour, record the pressure gauge reading and temperature again.

(4) A maximum pressure drop of 100 psi is permissible.

NOTE: Conduct the above tests in an area where changes of temperature will be less than 10 °F. If a leak occurs during the 1-hour period, suitable corrections would be required, or reconduct the test under conditions of unvarying temperatures.

9-51. SERVICE OXYGEN CYLINDERS. REQUIREMENTS (Ref 49 CFR 173.34 e, 16). Standard-weight cylinders must be hydrostatic tested at the end of each 5-year period (10 years if it meets the requirements in 49 CFR 173.34 e, 16). This is a Department of Transportation (DOT) requirement. These cylinders carry an ICC or DOT 3AA 1800 classification and are suitable for the use intended.

Lightweight cylinders must be hydrostatic tested every 3 years, and must be retired from service after 24 years or 4,380 pressurizations, whichever occurs first. These cylinders carry an ICC or DOT 3 HT 1850 classification and must be stamped with the approval after being inspected. (Ref. 49 CFR 173.34 e, 15).

CAUTION: Use only aviation breathing oxygen when having the oxygen bottle charged.

a. Charging High-Pressure Oxygen Cylinders. The following are recommended procedures for charging high-pressure oxygen cylinders from a manifold system, either permanently-installed or trailer-mounted.

CAUTION: Never attempt to charge a low-pressure cylinder directly from a high-pressure manifold system or cylinder.

(1) Inspection. Do not attempt to charge oxygen cylinders if any of the following discrepancies exist:

(a) Inspect for contaminated fittings on the manifold, cylinder, or outside filler valve. If cleaning is needed, wipe with stabilized trichlorethylene and let air dry. Do not permit the solvent to enter any internal parts.

(b) Check the hydrostatic test date of the cylinder. DOT regulations require ICC or DOT 3AA 1800 designation cylinders to be hydrostatic tested to 5/3 their working pressure, every 5 years (10 years if they meet the requirements in 49 CFR 173.34,e, 16).

Cylinders bearing designation ICC or DOT 3HT 1850 (Ref. 49 CFR 173.34,e, 15) must be hydrostatic tested to 5/3 their working pressure every 3 years, and retired from service 24 years or 4,380 filling cycles after the date of manufacture, whichever occurs first.

(c) If the cylinder is completely empty, do not charge. An empty cylinder must be removed, inspected, and cleaned before charging.

(2) Charging.

(a) Connect the cylinder valve outlet or the outside filler valve to the manifold.

(b) Slowly open the valve of the cylinder to be charged and observe the pressure on the gauge of the manifold system.

(c) Slowly open the valve of the cylinder on the manifold system having the lowest pressure and allow the pressure to equalize.

(d) Close the cylinder valve on the manifold system and slowly open the valve of the cylinder having the next highest pressure.

Continue this procedure until the cylinder has been charged in accordance with table 9-5.

(e) Close all valves on the manifold system.

(f) Close the valve on the filled cylinder and remove the cylinder from the manifold.

(g) Using a leak detector, test for leakage around the cylinder valve threaded connections. (If leakage is present, discharge the oxygen and return the cylinder to the facility for repair.)

(h) Let the cylinder stabilize for a period of at least 1 hour, and then recheck the pressure.

(i) Make any necessary adjustments in the pressure.

b. Charging of Low-Pressure Oxygen Systems and Portables. For recharging a low-pressure aircraft oxygen system, or portable cylinders, it is essential that the oxygen trailer or cart have a pressure-reducing regulator. Military types E-2 or C-1 reducing regulators are satisfactory. These types of regulators reduce the large cylinder pressure from 2,000 psi to a line pressure of 450 psi. (A welding pressure-reducing regulator is not satisfactory.)

CAUTION: When refilling the low-pressure system or portable cylinders, open the oxygen filler tank valve slowly to allow the system or portable cylinders to be filled at a slow rate. After the refilling operation is completed, check for leaks with a leak detector. If a leak is detected, paragraph 9-49b(2)(d) should be referred to for corrective action.

TABLE 9-5. Table of filling pressures.

Initial Temp (° F)	Filling Pressure (psi)
0	1,650
10	1,700
20	1,725
30	1,775
40	1,825
50	1,875
60	1,925
70	1,975
80	2,000
90	2,050
100	2,100
110	2,150
120	2,200
130	2,250

Initial Temperature-Refers to the ambient temperature in the filling room.

Filling Pressure-Refers to the pressure to which aircraft cylinders should be filled. This table gives approximations only, and assumes a rise in temperature of approximately 25 °F. due to the heat of compression. This table also assumes the aircraft cylinders will be filled as quickly as possible and that they will only be cooled by ambient air, with no water bath or other means of cooling being used.

Example: If ambient temperature is 70 °F, fill aircraft cylinders to approximately 1,975 psi-as close to this pressure as the gauge may be read. Upon cooling, cylinders should have approximately 1,850 psi pressure

9-52.—9-59. [RESERVED.]

SECTION 4. CABIN INTERIOR

9-60. GENERAL. Only materials that are flash-resistant should be used in cabin interiors. The requirements related to fire protection qualities of cabin interior materials are specified in CAR 3.388, fire precautions or 14 CFR part 23, section 23.853 compartment interiors

9-61. CAR-3 AIRCRAFT INTERIOR. The requirement for an interior of a CAR-3 aircraft that is used only in 14 CFR, part 91 operations, where smoking is not permitted, is that the materials shall be flash-resistant. (Reference CAR-3.388.)

a. For compartments in CAR-3 aircraft where smoking is permitted, the wall and ceiling linings, the covering of all upholstery, floors, and furnishings shall be flame-resistant. Such compartments should be equipped with an adequate number of self-contained ash trays. All other compartments shall be placarded against smoking. (Refer to CAR-3.388.)

(1) If fabric is bought in bulk to refurbish the interior, seats, and ceiling liners for a CAR-3 aircraft used in part 91 operations, a manufacturer's statement, declaring that the material meets the American Society for Testing and Materials (ASTM) or similar national standard for either flash resistance or flame resistance, would be acceptable, but only for a CAR-3 aircraft installation. (Refer to 14 CFR part 43, section 43.13(a).) A manufacturer's statement is acceptable due to neither the Civil Aeronautics Administration (CAA) nor the Federal Aviation Administration (FAA) having published an FAA fire standard for either flash or flame resistance for interior materials for CAR-3 aircraft. Since the FAA would accept and recognize a national

standard, the mechanic would reference the manufacturer's statement and the national standard that the material meets in the aircraft's maintenance records.

(2) If an annual inspection is performed on a CAR-3 aircraft with a new interior and there is no mention of a manufacturer's statement that the fabric is flash or flame resistant as applicable, the possibility exists that the fabric is an unapproved part. The mechanic should take the necessary steps to ensure that the fabric meets or exceeds the ASTM or national standards. (Refer to 14 CFR part 23, appendix F.)

(3) If an FAA-approved STC interior kit is installed in a CAR-3 aircraft, and the material and fabric in the kit are PMA or TSO approved, the mechanic should include the STC number in block 8 of FAA Form 337.

b. It is recommended that for all CAR-3 interiors to use only fabric and materials that meets the more stringent requirements of part 23, appendix F.

9-62. PART 23 AIRCRAFT INTERIOR. Materials used in part 23 aircraft interiors must meet the requirements of section 23.853, and the burn test requirements called out in part 23, appendix F.

a. If the fabric is bought in bulk to refurbish a part 23 aircraft then the fabric must meet the part 23 burn requirements. A burn test would have to be done on samples of the material and fabrics by an approved and rated FAA Repair Station. That FAA Repair Station would certify that all the material and fabrics meet part 23, appendix F requirements. The mechanic would include that repair station's statement in the aircraft's records.

b. If STC-approved interior kit with either PMA or TSO-approved materials for a part 23 aircraft is bought, the mechanic would only have to reference the STC number on FAA Form 337 and the aircraft's records. Part 23, appendix F would not be required.

c. If an annual inspection is to be performed on a part 23 aircraft in which a new interior was installed, but the aircraft's records do not reflect that a burn test was performed on the interior's materials and fabric by an FAA Approved Repair Station, or there is no mention of an STC or FAA Form 337 in the aircraft records, then a burn test that meets, part 23, appendix F must be accomplished before the aircraft is approved for return to service.

9-63. SOURCE OF INFORMATION. If information regarding the original or properly altered fire protection qualities of certain cabin interior materials is not available, requests for this information should be made to the aircraft manufacturer or the local FAA regional office, specifying the model aircraft and the aircraft manufacturer. The date the aircraft was manufactured or the serial number, and the 14 CFR part under which the aircraft is operated (i.e., CAR-3, 14 CFR part 91, or part 121, etc.).

9-64. UPHOLSTERY AND/OR BELTS. Upholstery and/or belts that have been washed may lose some or all of their fire-resistant qualities. Unless the soap is completely removed from the cloth, the strength of the material may be significantly reduced. Consult the manufacturer to determine how to maintain the fire-resistant qualities.

9-65.—9-70. [RESERVED.]

CHAPTER 10. WEIGHT AND BALANCE

SECTION 1 TERMINOLOGY

10-1. GENERAL. The removal or addition of equipment results in changes to the center of gravity (c.g.). The empty weight of the aircraft, and the permissible useful load are affected accordingly. Investigate the effects of these changes, since the aircraft flight characteristics may be adversely affected. Information on which to base the record of weight and balance changes to the aircraft may be obtained from the pertinent Aircraft Specifications, Type Certificate Data Sheet (TCDS), prescribed aircraft operating limitations, aircraft flight manual, aircraft weight and balance report, and maintenance manual. Removal of standard parts with negligible weight or addition of minor items of equipment such as nuts, bolts, rivets, washers, and similar standard parts of negligible weight on fixed-wing aircraft do not require a weight and balance check. Rotorcraft are, in general, more critical with respect to control with changes in the c.g. position. Refer to the procedures and instructions in that particular model's maintenance or flight manual.

