AEROSPACE RECOMMENDED PRACTICE

ARP5908

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Landing Gear Servicing

RATIONALE

ARP5908 has been reaffirmed to comply with the SAE five-year review policy.

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1. SCOPE

The present document addresses gas and hydraulic fluid servicing required on commercial and military aircraft landing gears, for both single and dual chamber shock struts.

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

ARP1311 Aircraft Landing Gear

AS4059 Aerospace Fluid Power - Cleanliness Classification for Hydraulic Fluids

2.1.2 U.S. Government Publications

Available from the Document Automation and Production Service (DAPS), Building 4/D, 700 Robbins Avenue, Philadelphia, PA 19111-5094, Tel: 215-697-6257, http://assist.daps.dla.mil/quicksearch/.

MIL-L-8552 Landing Gear, Aircraft Shock Absorber (Air-Oil Type)

A-A-59503 Technical Nitrogen – Commercial Item Description

2.2 Definitions

ADDITIVE: Additives mixed with the shock strut hydraulic fluid to improve lubricity.

FLUID DRAIN PORT: The port used for draining the hydraulic fluid from the shock strut, usually placed at the bottom of the shock strut. Fluid drain ports are not always required, especially for smaller shock struts.

FLUID FILLING PORT: The port used for refilling the shock strut with oil, placed at the top of the shock strut. The fluid filling port is sometimes combined with the gas servicing port.

GAS CHARGING VALVE: A valve installed on the shock strut to allow the gas servicing to the prescribed pressure.

GAS SERVICING PORT: The port used for gas servicing, typically placed at the top of the shock strut, where the gas charging valve is installed.

GAS SERVICING: A procedure to adjust the amount of gas only, assuming the shock strut fluid volume is correct.

HIGH PRESSURE CHAMBER: The gas chamber in a dual chamber shock strut filled with the higher extend pressure. The high pressure chamber is often referred to as the secondary chamber.

HYDRAULIC FLUID SERVICING: A procedure to adjust the volume of shock strut hydraulic fluid to the correct level. This procedure must be followed by a gas servicing procedure to provide a functioning strut.

INGASSING: A phenomenon that occurs in mixed gas-fluid shock absorbers when pressure is applied to the shock strut and the gas dissolves into the hydraulic fluid. Over the initial period gas will be absorbed by the fluid. (Sometimes this is seen as loss of gas pressure however no leaks can be found.) This is not to be confused with gas entrainment as bubbles.

LEAKAGE, HYDRAULIC:

a. Continuous hydraulic fluid accumulation forming drops.

b. Streaks of hydraulic fluid forming from wetted area and beginning to runoff.

LOW PRESSURE CHAMBER: The gas chamber in a dual chamber shock strut filled with the lower extend pressure. The low pressure chamber is often referred to as the primary chamber.

MIXED GAS-FLUID: A shock strut without mechanical means to separate the gas and the hydraulic fluid.

ONE-POINT CHECK: A check to ensure the shock strut is properly serviced, performed by verifying one point on the static air spring curve and assuming the shock strut contains the appropriate amount of hydraulic fluid.

OUTGASSING: A phenomenon that occurs in mixed gas-fluid shock absorbers when the pressure is reduced and the gas comes out of solution.

SEEPAGE: Normal loss of hydraulic fluid through piston wetting during functioning, in very small quantity, insufficient to qualify as a hydraulic leakage.

SEPARATED GAS-FLUID: A shock strut with mechanical means to separate the gas and the hydraulic fluid (such as a floating piston).

SERVICING: A procedure to ensure the correct amount of hydraulic fluid and gas under pressure is present in a shock strut.

STATIC AIR SPRING CURVE: The curve relating the pressure in the shock strut to the stroke, in static conditions, at standard temperature.

TWO-POINTS CHECK (SERVICING VERIFICATION): A check to verify the shock strut is properly serviced (with both gas and hydraulic fluid), performed by verifying two points on the static air spring curve (usually at the static stroke and at some other extended position). The two-point check confirms that both the fluid level and the gas charge are correct.

X-DIMENSION: A reference dimension representative for the exposed dynamic piston.

3. WARNINGS, CAUTIONS AND ADVISORIES

- Safety precautions: Deflating a shock strut can be a dangerous operation unless servicing personnel are thoroughly familiar with high pressure air valves. Always deflate slowly; proper deflating techniques should always be referenced

- Proper equipment: It is important to avoid the use of improvised servicing equipment. The use of improvised servicing equipment under an aircraft could cause injuries to personnel and damage to the aircraft. It can also result in improper servicing. The use of properly calibrated equipment having the proper range is essential when servicing a strut.

- Hydraulic fluid: Only hydraulic fluid as specified on the servicing placard should be used. Mixing of hydraulic fluid could have a detrimental effect on static and dynamic seals, as well as on shock strut performance.

- Dry nitrogen: Gas servicing usually means nitrogen (99.5% pure) servicing. The use of compressed air or oxygen instead of nitrogen could be a cause of corrosion inside the shock strut as well as auto-ignition inside the gas chamber (dieseling).

- Aircraft on ground servicing: caution should be used during pressure release to prevent injuries to personnel or aircraft damages from unbalancing the aircraft due to sudden shock strut movements or unintended fuel migration, or due to insufficient clearances for aircraft movement.

- Aircraft on jacks servicing: If a landing gear jack is used for shock strut stroking, appropriate measures must be provided to prevent lifting the aircraft from the aircraft jacks.

4. IMPORTANCE OF LANDING GEAR SERVICING

Proper servicing of the landing gear represents a necessary condition for proper functioning and adequate performance of the landing gears.

Mis-serviced landing gears, depending on the severity of the condition can generate:

- discomfort for the passengers and the crew
- possible instability and difficulty to control the aircraft on ground
- possibility to exceed the design loads envelope with effects on the structural integrity of the landing gear and of the aircraft
- malfunction of the weight-on-wheel sensing, affecting flight, brake or steering control systems
- insufficient piston extension load or overload of the gland nut
- shock strut bottoming
- insufficient fluid within the shock strut can result in loss of re-coil damping, and can cause damage to shock strut
- insufficient fluid within the shock strut can result in loss of landing damping, and can result in bottoming on landing
- abnormal aircraft load distribution on landing gear, therefore possible overload condition on tire(s), resulting in elevated operating temperatures leading to possible tire failure.

5. LANDING GEAR SERVICING OPERATIONS CLASSIFICATION – BACKGROUND INFORMATION AND INDUSTRY PRACTICES

5.1 Servicing Verification

5.1.1 One-point Check

5.1.1.1 Description and Rationale

The one-point check is a summary verification of servicing that assumes the shock strut hydraulic fluid level is correct.

The main purpose of this check is to provide an expeditious method of determining whether the shock absorber is properly serviced before the flight.

1. The one point check is performed by measuring the stroke (X-Dimension) and the pressure of the shock strut, verifying if it is within acceptable tolerances of the static air spring curve of the servicing instructions.

2. An alternate but non-preferred one-point check (when authorized by the design authority based on a thorough analysis of possible mis-servicing effects), is using the aircraft weight (or an estimated on-wheel weight) instead of the pressure.

   This method is not preferred due to the friction effects. For a given weight on the wheel, a wide range of strokes can be found even for a properly serviced strut. Also, the range of strokes achievable for a mis-serviced gear can include values in the acceptable range.

   The main sources of friction are the friction in the shock absorber bearings due to the reactions in bearings and the friction in the dynamic seals and scrapers. Of special concern is the breakout friction.

   Another reason this method is not preferred is the possible errors induced when the weight on a gear is obtained by estimation from the aircraft weight. This may be overcome by using a scale under each gear but it may not be practical in all the cases.

   This method based on weight is not banned completely because some specific designs may be less affected by friction as the fully articulated gear designs or a cantilever gear with the vertical load from ground applied in its axis.

5.1.1.2 Possible Methods for One Point Check

The X-dimension is typically measured using a tape, a ruler or a caliper. The pressure can be measured by:

1. Use of ground support tooling consisting in a special line for servicing check with a very small volume (a capillary line is preferred) for attaching the pressure gauge directly to the gas charging valve (see Figure 1). This is the method used typically.

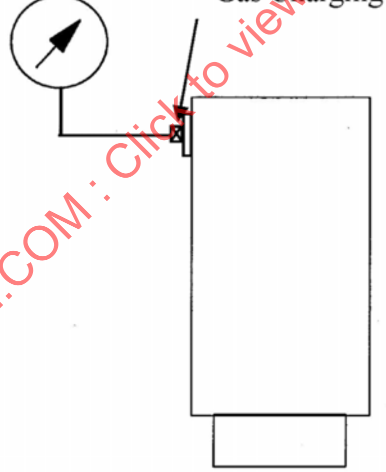


FIGURE 1 - PRESSURE GAGE INSTALLED DIRECTLY ON THE GAS CHARGING VALVE

+ Quick and practical

- Only usable for large gears. For landing gears with a small air volume, the volume of air lost over several servicing checks makes up an important volume percentage-wise therefore the gear would become mis-serviced.

2. Same as above except a nitrogen source is used to pressurize the line volume to the expected pressure, according to the servicing curve. The volume is then isolated from the nitrogen source by closing the valve (see Figure 2) before opening the gas charging valve to read the shock strut pressure.

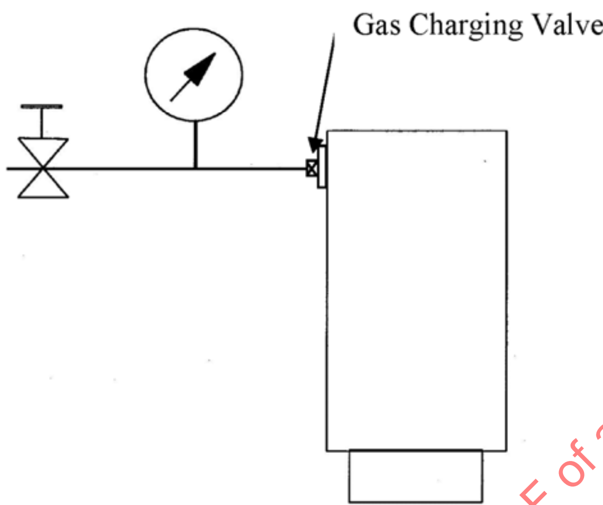


FIGURE 2 - LINE PRESSURIZED TO PREVENT PRESSURE LOSS

+ This method fully corrects the deficiency of the method shown at paragraph 1. above - i.e. there is no pressure loss during servicing verification.