10-2. TERMINOLOGY. The following terminology is used in the practical application of weight and balance control.

a. Maximum Weight. The maximum weight is the maximum authorized weight of the aircraft and its contents as listed in the specifications.

b. Empty Weight. The empty weight of an aircraft includes all operating equipment that has a fixed location and is actually installed in the aircraft. It includes the weight of the airframe, powerplant, required equipment, optional and special equipment, fixed ballast, full engine coolant, hydraulic fluid, residual fuel, and oil. Additional information regarding

fluids that may be contained in the aircraft systems and must be included in the empty weight will be indicated in the pertinent Aircraft Specifications or TCDS.

c. Negligible Weight Change is any change of one pound or less for aircraft whose weight empty is less than 5,000 pounds; two pounds or less for aircraft whose weight empty is more than 5,000 and 50,000 pounds; and five pounds or less for aircraft whose weight empty is more than 50,000 pounds. Negligible c. g. change is any change of less than 0.05% MAC for fixed wing aircraft, 0.2 percent of the maximum allowable c. g. range for rotary wing aircraft.

d. Useful Load. The useful load is the empty weight subtracted from the maximum weight of the aircraft. This load consists of the pilot, crew (if applicable), maximum oil, fuel, passengers, and baggage unless otherwise noted.

e. Weight Check. The weight check consists of checking the sum of the weights of all items of useful load against the authorized useful load (maximum weight less empty weight) of the aircraft.

f. Datum. The datum is an imaginary vertical plane from which all horizontal measurements are taken for balance purposes with the aircraft in level flight attitude. The datum is indicated in most Aircraft Specifications or TCDS. On some of the older aircraft, when the datum is not indicated, any convenient datum may be selected. Once the datum is selected, all moment arms and the location of the permissible c.g. range must be taken with reference to it. Examples of typical locations of the datum are shown in figure 10-1.

g. Arm (or Moment Arm). The arm (or moment arm) is the horizontal distance in inches from the datum to the c.g. of an item. The algebraic sign is plus (+) if measured aft

of the datum, and minus (-) if measured forward of the datum. Examples of plus and minus arms are shown in figure 10-2.

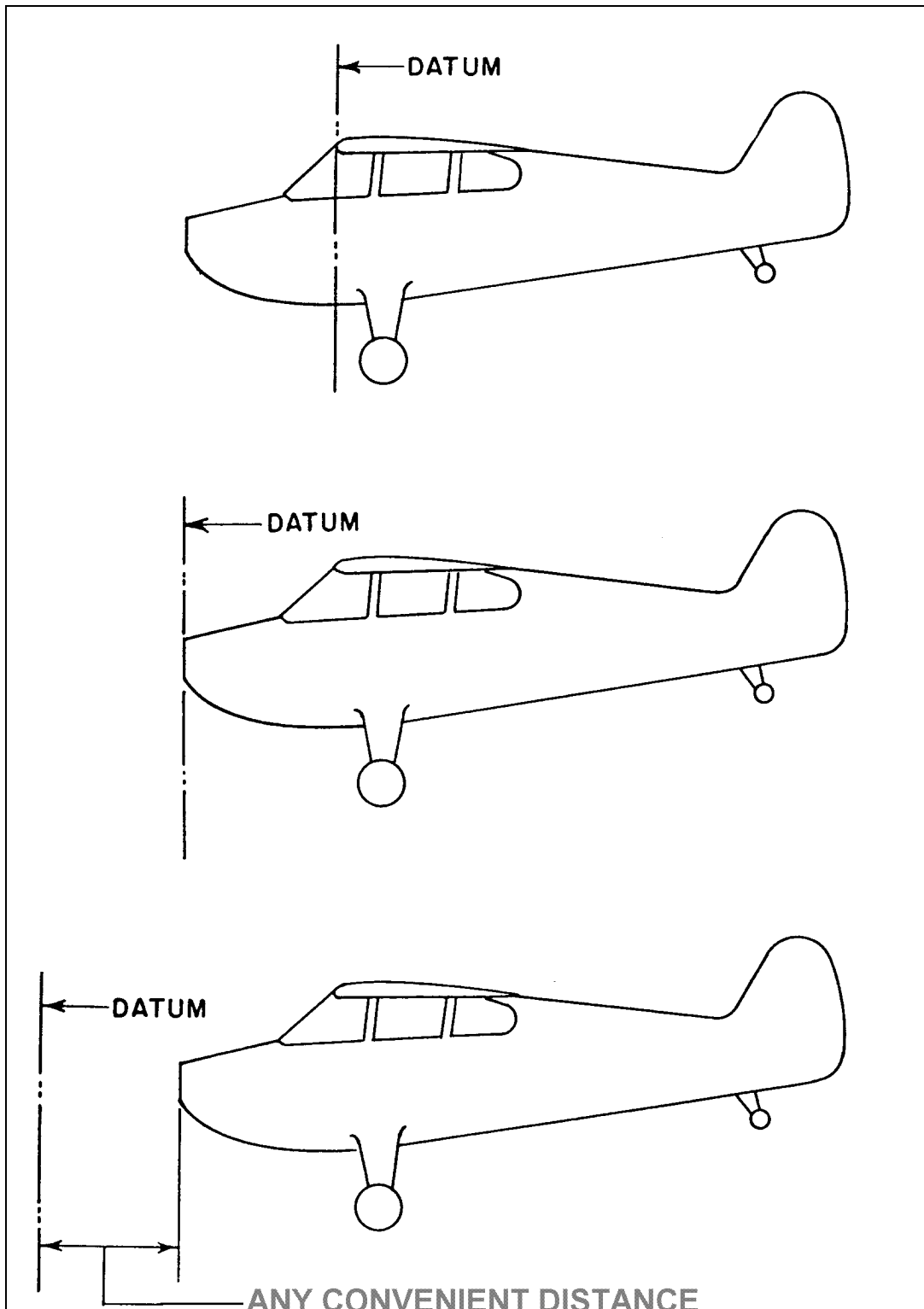


FIGURE 10-1. Typical datum locations.

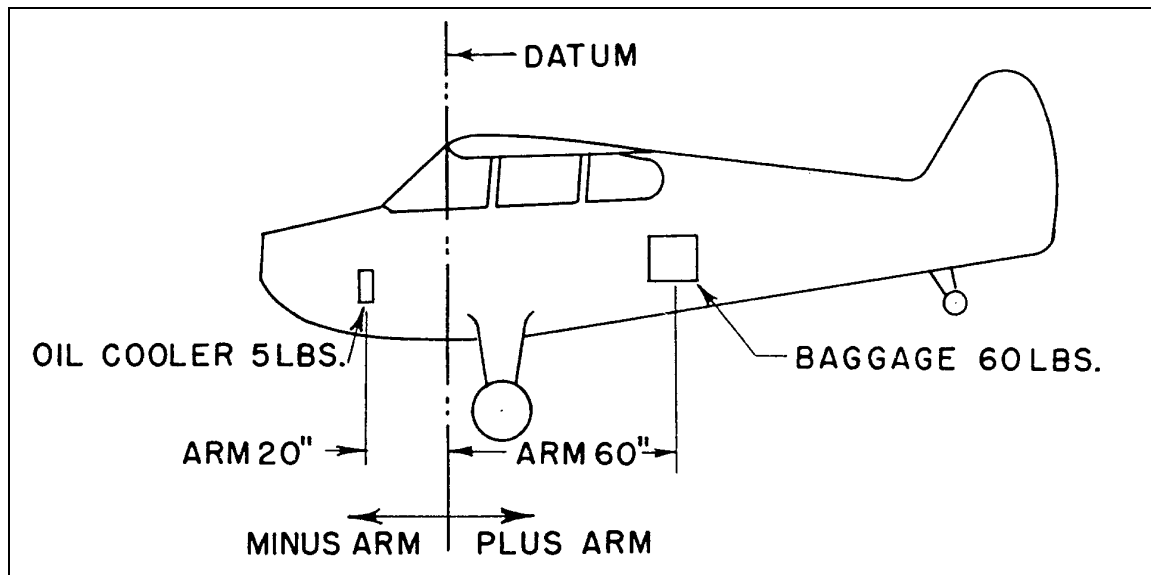


FIGURE 10-2. Illustration of arm (or moment arm).

h. Moment. The moment is the product of a weight multiplied by its arm. The moment of an item about the datum is obtained by multiplying the weight of the item by its horizontal distance from the datum. A typical moment calculation is given in figure 10-3.

i. Center of Gravity. The c.g. is a point about which the nose-heavy and tail-heavy moments are exactly equal in magnitude. If the aircraft is suspended from the c.g., it will not have a tendency to pitch in either direction (nose up or down). The weight of the aircraft (or any object) may be assumed to be concentrated at its c.g. (See figure 10-3.)

j. Empty Weight Center of Gravity. The empty weight c.g. is the c.g. of an aircraft in its empty weight condition, and is an essential part of the weight and balance record. Formulas for determining the c.g. for tail and nosewheel type aircraft are given in figure 10-4. Typical examples of computing the empty weight and empty weight c.g. for aircraft are shown in figures 10-5 and 10-6.

k. Empty Weight Center of Gravity Range. The empty weight c.g. range is determined so that the empty weight c.g. limits will not be exceeded under standard specifications loading arrangements. Calculations as outlined in paragraph 10-16 should be completed when it is possible to load an aircraft in a manner not covered in the Aircraft Specifications or TCDS (extra tanks, extra seats, etc.). The empty weight c.g. range, when applicable, is listed in the Aircraft Specifications or TCDS. Calculation of empty weight c.g. is shown in figures 10-5 and 10-6.

l. Operating Center of Gravity Range. The operating c.g. range is the distance between the forward and rearward c.g. limits indicated in the pertinent Aircraft Specifications or TCDS. These limits are determined for the most forward and most rearward loaded c.g. positions at which the aircraft meets the requirements of Title 14 of the Code of Federal Regulation (14 CFR). The limits are indicated in the specifications in either percent of mean aerodynamic chord (MAC) or inches from the

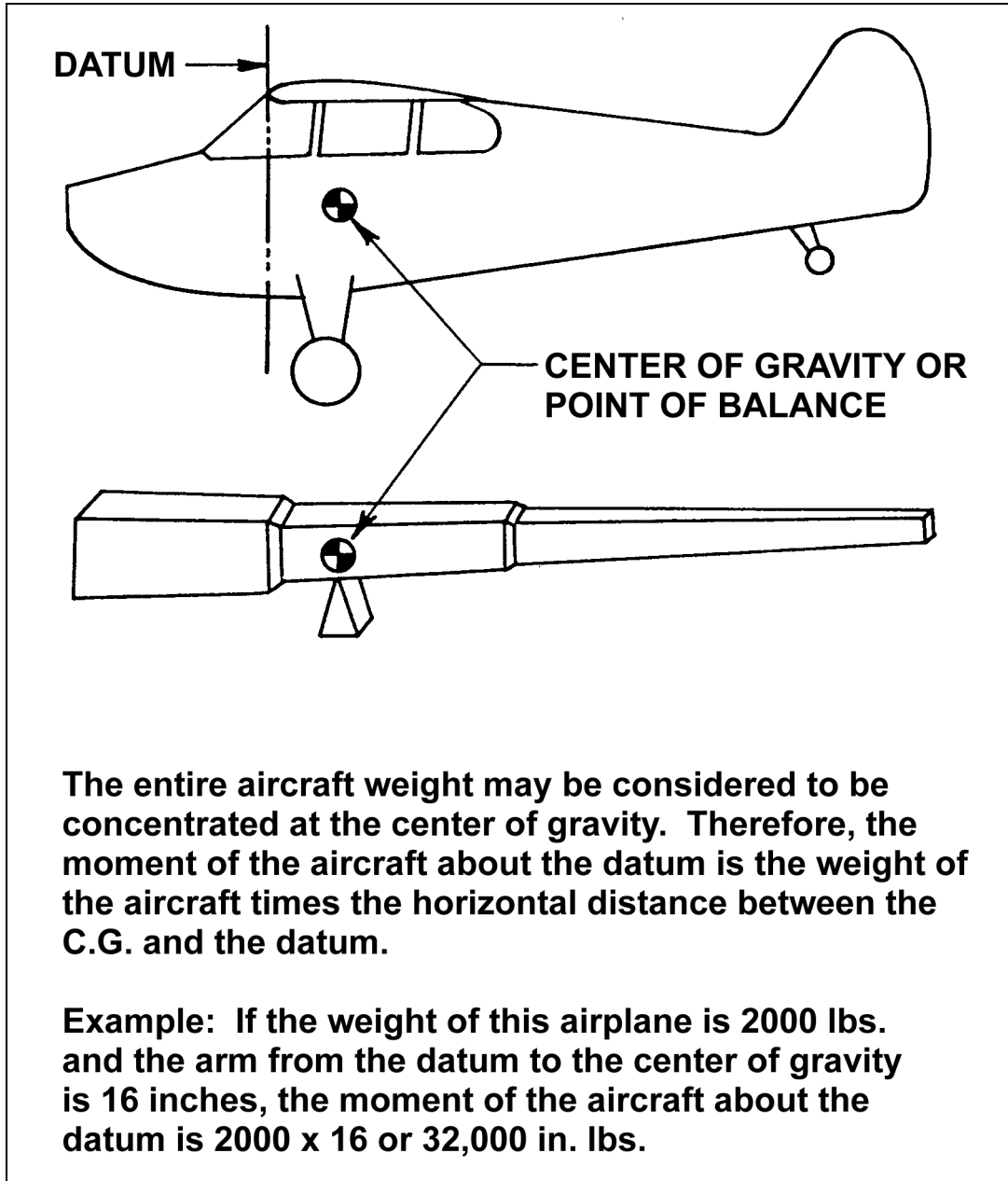


FIGURE 10-3. Example of moment computation.

datum. The c.g. of the loaded aircraft must be within these limits at all times as illustrated in figure 10-7.

m. Mean Aerodynamic Chord (MAC).

The MAC is established by the manufacturer who defines its leading edge and its trailing edge in terms of inches from the datum. The c.g. location and various limits are then expressed in percentages of the chord. The

location and dimensions of the MAC can be found in the Aircraft Specifications, the TCDS, the aircraft flight manual, or the aircraft weight and balance report.

n. Weighing Point. If the c.g. location is determined by weighing, it is necessary to obtain horizontal measurements between the points on the scale at which the aircraft's weight is concentrated. If weighed using

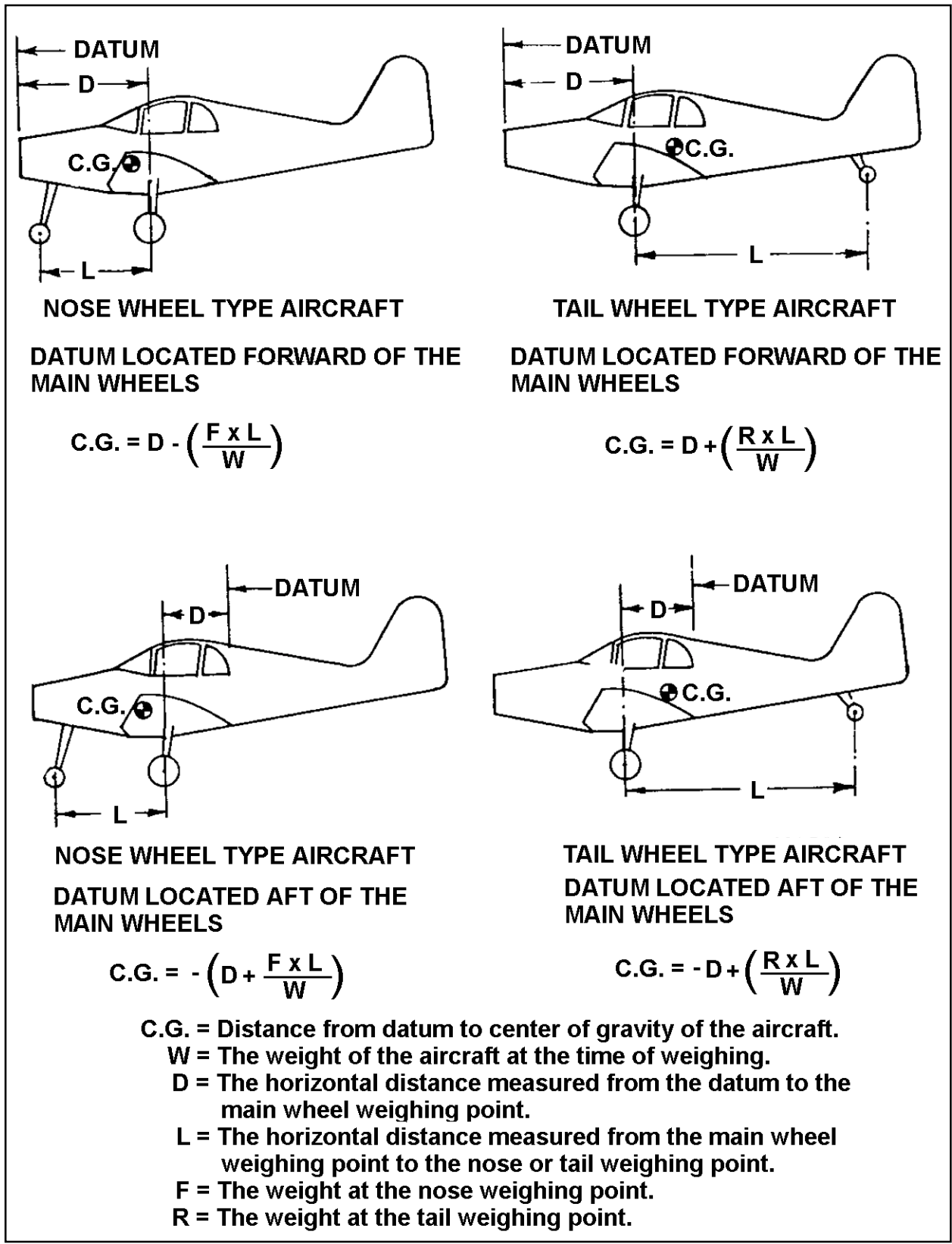
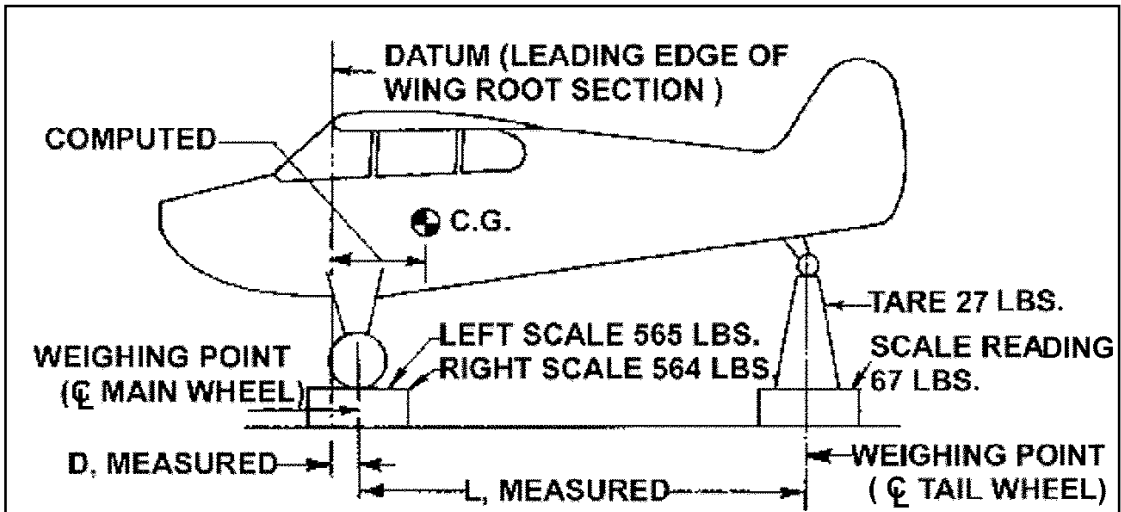


FIGURE 10-4. Empty weight center of gravity formulas.



TO FIND: EMPTY WEIGHT AND EMPTY WEIGHT CENTER OF GRAVITY

- Datum is the leading edge of the wing (from aircraft specification)
- (D) Actual measured horizontal distance from the main wheel weighing point (☉ main wheel) to the Datum ----- 3"
- (L) Actual measured horizontal distance from the rear wheel weighing point (☉ rear wheel) to the main wheel weighing point ----- 222"

SOLVING : EMPTY WEIGHT

Weighing Point	Scale Reading #	Tare #	Net Weight #
Right	564	0	564
Left	565	0	565
Rear	67	27	40
Empty Weight (W)			1169

SOLVING: EMPTY WEIGHT CENTER OF GRAVITY

Formula: $C.G. = D + \frac{R \times L}{W} = 3" + \frac{40 \times 222}{1169} = 3" + 7.6" = 10.6"$

Reference for formula, Figure 10-4.

This case is shown properly entered on a sample weight and balance report form, Figure 10-17

FIGURE 10-5. Empty weight and empty center of gravity - tail-wheel type aircraft.