+ Having the nitrogen supply already connected makes it easy to gas service the strut if needed.

- Having the nitrogen supply already connected may lead to abuse of gas servicing. A very clear distinction must be made between servicing check (verification) and gas servicing (adding nitrogen). When gas servicing is performed, this should be properly noted in the aircraft maintenance log.

- Requires nitrogen cart.

3. Use of a pressure gage permanently installed on the shock strut.

+ Very practical.

- The accuracy of existing devices is typically not sufficient. This may be increased by limiting the range of pressures to be read to the pressures corresponding to the range of aircraft weights from min to max.

- A calibration schedule should be observed. This is an additional maintenance effort.

- In most cases this requires an additional hole in a structural component (the cylinder). This may be overcome by a special design that combines the functionality of the gas charging valve with the pressure gage function or by addition of a fitting similar to AN6285.

- Creates an additional leak path.

4. Use of a pressure transducer permanently installed on the shock strut.

+ Can be installed in a non-structural component (as the metering pin base)

+ Appropriate accuracy

+ Can incorporate a hydraulic fluid temperature probe for correction of temperature effects

+ Can be either read by the maintenance crew or fed into an aircraft computer where with a stroke reading can yield the servicing status.

- May require special processing of signals or special processor

- May require additional instrumentation

- Increased use of on board systems may reduce reliability and increase maintenance (requires development of appropriate routines to avoid maintenance penalty)

5.1.2 Two-point Check

5.1.2.1 Description and Rationale

This is an accurate servicing inspection where both the hydraulic fluid level and the amount of gas are verified to be correct.

This procedure is performed by measuring the stroke (X-Dimension) and the pressure of the shock strut for two points and verifying if they are on the static air spring curve within acceptable tolerances.

NOTE:

After stroking to extend or to compress a shock absorber, some time (a few minutes) should be allowed before measuring the pressure in order to allow gas temperature to return to the ambient temperature.

Typically the two points are:

- One in the fully extended position
- One with the aircraft weight on wheels, close to the static stroke

Under specific circumstances established by the landing gear manufacturer the two points can be:

- Lightly loaded aircraft
- Heavily loaded aircraft

5.1.2.2 Possible Methods for Two Point Check

1. With a pressure gage and a measuring tape measure the pressure and the X-dimension at static and fully extended stroke conditions. This is the method typically used. A two-point servicing check can be scheduled together with other maintenance activities that require aircraft jacking. In this situation, one-point servicing check will be performed before jacking the aircraft and the second one-point check will be performed on the fully extended gear after jacking.

    + Minimal temperature effects.

2. With a shock strut equipped with a pressure transducer permanently installed on the shock strut and being read by an aircraft computer. For the first point the maintenance crew on ground can input the stroke and the aircraft computer will provide the pressure reading. For the second point, the evaluation will be made by the aircraft computer at a given delay after take-off based on the pressure reading and the shock strut stroke (known: fully extended). The pressure reading should be compensated for temperature and outgassing effects as applicable.

    + The second point reading is available every flight

    - Requires special processing of signals

    - Increased use of on board systems may reduce reliability. If not properly used can increase the maintenance work for performing the servicing (nuisance faults).

3. Same as above but with the addition of a transducer for gear stroke. This system will be able to perform servicing check with the aircraft resting on ground or during flight but not in dynamic conditions.

    + Performs Two Point Check every flight.

    + Reduces maintenance work for servicing verification

    - Adds complexity and upfront cost to the landing gear and aircraft

    - Requires special processing of signals.

    - Increased use of on board systems may reduce reliability. If not properly used can increase the maintenance work for performing the servicing (nuisance faults).

5.2 Gas Servicing

This is the procedure employed to correct a situation where the stroke of the shock strut in static position is not that required (usually shorter than required).

NOTE:

If the X-dimension is shorter than required there can be two possible causes: insufficient gas charge and insufficient hydraulic fluid volume. The indiscriminate and abusive use of gas servicing can significantly change the oil/gas ratio, resulting in malfunctioning shock strut.

The gas servicing is performed by introducing or releasing an amount of gas in/from the shock strut in order to bring the point defined by the pressure and the stroke within the acceptable tolerances. If the underlying assumption that the appropriate amount of hydraulic fluid exists in the shock strut is correct, this procedure results in a correctly serviced gear.

5.2.1 Possible Gas Servicing Methods

5.2.1.1 Gas Servicing without Pressure Release

This is the method typically used for adjusting the content of nitrogen in the shock strut.

This can be done with a set-up as described in 5.1.1.2., item 2.

+ This would ensure that the gas dissolved in solution remains in solution.

+ Prevents hydraulic fluid loss through outgas foaming.

5.2.1.2 Gas Servicing with Pressure Release

If the pressure release method is used, the effect of gas dissolution should be considered for the shock absorbers of mixed gas-fluid design: Under the effect of the high pressure of the nitrogen charge, some of the nitrogen will dissolve into the hydraulic fluid. The nitrogen volume will then decrease without increasing the oil volume, resulting in a lower pressure. The percentage of solubility is not predictable, but is usually a simultaneous function of the temperature, pressure and sometimes hydraulic fluid age (new oil absorbing more nitrogen than aged one). Ideally it is best to allow conditions to stabilize before adjusting the nitrogen pressure. This is not always possible due to time constraints. Based on a specific shock strut experience, it is sometimes sufficient to service the strut on the high side within the tolerance range. As an alternative, the gas servicing may be done twice, the second time only after allowing enough time for gas dissolution in fluid (some industry practice uses two to three flights). If hydraulic fluid was lost through foaming during pressure releasing, hydraulic fluid servicing should be done before gas servicing.

Using this method is not desirable but sometimes unavoidable (as after a hydraulic fluid servicing or for new shock struts).

- May require re-doing a gas servicing and therefore creating confusion due to the similarity with a gas leakage.

- May lead to oil loss through outgas foaming.

NOTE:

The shock absorbers of separated gas-fluid design are not sensitive to problems related to gas dissolution.

5.3 Hydraulic Fluid Servicing

Hydraulic fluid servicing is usually performed to replenish the fluid lost during normal usage due to small leakage and/or seepage.

Unless otherwise noted on the servicing placard, the required volume of hydraulic fluid is the volume of fluid that can be contained in a fully compressed shock strut in the working position, with the air charging valve removed and the internal floating pistons bottomed in their depressurized state (for floating piston equipped shock struts). There are exceptions to this general rule as some existing designs of shock struts establish the hydraulic fluid volume at a certain stroke.

Caution should be exercised to ensure no gas is entrapped in the shock strut internal components. This is achieved by stroking the shock strut. As often it is impractical to stroke the shock strut through the full stroke, stroking through about 30% of the stroke was found to be effective in removing the entrapped gas.

A clean clear plastic hose should be installed at return and extended down the strut into a clean container. As fluid is expelled, trapped air bubbles will be visually observed. Continue to service until a bubble free (pure fluid) observation is made indicating all air has been expelled with gear at the fully collapsed position (or at the required stroke).

5.3.1 Possible Hydraulic Fluid Servicing Methods

The hydraulic fluid servicing methods can be classified as follows:

Type I - Using a fluid filling port. The shock strut should be equipped with such a port (see Figure 3).

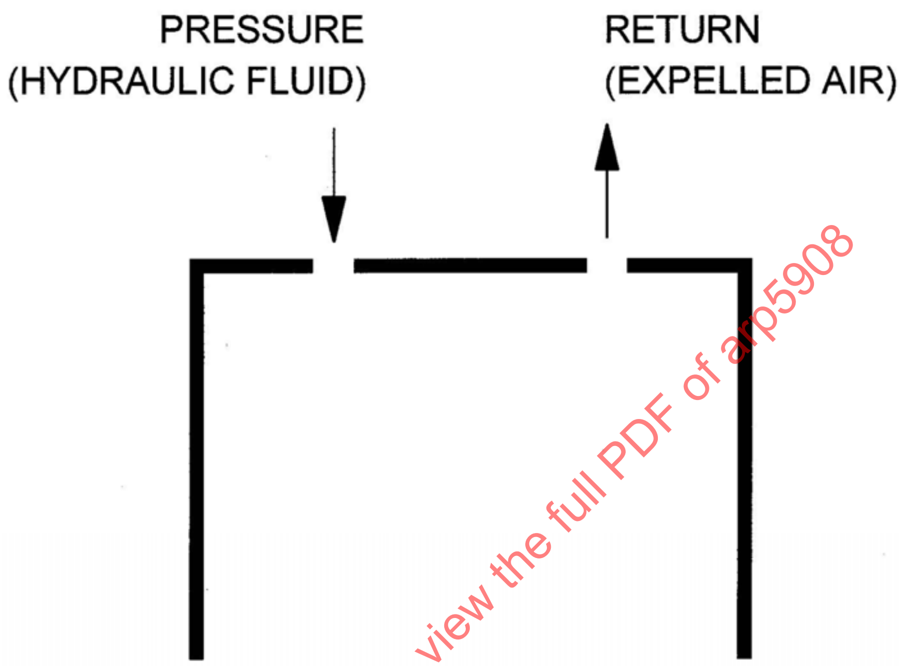


FIGURE 3 - TYPE I HYDRAULIC FLUID SERVICING

Type II - Using a check valve installed in the drain port (see Figure 4).