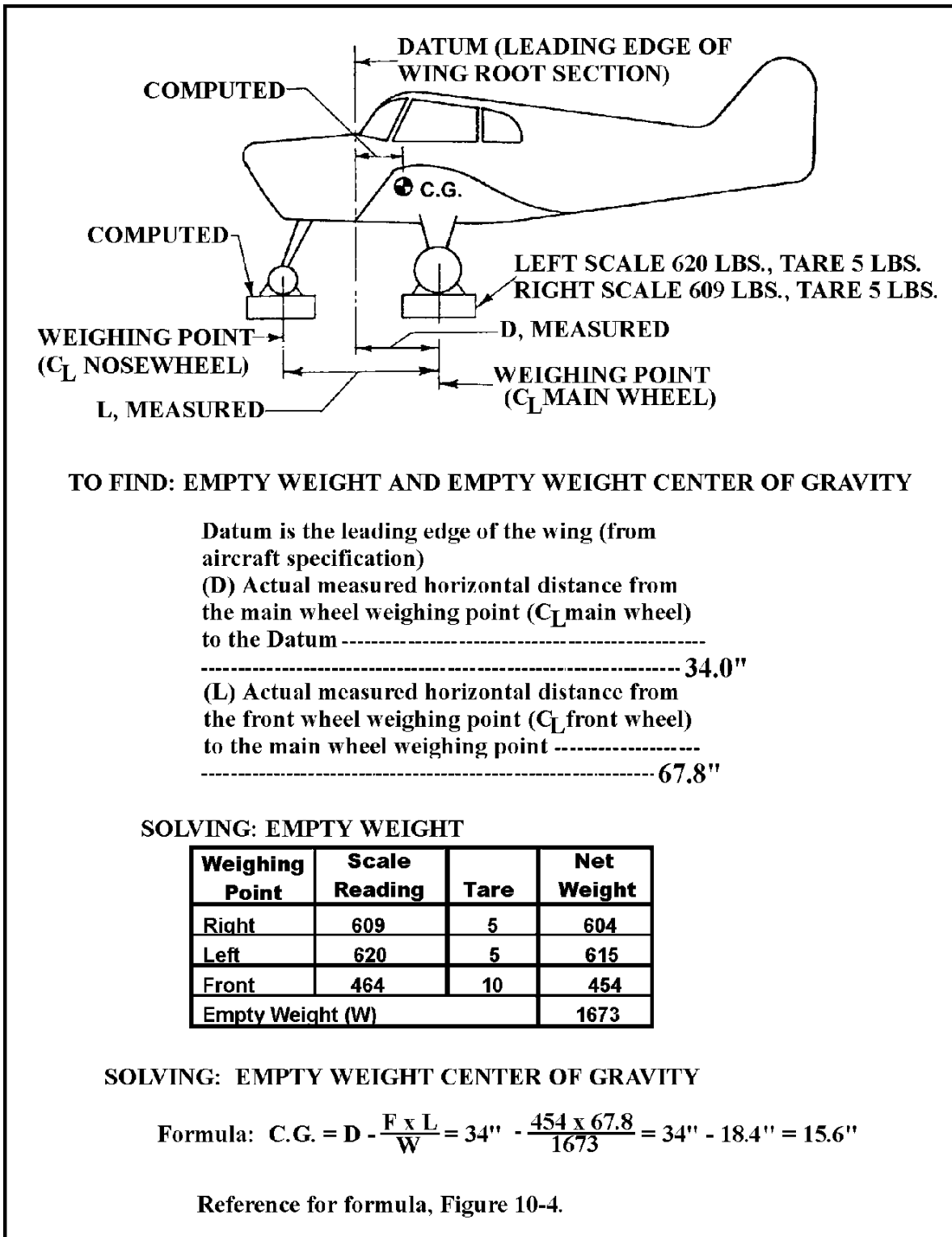


FIGURE 10-6. Empty weight and empty weight center of gravity - nosewheel-type aircraft.

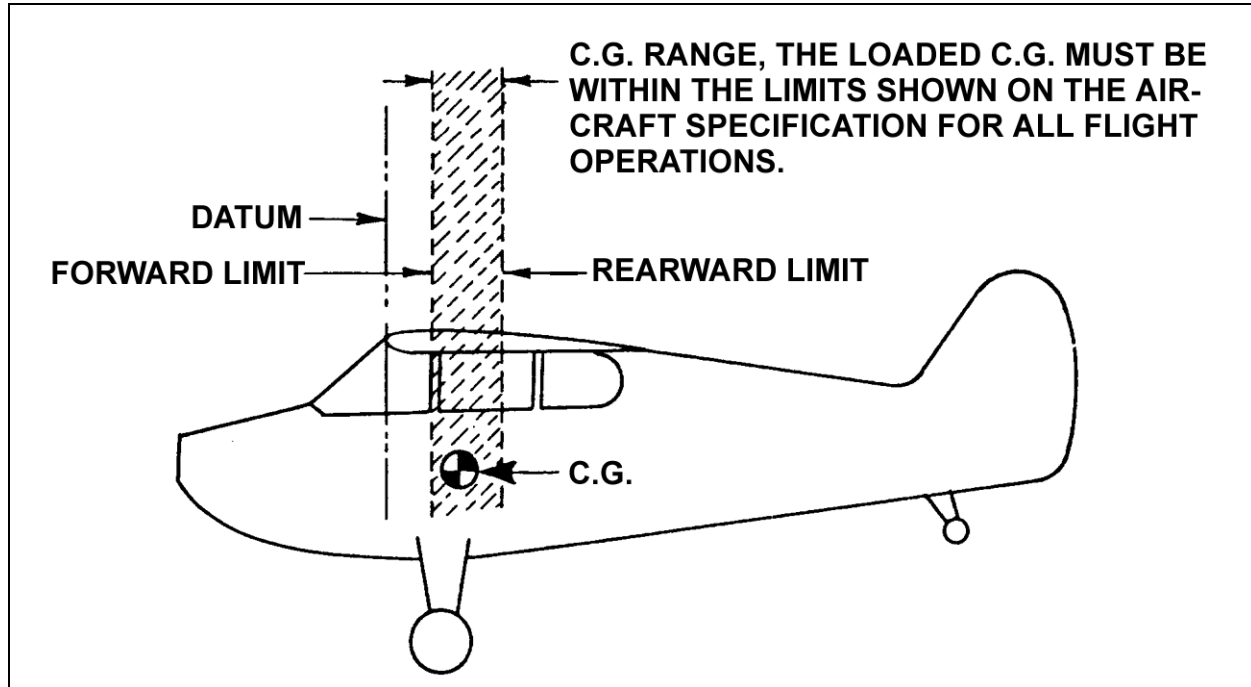


FIGURE 10-7. Operating center of gravity range.

scales under the landing gear tires, a vertical line passing through the centerline of the axle will locate the point on the scale at which the weight is concentrated. This point is called the “weighing point.” Other structural locations capable of supporting the aircraft, such as jack pads on the main spar, may also be used if the aircraft weight is resting on the jack pads. Indicate these points clearly in the weight and balance report when used instead of the landing gear. Typical locations of the weighing points are shown in figure 10-8.

o. Zero Fuel Weight. The maximum permissible weight of a loaded aircraft (passengers, crew, cargo, etc.) less its fuel is zero fuel weight. All weights in excess of maximum zero fuel weight must consist of usable fuel.

p. Minimum Fuel. The minimum fuel for balance purposes is 1/12 gallon per maximum-

except-take-off horsepower (METO). Minimum fuel is the maximum amount of fuel which can be used in weight and balance computations when low fuel might adversely affect the most critical balance conditions. To determine the weight of fuel in pounds divide the METO horsepower by two.

q. Full Oil. The full oil is the quantity of oil shown in the Aircraft Specifications or TCDS as oil capacity. Use full oil as the quantity of oil when making the loaded weight and balance computations.

r. Tare. The weight of chocks, blocks, stands, etc., used when weighing aircraft is called tare and is included in the scale readings. Tare is deducted from the scale reading at each respective weighing point when tare is involved, to obtain the actual aircraft weight.

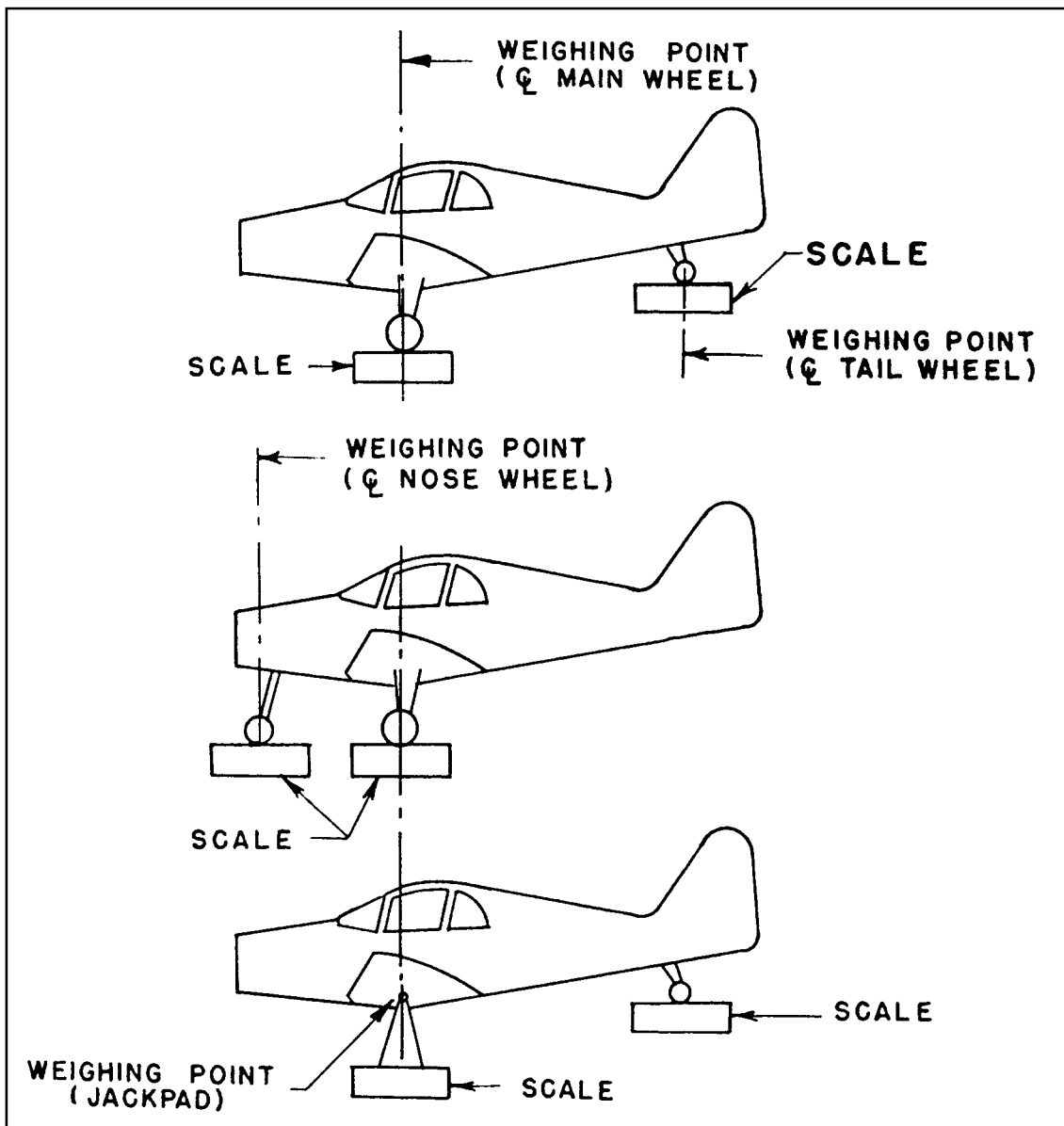


FIGURE 10-8. Weighing point centerline.

10-3.—10-13. [RESERVED.]

SECTION 2 WEIGHING PROCEDURES

10-14. GENERAL. Weighing procedures may vary with the aircraft and the type of weighing equipment employed. The weighing procedures contained in the manufacturer's maintenance manual should be followed for each particular aircraft.