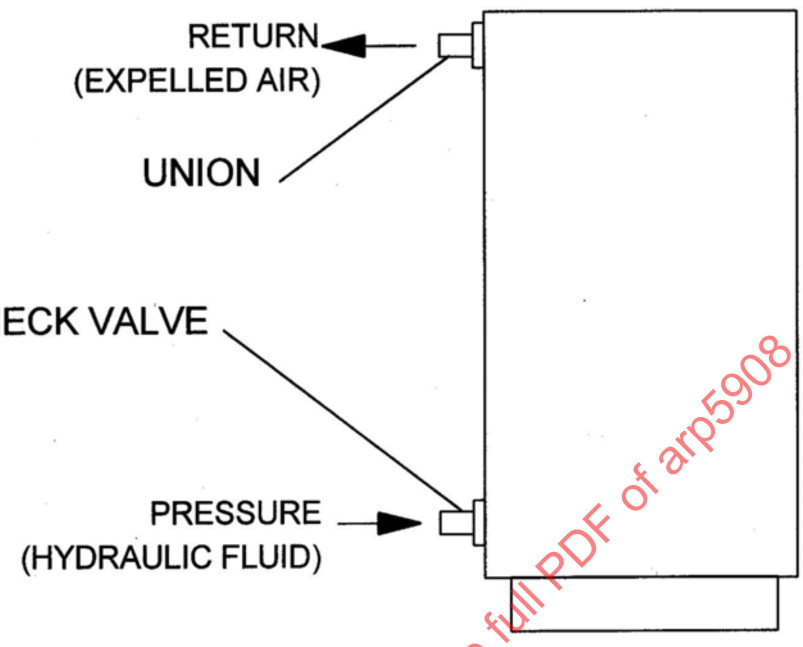


FIGURE 4 - TYPE II HYDRAULIC FLUID SERVICING

Type III - Pouring the hydraulic fluid through the gas servicing port (see Figure 5). To facilitate air expelling, a special Tee-adapter can be used. In order to use this method, the fluid flow from the servicing port into the shock strut must not be obstructed.

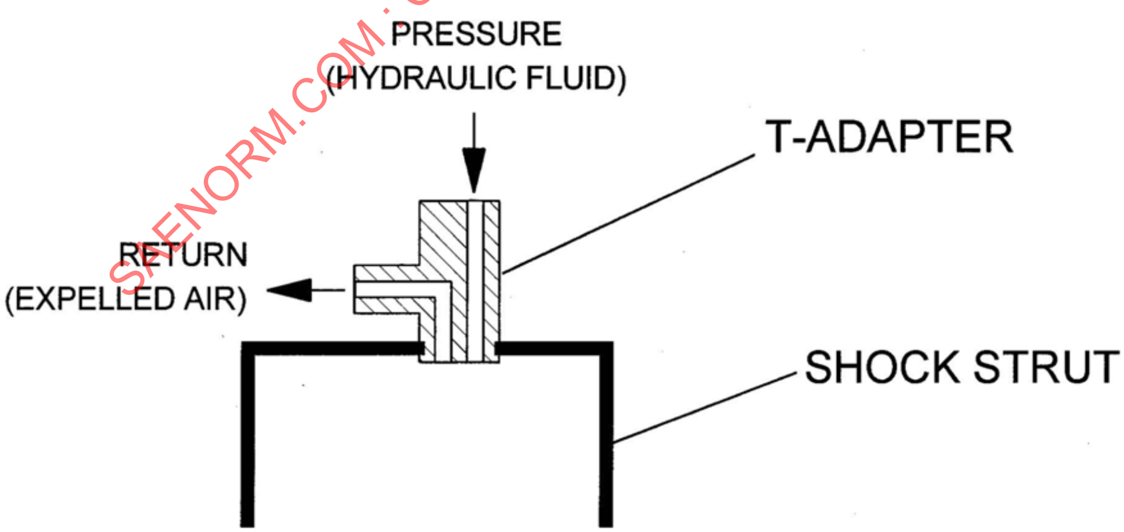


FIGURE 5 - TYPE III HYDRAULIC FLUID SERVICING

Type IV - By repeatedly applying low hydraulic pressure at the servicing port and releasing it to the return (see Figure 6). This can be done by either stroking the strut or with the gear restrained.