10-15. PROCEDURES. Accepted procedures when weighing an aircraft are:

a. Remove excessive dirt, grease, moisture, etc., from the aircraft before weighing.

b. Weigh the aircraft inside a closed building to prevent error in scale reading due to wind.

c. Determine the empty weight c. g. by placing the aircraft in a level flight attitude.

d. Have all items of equipment that are included in the certificated empty weight report installed in the aircraft when weighing. These items of equipment are a part of the current weight and balance report.

e. The scales should have a current calibration before weighing begins. Zero and use the scales in accordance with the scale manufacturer's instructions. Platform scales and suitable support for the aircraft, if necessary, are usually placed under the wheels of a landplane, the keel of a seaplane float, or the skis of a skiplane. Other structural locations capable of supporting the aircraft, such as jack pads, may be used. Clearly indicate these points and the alternate equipment used in the weight and balance report.

f. Drain the fuel system until the quantity indicator reads *zero* or until the tanks are empty with the aircraft in level flight attitude, unless otherwise noted in the TCDS or Aircraft Specifications. The amount of fuel remaining in the tank, lines, and engine is termed residual fuel

and is to be included in the empty weight. In special cases, the aircraft may be weighed with full fuel in tanks provided a definite means of determining the exact weight of the fuel is available.

g. The oil system should be filled to the quantity noted in the TCDS or Aircraft Specifications.

NOTE: On Civil Aeronautics Regulations (CAR-3) Certified Aircraft, the weight of the oil was subtracted mathematically to get the empty weight. In 14 CFR, part 23 aircraft, the weight of the oil is included in the empty weight.

When weighed with full oil, actual empty weight equals the actual recorded weight less the weight of the oil in the oil tank (oil weight = oil capacity in gallons x 7.5 pounds). Indicate on all weight and balance reports whether weights include full oil or oil drained. (See figure 10-9.)

h. Do not set brakes while taking scale reading.

i. Note any tare reading when the aircraft is removed from the scales.

10-15a. REPAIRS AND ALTERATIONS are the major sources of weight changes, and it is the responsibility of the aircraft mechanic making any repairs or alteration to know the weight and location of these changes, and to compute the new CG and record the new empty (EW) weight and EWCG data in the aircraft flight manual.

10-15b. ANNUAL OR 100-HOUR INSPECTION. After conducting an annual or 100-hour inspection, the aircraft mechanic

must ensure the weight and balance data in the aircraft records is current and accurate.

10-16. WEIGHT AND BALANCE COMPUTATIONS. It is often necessary after completing an extensive alteration to establish by computation that the authorized weight and c.g. limits as shown in the TCDS and Aircraft Specifications are not exceeded. Paragraph b(2) explains the significance of algebraic signs used in balance computations.

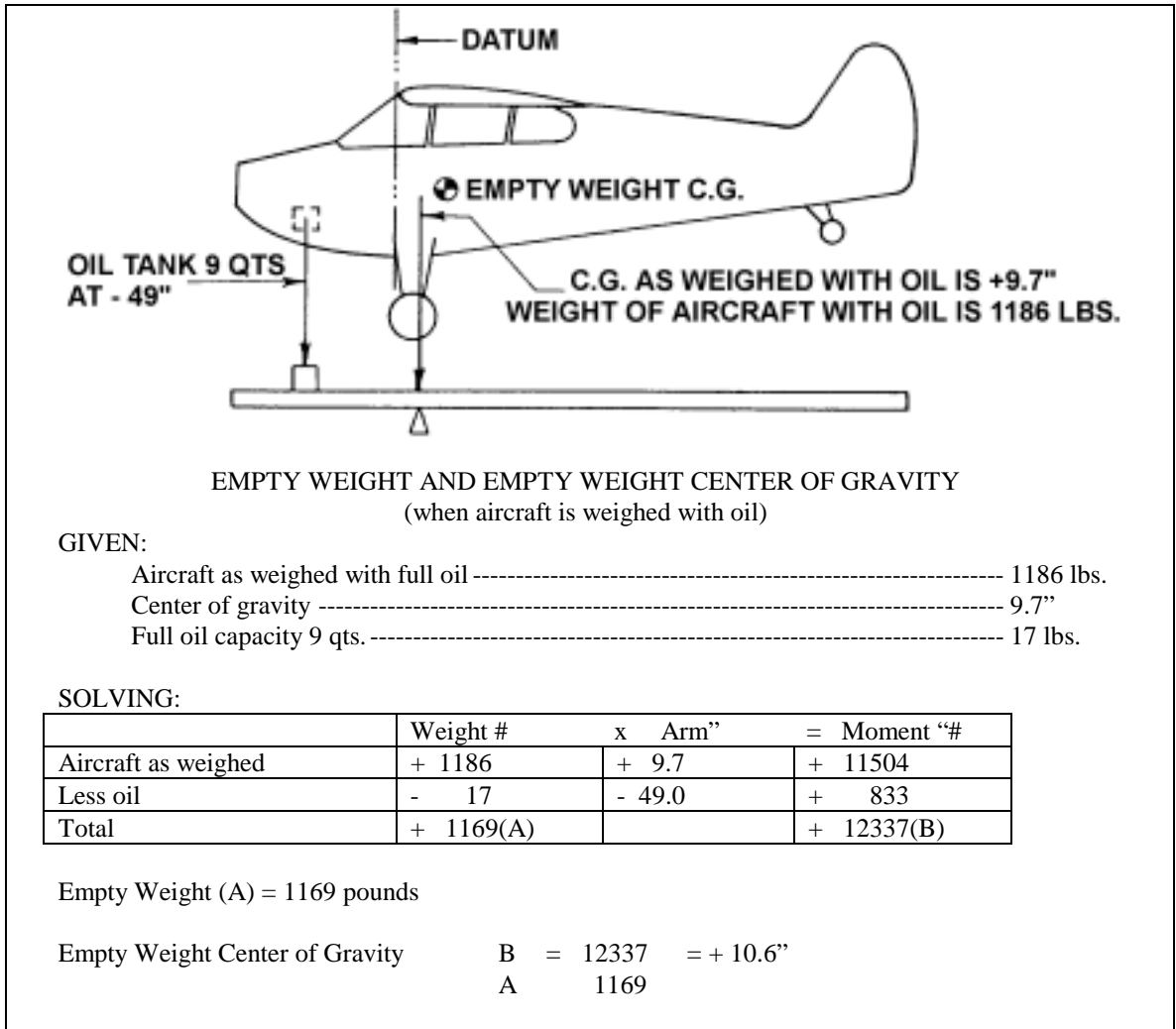


FIGURE 10-9. Empty weight and empty weight center of gravity when aircraft is weighed with oil.

a. The TCDS or Aircraft Specifications contain the following information relating to the subject:

- (1) Center of gravity range.
- (2) Empty weight c.g. range when applicable.
- (3) Leveling means.
- (4) Datum.
- (5) Maximum weights.
- (6) Number of seats and arm.

- (7) Maximum baggage and arm.
- (8) Fuel capacity and arm.
- (9) Oil capacity and arm.
- (10) Equipment items and arm.

b. The TCDS do not list the basic required equipment prescribed by the applicable airworthiness regulations for certification. Refer to the manufacturer's equipment list for such information.

(1) Unit weight for weight and balance purposes.

Gasoline ----- 6 pounds per U.S. gal.
Turbine Fuel ----- 6.7 pounds per U.S. gal.
Lubricating oil ---- 7.5 pounds per U.S. gal.
Crew and
passengers ----- 170 pounds per person.

(2) It is important to retain the proper algebraic sign (+ or -) through all balance computations. For the sake of uniformity in these computations, visualize the aircraft with the nose to the left. In this position any arm to the left (forward) of the datum is “minus” and any arm to the right (rearward) of the datum is “plus.” Any item of weight added to the aircraft either side of the datum is plus weight, any weight item removed is a minus weight. When multiplying weights by arms, the answer is plus if the signs are the same, and minus if the signs are different. The following combinations are possible:

Items added forward of the datum-

(+) weight x (-) arm = (-) moment.

Items added to the rear of the datum-

(+) weight x (+) arm = (+) moment.

Items removed forward of the datum-

(-) weight x (-) arm = (+) moment.

Items removed rear of the datum-

(-) weight x (+) arm = (-) moment.

(3) The total weight of the airplane is equal to the weight of the empty aircraft plus the weight of the items added minus the weight of the items removed.

(4) The total moment of the aircraft is the algebraic sum of the empty weight moment of the aircraft and all of the individual moments of the items added and/or removed.

10-17. WEIGHT AND BALANCE EXTREME CONDITIONS. The weight and balance extreme conditions represent the maximum forward and rearward c.g. position for the aircraft. Include the weight and balance data information showing that the c.g. of the aircraft (usually in the fully loaded condition) falls between the extreme conditions.

a. Forward Weight and Balance Check.

When a forward weight and balance check is made, establish that neither the maximum weight nor the forward c.g. limit listed in the TCDS and Aircraft Specifications are exceeded. To make this check, the following information is needed:

(1) The weights, arms, and moment of the empty aircraft.

(2) The maximum weights, arms, and moments of the items of useful load that are located ahead of the forward c.g. limit.

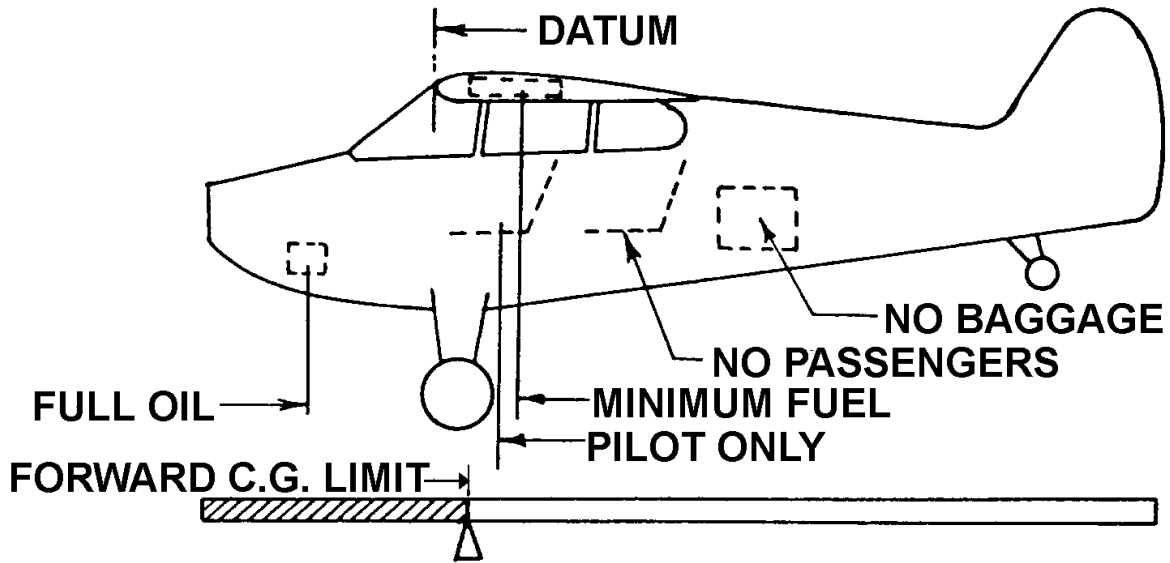
(3) The minimum weights, arms, and moments of the items of useful load that are located aft of the forward c.g. limit. A typical example of the computation necessary to make this check, using this data, is shown in figure 10-10.

b. Rearward Weight and Balance Check.

When a rearward weight and balance check is made, establish that neither the maximum weight nor the rearward c.g. limit listed in the TCDS and Aircraft Specifications are exceeded. To make this check, the following information is needed:

(1) The weight, arms, and moments of the empty aircraft.

(2) The maximum weights, arms, and moments of the items of useful load that are located aft of the rearward c.g. limit.



TO CHECK: MOST FORWARD WEIGHT AND BALANCE EXTREME.

GIVEN:

- Actual empty weight of the aircraft-----1169#
- Empty weight center of gravity-----+ 10.6"
- *Maximum weight-----2100#
- *Forward C.G.. limit -----+ 8.5"
- *Oil capacity, 9 qts. -----17# at -49"
- *Pilot in farthest forward seat equipped with controls (unless otherwise placarded) -----170# at +16"
- *Since the fuel tank is located to the rear of the forward C.G. limit, minimum fuel should be included.
- METO HP = $\frac{165}{12} = 13.75$ gal. x 6#-----83# at +22"

* Information should be obtained from the aircraft specification.

Note: Any items or passengers must be used if they are located ahead of the forward C.G. limit.
Full fuel must be used if the tank is located ahead of the forward C.G. limit.

CHECK OF FORWARD WEIGHT AND BALANCE EXTREME

	Weight (#) x Arm (") = Moment ("#)		
Aircraft empty	+ 1169	+ 10.6	+ 12391
Oil	+ 17	- 49	- 833
Pilot	+ 170	+ 16	+ 2720
Fuel	+ 83	+ 22	+ 1826
Total	+ 1439 (TW)		+ 16104 (TM)

Divide the TM (total moment) by the TW (total weight) to obtain the forward weight and balance extreme.

$$\frac{TM}{TW} = \frac{16104}{1439} = + 11.2"$$

Since the forward C.G. limit and the maximum weight are not exceeded, the forward weight and balance extreme condition is satisfactory.

FIGURE 10-10. Example of check of most forward weight and balance extreme.

(3) The minimum weights, arms, and moments of the items of useful load that are located ahead of the rearward c.g. limit. A typical example of the computation necessary to make this check, using this data, is shown in figure 10-11.

10-18. LOADING CONDITIONS

AND/OR PLACARDS. If the following items have not been covered in the weight and balance extreme condition checks and are not covered by suitable placards in the aircraft, additional computations are necessary. These computations should indicate the permissible distribution of fuel, passengers, and baggage that may be carried in the aircraft at any one time without exceeding either the maximum weight or c.g. range. The conditions to check are:

a. With full fuel, determine the number of passengers and baggage permissible.

b. With maximum passengers, determine the fuel and baggage permissible.

c. With maximum baggage, determine the fuel and the number and location of passengers.

d. Examples of the computations for the above items are given in figures 10-12, 10-13, and 10-14 respectively. The above cases are mainly applicable to the lighter type personal aircraft. In the case of the larger type transport aircraft, a variety of loading conditions is possible and it is necessary to have a loading schedule.

10-19. EQUIPMENT LIST. A list of the equipment included in the certificated empty weight may be found in either the approved aircraft flight manual or the weight and balance report. Enter into the weight and balance

report all required, optional, and special equipment installed in the aircraft at time of weighing and/or subsequent equipment changes.

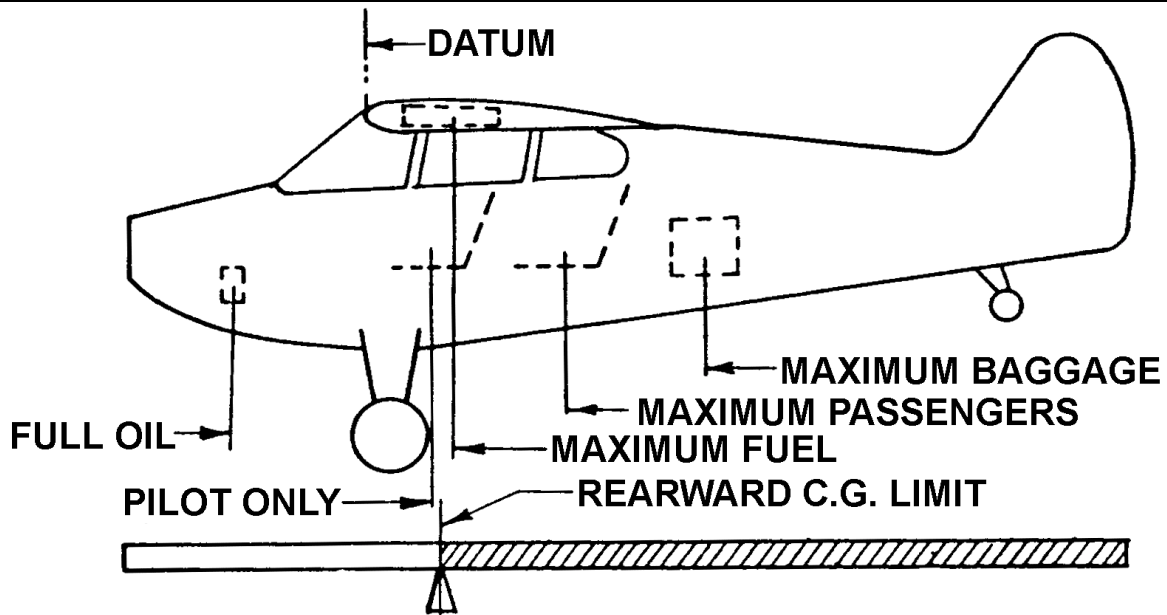
a. Required equipment items are listed in the pertinent Aircraft Specifications.

b. Optional equipment items are listed in the pertinent Aircraft Specifications and may be installed in the aircraft at the option of the owner.

c. Special equipment is any item not corresponding exactly to the descriptive information in the Aircraft Specifications. This includes items such as emergency locator transmitter (ELT), tail or logo lights, instruments, ashtrays, radios, navigation lights, and carpets.

d. Required and optional equipment may be shown on the equipment list with reference to the pertinent item number listed in the applicable specifications only when they are identical to that number item with reference to description, weight, and arm given in the specifications. Show all special equipment items with reference to the item by name, make, model, weight, and arm. When the arm for such an item is not available, determine by actual measurement.

10-20. EQUIPMENT CHANGE. The person making an equipment change is obligated to make an entry on the equipment list indicating items added, removed, or relocated with the date accomplished, and identify himself by name and certificate number in the aircraft records. Examples of items so affected are the installation of extra fuel tanks, seats, and baggage compartments. Figure 10-15 illustrates the effect on balance when equipment items are added within the acceptable c.g. limits and fore and aft of the established c.g. limits.



TO CHECK: MOST REARWARD WEIGHT AND BALANCE EXTREME.

GIVEN:

- Actual empty weight of the aircraft----- 1169#
- Empty weight center of gravity----- 10.6"
- *Maximum weight----- 2100#
- *Rearward C.G.. limit----- 21.9"
- *Oil capacity, 9 qts. ----- 17# at -49"
- *Baggage, placarded do not exceed 100 lbs ----- 100# at +75.5"
- *Two passengers in rear seat, 170# x 2 ----- 340# at +48"
- *Pilot in most rearward seat equipped with controls (unless otherwise placarded)----- 170# at +16"
- *Since the fuel tank is located aft of the rearward C.G. limit full fuel must be used----- 240# at +22"

* Information should be obtained from the aircraft specification.

Note: If fuel tanks are located ahead of the rearward C.G. limit minimum fuel should be used.

CHECK OF REARWARD WEIGHT AND BALANCE EXTREME

	Weight (#) x Arm (") = Moment ("#)		
Aircraft empty	+ 1169	+ 10.6	+ 12391
Oil	+ 17	- 49	- 833
Pilot (1)	+ 170	+ 16	+ 2720
Passenger (2)	+ 340	+ 48	+ 16320
Fuel (40 gals.)	+ 240	+ 22	+ 5280
Baggage	+ 100	+ 75.5	+ 7550
Total	+ 2036 (TW)		+ 43428 (TM)

Divide the TM (total moment) by the TW (total weight) to obtain the rearward weight and balance extreme.

$$\frac{TM}{TW} = \frac{43428}{2036} = + 21.3"$$

Since the rearward C.G. limit and the maximum weight are not exceeded, the rearward weight and balance extreme condition is satisfactory.

FIGURE 10-11. Example of check of most rearward weight and balance extreme.

EXAMPLE OF THE DETERMINATION OF THE NUMBER OF PASSENGERS AND BAGGAGE PERMISSIBLE WITH FULL FUEL

GIVEN:

Actual empty weight of the aircraft ----- 1169#
 Empty weight center of gravity ----- 10.6”
 Maximum weight----- 2100#
 Datum is leading edge of the wing
 Forward center of gravity limit ----- 8.5”
 Rearward center of gravity limit ----- 21.9”
 Oil capacity, 9 qts.; show full capacity ----- 17# at -49”
 Baggage, maximum----- 100# at +75.5”
 Two passengers in rear seat, 170# x 2 ----- 340# at +48”
 Pilot in most rearward seat equipped with
 controls (unless otherwise placarded) ----- 170# at +16”
 Full fuel, 40 gals. x 6#----- 240# at +22”

	Weight (#)	x Arm (“)	= Moment (“#)
Aircraft empty	+ 1169	+ 10.6	+ 12391
Oil	+ 17	- 49	- 833
Full Fuel	+ 240	+ 22	+ 5280
Passengers 2 rear	+ 340*	+ 48	+16320
Pilot	+ 170	+ 16	+ 2720
Baggage	+ 100	+ 75.5	+ 7550
Total	+ 2036 (TW)		+ 43428 (TM)

Divide the TM (total moment) by the TW (total weight) to obtain the loaded center of gravity.

$$\frac{TM}{TW} = \frac{43428}{2036} = + 21.3”$$

The above computations show that with full fuel, 100 pounds of baggage and two passengers in the rear seat may be carried in this aircraft without exceeding either the maximum weight or the approved C. G. range.

This condition may be entered in the loading schedule as follows:

GALLONS OF FUEL	NUMBER OF PASSENGERS	POUNDS OF BAGGAGE
Full	2 Rear	100

* Only two passengers are listed to prevent the maximum weight of 2100 lbs. from being exceeded.

FIGURE 10-12. Loading conditions: determination of the number of passengers and baggage permissible with full fuel.