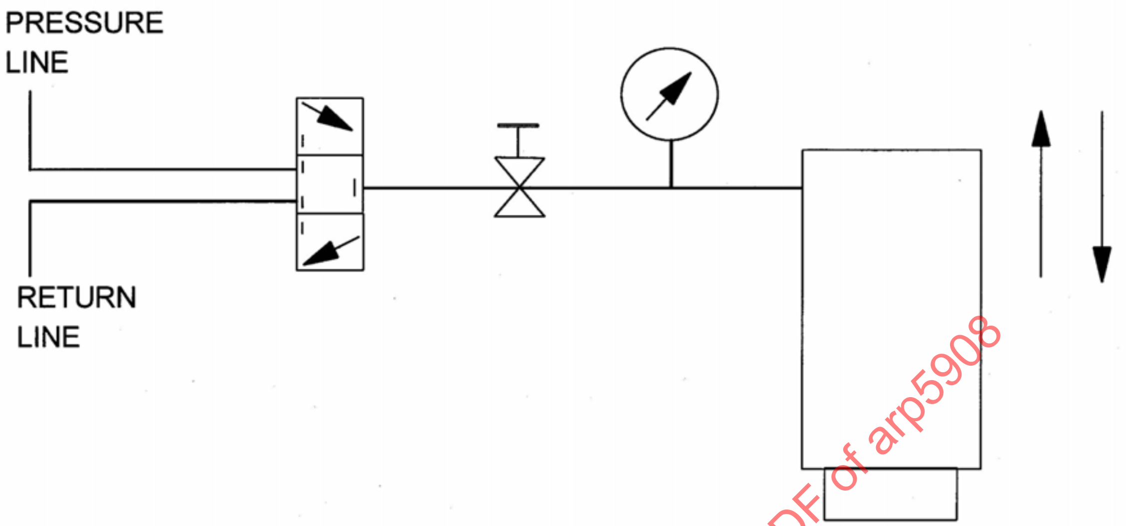


FIGURE 6 - TYPE IV HYDRAULIC FLUID SERVICING

5.3.2 Aircraft on Ground (Weight on Wheels) - Hydraulic Fluid Servicing

Prior to hydraulic fluid servicing, release the pressure. Add hydraulic fluid to fill the shock strut (see 5.3.1).

Gas servicing per 5.2.1.2 should be done to complete the servicing.

5.3.3 Aircraft on Jacks (Weight off Wheels) - Hydraulic Fluid Servicing

Prior to hydraulic fluid servicing, release the pressure. Remove the gas charging valve and fill with hydraulic fluid.

Raise the gear to completely compress the shock strut in order to expel the surplus hydraulic fluid. The gear can be compressed using a ratchet strap or a landing gear jack.

Remove the strap (or lower the jack) and extend the gear.

Perform gas servicing with one point check in fully extended position per 5.2.1.2.

It is good practice to recheck the servicing after lowering the aircraft on ground (in static position). This second point check will provide positive confirmation of a correct serviced gear.

5.3.4 Hydraulic Fluid Filling

This particular situation occurs when there is a large quantity of oil missing from the shock strut. This can be the case when initially filling the shock strut with hydraulic fluid during depot maintenance or, on the aircraft, after replacing a gland seal.

In order to ensure a correct servicing and to remove the entrapped air, gear stroking is typically used. While at depot level this poses no problem, with the landing gear installed on the aircraft, special caution must be used to prevent unbalancing the aircraft.

6. OTHER CONSIDERATIONS – BACKGROUND INFORMATION

6.1 Temperature Effect

To avoid temperature effects it is best to service landing gear at the same temperature for which it will be operated, if possible.

6.1.1 Landing Gear Serviced at Normal Ambient Temperature Used in Extreme Temperatures

The low temperature has the effect of reducing the volume of hydraulic fluid and of the gas pressure and/or volume resulting in an "under inflated" and "low oil" condition. Some landing gear designs are more sensitive to these effects and may have special servicing requirements for extreme low temperatures. A possible effect of shock strut under inflation due to extreme low temperature could be its "bottoming" during landing or ground operations.

Inversely, if a strut is operated at a temperature above the servicing temperature, it will appear to be over inflated and with excess of oil. Operation in this condition is tolerable when not excessively exceeded, but could alter the strut damping characteristics when exaggerated.

6.1.2 Landing Gear Serviced at Extreme Temperature Used in Normal Ambient Temperatures

If the landing gear was serviced with hydraulic fluid at extreme low temperature, the volume of hydraulic fluid will be excessive for use at normal or high temperatures, therefore hydraulic fluid re-servicing at ambient temperature may be needed.

Inversely, a landing gear fully serviced in extreme hot conditions will have low oil volume at ambient temperature.

The severity of these conditions should be established on a case-by-case basis.

Usually, if only gas servicing without pressure release (see 5.2.1.1) is performed, considering the temperature effects, no further re-servicing is needed.

6.2 Outgassing Effects

In the normally serviced condition, the hydraulic fluid inside a mixed gas-fluid shock strut contains a certain quantity of nitrogen dissolved in solution. The outgassing occurs when the pressure is released from the shock strut and the gas comes out of the solution, producing oil foaming (like opening a can of soda). The gas being released will also expel hydraulic fluid foam produced through outgassing. The hydraulic fluid volume lost can be important enough to create a mis-serviced condition. The loss of oil can be reduced if the shock strut is extended and the gas is released slowly.

Also, if the shock strut is fully compressed in an attempt to perform hydraulic fluid servicing before the outgassing is finished, a part of the hydraulic fluid will be inadvertently expelled and the operation will result in a low hydraulic fluid condition.

6.3 Useful Design Features

A design feature to consider might be an active pressure system that can monitor the strut servicing from the aircraft flight computer.

Servicing ports such as separate drain ports might be considered.

Ensure all servicing ports have adequate space for use of standard tools.

A good shock strut design without pockets and voids will reduce the amount of entrapped air and will provide a more consistent servicing.

Shock struts with extended pressure above 200 psi have a more consistent behaviour and avoid outgassing during flight.

6.4 Hydraulic Fluid - Quality Monitoring or Replacing

A sampling inspection of the hydraulic fluid for contaminants and the gas for water when completing strut servicing might be considered.