EXAMPLE OF THE DETERMINATION OF THE POUNDS OF FUEL AND BAGGAGE PERMISSIBLE WITH MAXIMUM PASSENGERS

	Weight (#)	x Arm (")	= Moment ("#)
Aircraft empty	+ 1169	+ 10.6	+ 12391
Oil	+ 17	- 49	- 833
Pilot	+ 170	+ 16	+ 2720
Passenger (1) front	+ 170	+ 16	+ 2720
Passenger (2) rear	+ 340	+ 48	+16320
Fuel (39 gals.)	+ 234	+ 22	+ 5148
Baggage	----	----	----
Total	+ 2100		+ 38466

Divide the TM (total moment) by the TW (total weight) to obtain the loaded center of gravity.

$$\frac{TM}{TW} = \frac{38466}{2100} = + 18.6''$$

The above computations show that with the maximum number of passengers, 39 gallons of fuel and zero pounds of baggage may be carried in this aircraft without exceeding either the maximum weight or the approved C. G. range.

This condition may be entered in the loading schedule as follows:

GALLONS OF FUEL	NUMBER OF PASSENGERS	POUNDS OF BAGGAGE
*Full	*2 Rear	* 100
39	1(F) 2(R)	None

- * Conditions as entered from Figure 10-12
- (F) Front seat
- (R) Rear seat

FIGURE 10-13. Loading conditions: determination of the fuel and baggage permissible with maximum passengers.

EXAMPLE OF THE DETERMINATION OF THE FUEL AND THE NUMBER AND LOCATION OF PASSENGERS PERMISSIBLE WITH MAXIMUM BAGGAGE

	Weight (#) x Arm (") = Moment (""#)		
Aircraft empty	+ 1169	+ 10.6	+ 12391
Oil	+ 17	- 49	- 833
Pilot	+ 170	+ 16	+ 2720
Passenger (1) rear	+ 170	+ 48	+ 8160
Passenger (1) front	+ 170	+ 16	+ 2720
Fuel (40 gals.)	+ 240	+ 22	+ 5280
Baggage	+ 100	+ 75.5	+ 7550
Total	+ 2036		+ 37988

Divide the TM (total moment) by the TW (total weight) to obtain the loaded center of gravity.

$$\frac{TM}{TW} = \frac{37988}{20366} = + 18.7$$

The above computations show that with maximum baggage, full fuel and 2 passengers (1 in the front seat and 1 in the rear seat) may be carried in this aircraft without exceeding either the maximum weight or the approved C. G. range.

This condition may be entered in the loading schedule as follows:

GALLONS OF FUEL	NUMBER OF PASSENGERS	POUNDS OF BAGGAGE
*Full	*2 Rear	* 100
** 39	*1(F) 2(R)	**None
Full	1(F) 1(R)	Full

- * Conditions as entered from Figure 10-12
- ** Conditions as entered from Figure 10-13
- (F) Front seat
- (R) Rear seat

FIGURE 10-14. Loading conditions: determination of the fuel and the number and location of passengers permissible with maximum baggage.

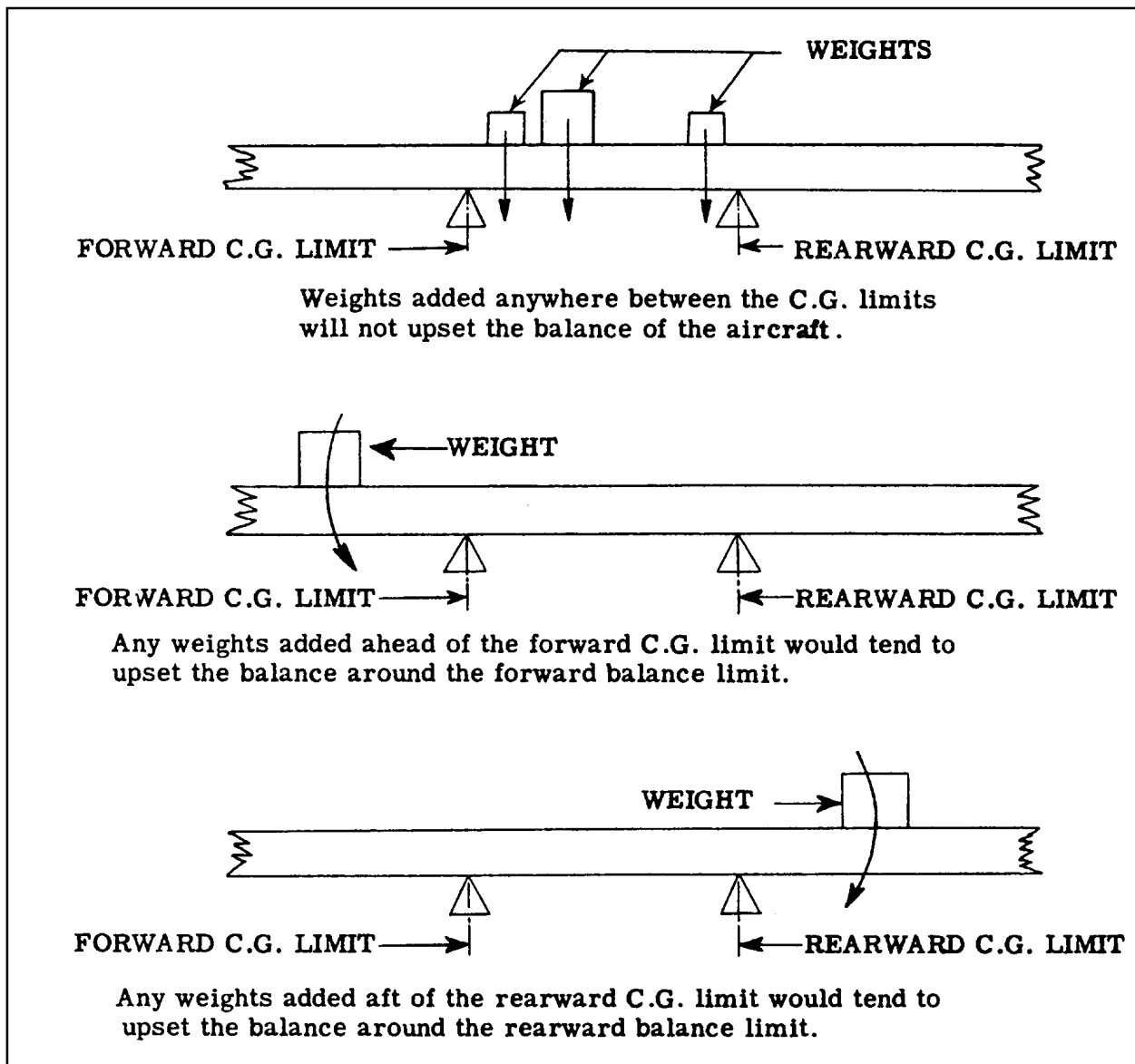


FIGURE 10-15. Effects of the addition of equipment items on balance.

Moment computations for typical equipment changes are given in figure 10-16 and are also included in the sample weight and balance sheet in figure 10-18.

10-21. SAMPLE WEIGHT AND BALANCE REPORT. Suggested methods of tabulating the various data and computations for determining the c.g., both in the empty weight condition and the fully loaded condition, are given in figures 10-17 and 10-18, respectively, and represent a suggested means of recording this information. The data presented in figure 10-17 have previously been computed

in figures 10-10 and 10-11 for the extreme load conditions and figure 10-16 for equipment change, and represents suggested means of recording this information.

10-22. INSTALLATION OF BALLAST. Ballast is sometimes permanently installed for c.g. balance purposes as a result of installation or removal of equipment items and is not used to correct a nose-up or nose-down tendency of an aircraft. It is usually located as far aft or as far forward as possible in order to bring the

c.g. position within acceptable limits with a minimum of weight increase. Permanent ballast is often lead plate wrapped around and bolted to the fuselage primary structure (e.i., tail-post, longerons, or bulkhead members). Permanent ballast invariably constitutes a concentrated load; therefore, the strength of the local structure and the attachment of the ballast thereto should be investigated for the design loading conditions pertinent to that particular aircraft. Placard permanent ballast with *Permanent ballast - do not remove*. It is not

desirable to install permanent ballast by pouring melted lead into the tail-post or longerons due to difficulties that may be encountered in subsequent welding repair operations. It should be noted that the installation of permanent ballast results in an increase of aircraft empty weight. See figure 10-19 for ballast computation. The local strength of the compartment in which the ballast is carried and the effect of the ballast on aircraft weight and balance should be investigated when disposable ballast is carried.

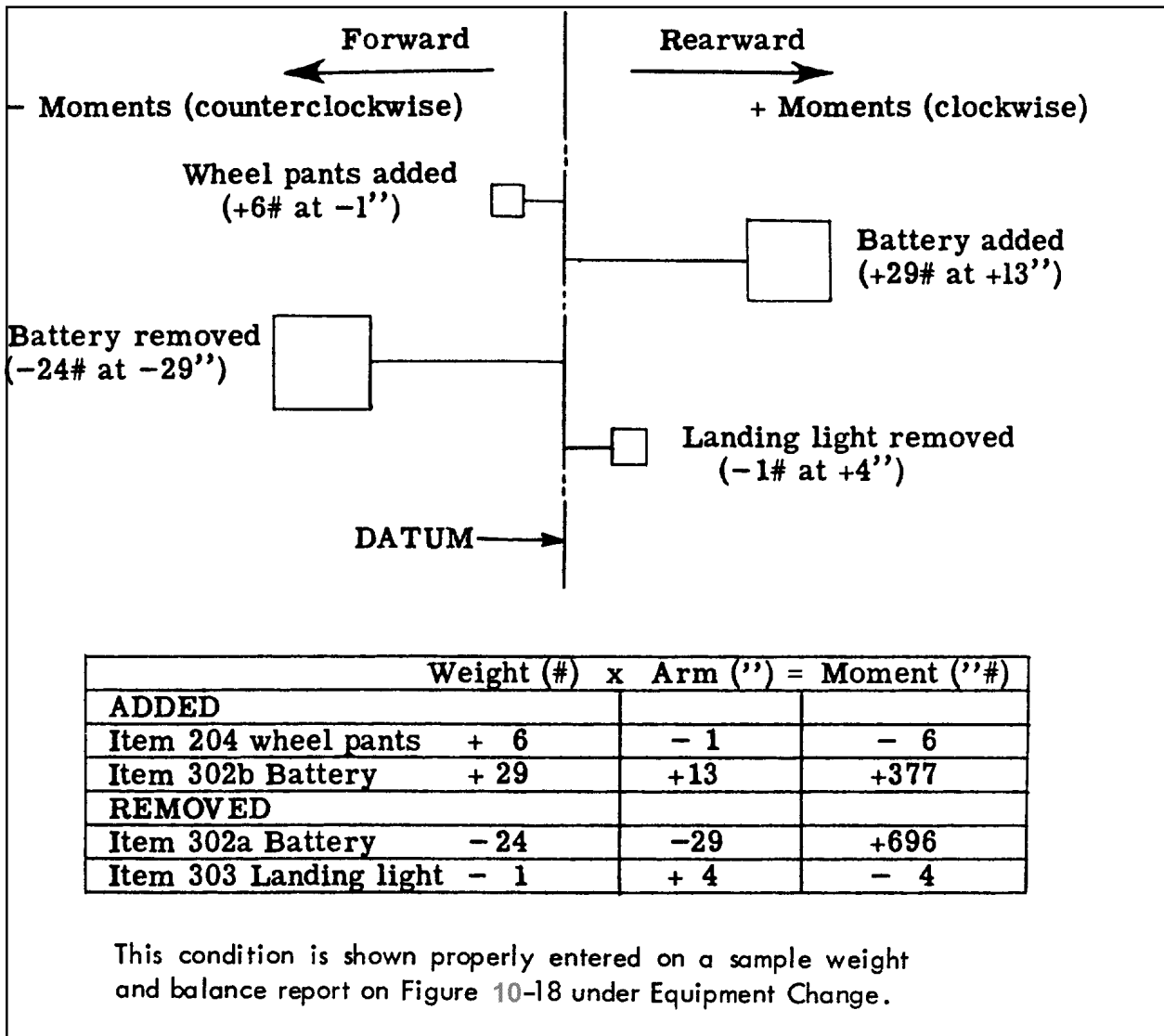


FIGURE 10-16. Example of moment and weight changes resulting from equipment changes.

MAKE MA-700 MODEL A SERIAL # 0000 REGISTRATION # N1234.
 DATUM IS leading edge of wing.

COMPUTE AS FOLLOWS IF AIRCRAFT WEIGHED

1. Leveling means: level top longeron between front and rear seats.
2. Main wheel weighing point is located ("FORWARD) (+ 3 " AFT) of datum.
3. Actual measured distance from the main weight point centerline to the tail (or nose) point centerline 222 "
4. Oil over and above "ZERO" tank reading = (a. Gals.) (b. Lbs.) (c. In.)

ACTUAL EMPTY WEIGHT

Weight Point	Scale Reading	- Tare	=	Net Weight
5. Right	564	0		564
6. Left	565	0		565
7. Tail	67	27		40
8. Nose	----	----		----
9. Total Net Weight	X	X		1169

CENTER OF GRAVITY AS WEIGHED

10. C.G. relative to main wheel weighing point:
 - (a) Tail wheel airc. $\frac{(\text{Item 3, 222}) \times (\text{Item 7, 40})}{(\text{Item 9, 1169})} = + \underline{7.6} = \text{C.G.}$
 - (b) Nose wheel airc. $\frac{(\text{Item 3 } \text{----}) \times (\text{Item 8 } \text{----})}{(\text{Item 9 } \text{----})} = \underline{\hspace{2cm}} = \text{C.G.}$
11. C.G. relative to datum:
 - (a) Tail wheel airc. $\frac{(\text{Item 10a, } + 7.6)}{\hspace{2cm}} \text{ added to } \frac{(\text{Item 2, } + 3)}{\hspace{2cm}} = \underline{+10.6"} = \text{C.G.}$
 - (b) Nose wheel airc. $\frac{(\text{Item 10b, } \hspace{2cm})}{\hspace{2cm}} \text{ added to } \frac{(\text{Item 2, } \hspace{2cm})}{\hspace{2cm}} = \underline{\hspace{2cm}} = \text{C.G.}$

COMPUTE IF AIRCRAFT WEIGHED WITH OIL (Item 4)

	Weight	x	Arm	=	Moment
Aircraft	(9)		(11)		
Less Oil	(4b)		(4c)		
Empty Totals	(a)		X		(b)

(b) ----- = (c) ----- " = Empty weight C.G.

12. (a) _____

REPAIR AGENCY _____ DATE _____
 Name Number

FIGURE 10-17. Sample weight and balance report to determine empty weight center of gravity.

EQUIPMENT LIST						
*Required or Optional Item Numbers as Shown in Aircraft Specification						
1	2	101	102	103	104	105
106	201	202	203	301	302(a)	303
401(a)	402	----	----	----	----	----
Special Equipment						
Item	Make	Model	Weight	Arm		
3 Flares 1-1/2 Min.	XYZ	03	25#	105"		
Enter above those items included in the empty weight.						
WEIGHT AND BALANCE EXTREME CONDITIONS						
Approved fwd limit 8.5" Approved max. weight 2100# Approved aft limit 21.9"						
Item	FORWARD CHECK			REARWARD CHECK		
	Weight	X Arm	= Moment	Weight	X Arm	= Moment
Airo. Empty	+ 1169 (9 or 12a)	+ 10.6 (11 or 12c)	+ 12391	+ 1169 (9 or 12a)	+ 10.6 (11 or 12c)	+ 12391
Oil	+ 17	- 49	- 833	+ 17	- 49	- 833
Pilot	+ 170	+ 16	+ 2720	+ 170	+ 16	+ 2720
Fuel	+ 83	+ 22	+ 1826	+ 240	+ 22	+ 5280
Passenger (s)				+ 340	+ 48	+ 16320
Baggage				+ 100	+ 75.5	+ 7550
TOTAL	+ 1439 = TW	X	+ 16104 = TM	+ 2036 = TW	X	+43428=TM
$\frac{TM}{TW} = \frac{16104}{1439} = +11.2" =$ Most Forward C.G. location			$\frac{TM}{TW} = \frac{43428}{2036} = +21.3" =$ Most Rearward C.G. location			

LOADING SCHEDULE		
Gallons of Fuel	Number of Passengers	Pounds of Baggage
40	2(R)	100
The above includes pilot and capacity oil.		

EQUIPMENT CHANGE			
Computing New C.G.			
Item, Make, and Model*	Weight	X Arm	Moment
Airc. Empty	+ 1169 (9 or 12a)	+ 10.6 (11 or 12c)	+ 12391
204 added	+ 6	- 1	- 6
302(b) added	+ 29	+ 13	+ 377
302(a) removed	- 24	+ 29	+ 696
303 removed	- 1	+ 4	- 4
NET TOTALS	- 1179 = NW	X	+ 13454 = NM
$NM = \frac{13454}{1179} = +11.4" =$ New C.G. NW 1179			

*ITEM NUMBERS WHEN LISTED IN PERTINENT AIRCRAFT SPECIFICATION MAY BE USED IN LIEU OF "ITEM, MAKE, AND MODEL".

PREPARED BY _____ DATE _____

FIGURE 10-18. Sample weight and balance report including an equipment change for aircraft fully loaded.

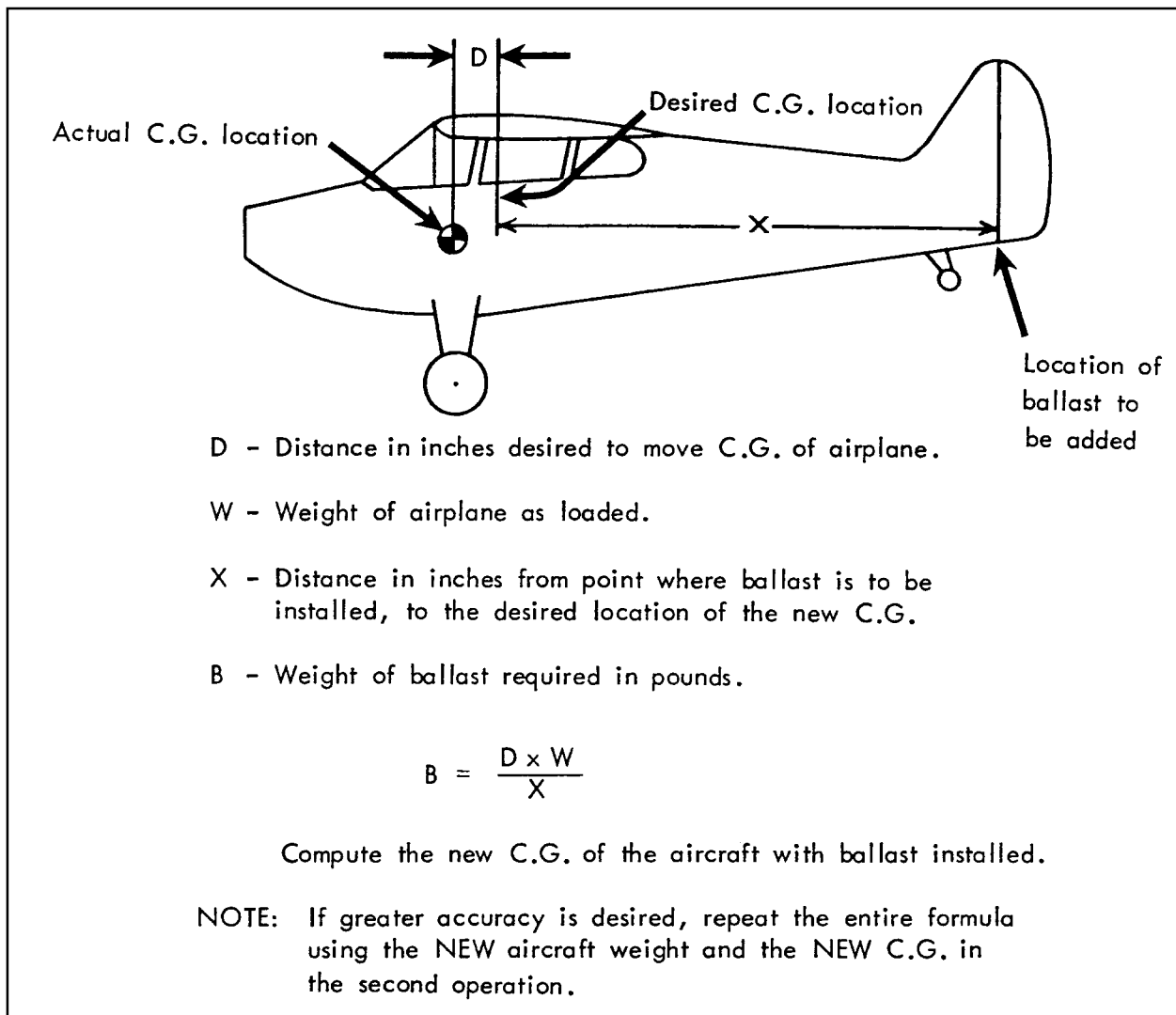


FIGURE 10-19. Permanent ballast computation formula.

10-23. LOADING SCHEDULE. The loading schedule should be kept with the aircraft and form a part of the aircraft flight manual. It includes instructions on the proper load distribution such as filling of fuel and oil tanks, passenger seating, restrictions of passenger movement, and distribution of cargo.

a. Other means of determining safe loading conditions such as the use of a graphical index and load adjuster are

acceptable and may be used in lieu of the information in paragraph 10-18.

b. Compute a separate loading condition when the aircraft is to be loaded in other than the specified conditions shown in the loading schedule.

10-24.—10-34. [RESERVED.]