Some shock strut designs are more prone to fluid contamination due to wear of internal components (seals, surface treatments, etc.). Severe contamination of the fluid can cause increased friction of sliding components and premature wear. In such conditions some landing gear suppliers are recommending that the fluid be replaced periodically.

7. GROUND EQUIPMENT/ SPECIAL TOOLING AND ADAPTERS – BACKGROUND INFORMATION AND INDUSTRY PRACTICES

7.1 Nitrogen Supply

Typically, nitrogen bottles are used to supply the gas. They present the advantage of a higher Nitrogen purity, 99.5%.

Also used are Nitrogen generating carts. The purity of the Nitrogen supplied by the self generating carts is 95.5%. The content of moisture of the Nitrogen from the generating carts should meet the same requirements as the Nitrogen bottle moisture (maximum 26.3 ppm per A-A-59503).

7.2 Hydraulic Fluid Supply

Hydraulic fluid when introduced in the shock strut should meet AS4059 Class 6 or better.

Typically a hydraulic fluid supply cart is used (see Figures 7 and 8) but depending on the design of the shock absorber and on the type of hydraulic servicing (see 5.3) a hand pump or a beaker with clean hydraulic fluid can be used.

Special attention should be paid to use the approved hydraulic fluid as per the servicing plate or the applicable maintenance manual.

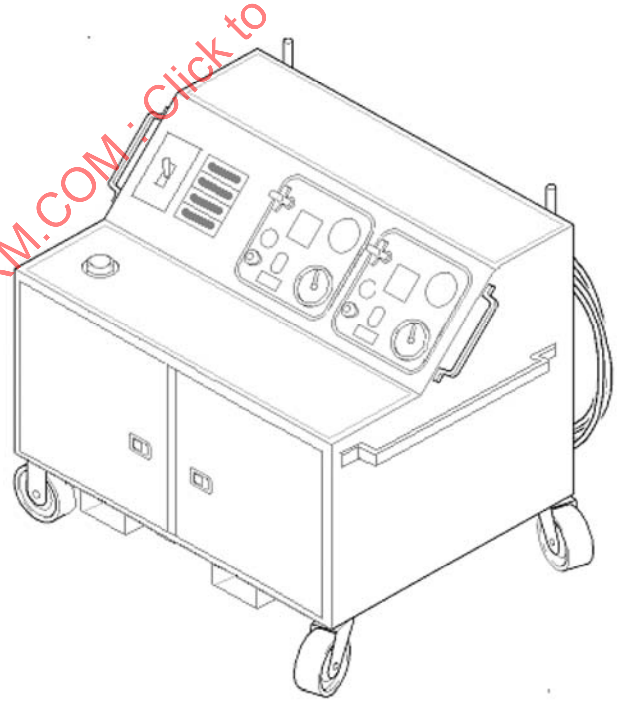


FIGURE 7 - FLUID SERVICING CART

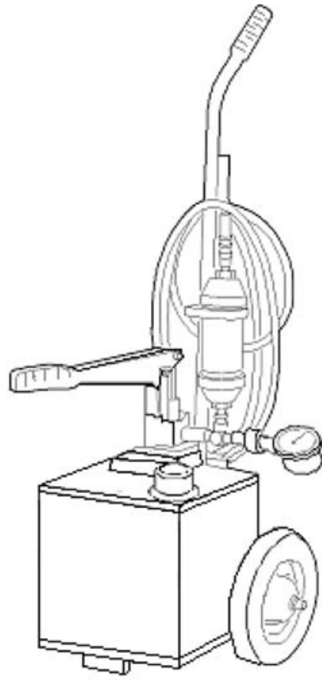


FIGURE 8 - SERVICING CART

7.3 Pressure Gages

The pressure gages used for servicing and servicing verification are typically of high accuracy (±1% of reading or ±2 psi, whichever is greater).

The range of the pressure gage (and this is particularly important for measuring the pressure in the fully extended position) should be appropriate for the pressure being measured.

7.4 Hydraulic Hoses and Adapters

Hoses and adapters must meet the AS4059 Class 5 or better cleanliness requirements.

Hydraulic lines set up for specific purposes as described in 5.1, 5.2, and 5.3 are assembled and kept dedicated to the task.

The hydraulic lines and hoses used for different hydraulic fluids should be kept and used segregated.

8. LANDING GEAR SERVICING AND THE MAINTENANCE SCHEDULE - RECOMMENDATIONS

The landing gear design should make provisions for an expeditious and reliable method to determine whether the landing gear servicing is correct. This method should be based on the verification of the pressure versus stroke and not of weight versus stroke, except if it can be shown that the worst possible mis-servicing is acceptable for all design conditions.

A specific maintenance schedule is not presented since this would depend on the specific type of aircraft, landing gear and operational conditions. Nevertheless it is recommended that each operator outlines and follows its specific schedule for the verifications below.

The maintenance manuals should specify the methods to be used for servicing verifications and adjustments.

8.1 Servicing Verifications Operations

The following servicing operations should be included in the maintenance schedule:

8.1.1 One-point Servicing Check

This summary servicing verification is more expeditious and is therefore appropriate to be performed the most frequently. The maintenance schedule should specify the frequency of this verification.

8.1.2 Two-point Servicing Check

This is a thorough verification of gas and hydraulic fluid servicing.

For performing the two-point check, both point measurements should be based on pressure, not on weight, since this verification is intended to be a positive confirmation of proper amounts of both dry nitrogen and hydraulic fluid.

A frequency adequate for this task depends on the aircraft type and usage as well as on the landing gear configuration. The maintenance schedule should specify the frequency of this verification.

8.2 Servicing Adjustment Operations

8.2.1 One-point Servicing Check – Outside Tolerances

See flowchart in Figure A1, Appendix A.

If one-point servicing check is performed and the measured point falls outside the acceptable range (typically "low chrome"), shock strut servicing is needed.

If there are no traces of hydraulic fluid leakage or seepage and the landing gear was not recently subjected to gas servicing more than two times, gas servicing can be performed to correct the situation (record operation in aircraft's maintenance log book), otherwise a gas servicing followed by a two-points check is needed (see below). Alternatively the maintenance manual or the operator may specify how many gas servicings in a row without two point check are acceptable.

NOTE:

When a gear requires frequent gas servicing this may indicate a separate problem, typically leakage (gas or hydraulic fluid, external or internal).

8.2.2 Two-points Servicing Check – Outside Tolerances

See flowchart in Figure A2, Appendix A.

If the first point check fails, the gear should be gas serviced to bring the point within the acceptable tolerances. The procedure is then continued with the verification of the second point.

If the second point servicing is within the tolerances then the gear is properly serviced and there is no need for further servicing.

If the second point servicing is found outside the tolerances the hydraulic fluid volume is incorrect; both hydraulic and gas servicing must be performed.

8.3 Unscheduled Maintenance

8.3.1 Gas or Hydraulic Fluid Leakage

Oil leakage: Hydraulic fluid leakage is not common or acceptable in shock struts due to the advances in sealing/scraper technology. However, some seeping or wetting of the piston surfaces will occur, which could result in a reduced volume over long periods of service. Excessive seepage is not easily determined, but should be limited to a reasonable amount of wetness on the piston chrome plated/HVOF coated surface.

Gas leakage: Most struts will experience a small leakage over long periods of time. Therefore periodic verification of the strut servicing should be accomplished.

A properly serviced strut should be verified for leakage using a suitable gage with proper consideration to temperature effects and using a soap solution to ensure no external leakage occurs.

If gas or hydraulic fluid leakage is identified, the integrity of the sealing systems should be re-established. (The existence of such a problem is identified using leakage tests per MIL-L-8552 and/or the applicable maintenance manual.)

9. SERVICING PLACARD – RECOMMENDATIONS

The intent of the servicing placard is to provide a quick reference for the verification of the shock strut servicing. For detailed servicing procedure, the component maintenance manual and the aircraft maintenance manual should be used. The use of servicing placards is not mandatory. However, when servicing placards are required by the aircraft manufacturer, the following recommendations apply.

9.1 Location

The servicing placards should be located on a visible area of the shock strut cylinder. If this is not feasible, an appropriate location on the aircraft in the landing gear vicinity is acceptable.

9.2 Content

The servicing placard content should be simple and clear.

The servicing placard should contain the following information:

1. A clear identification of a reference dimension representative for the exposed dynamic piston (typically called the X dimension). The change in the X dimension represents the stroke of the shock absorber.

2. The pressure in the shock strut as a function of the X-dimension – the static air spring curve and instructions for its use. The static air spring can be presented graphically (as a curve) or as a table. It is recommended that the values shown focus on the strokes corresponding to aircraft weights between the minimum weight and the maximum weight and, in addition, the fully extended position. The airspring shown must correspond to the hydraulic servicing performed with the shock absorber installed on the aircraft (which often is not vertical).

3. A range of tolerance for reference dimension and pressure:

    a. The tolerance should be small enough to ensure that the effect of a servicing performed within the specified range limits on the landing gear and aircraft performance is acceptable.

    b. The tolerance should be large enough such that:

        1) Unnecessary maintenance actions are avoided.

        2) Servicing is reasonably easy to achieve within the specified range.

4. Type of hydraulic fluid and of gas used.
5. Information relative to high and low pressure chambers, including the order of servicing, as applicable.
6. Location of the gas charging valve and hydraulic fluid servicing port, if applicable.
7. A brief description of the servicing verification method to be used (for detailed full servicing procedure the aircraft maintenance manual must be used).
8. A warning advising to release the pressure before disassembly.

The following information may be found necessary or useful on a case by case basis:

1. Conversion factors to account for temperature effects, unless the servicing will always be verified and adjusted at operating temperature conditions.
2. Special servicing requirements for extreme cold conditions.
3. Gas charging valve torques.
4. A brief description of servicing instructions.
5. Where to find the servicing procedures.

Servicing plates examples are shown in Figures 9 to 12.

10. NOTES

10.1 A change bar (l) located in the left margin is for the convenience of the user in locating areas where technical revisions, not editorial changes, have been made to the previous issue of this document. An (R) symbol to the left of the document title indicates a complete revision of the document, including technical revisions. Change bars and (R) are not used in original publications, nor in documents that contain editorial changes only.

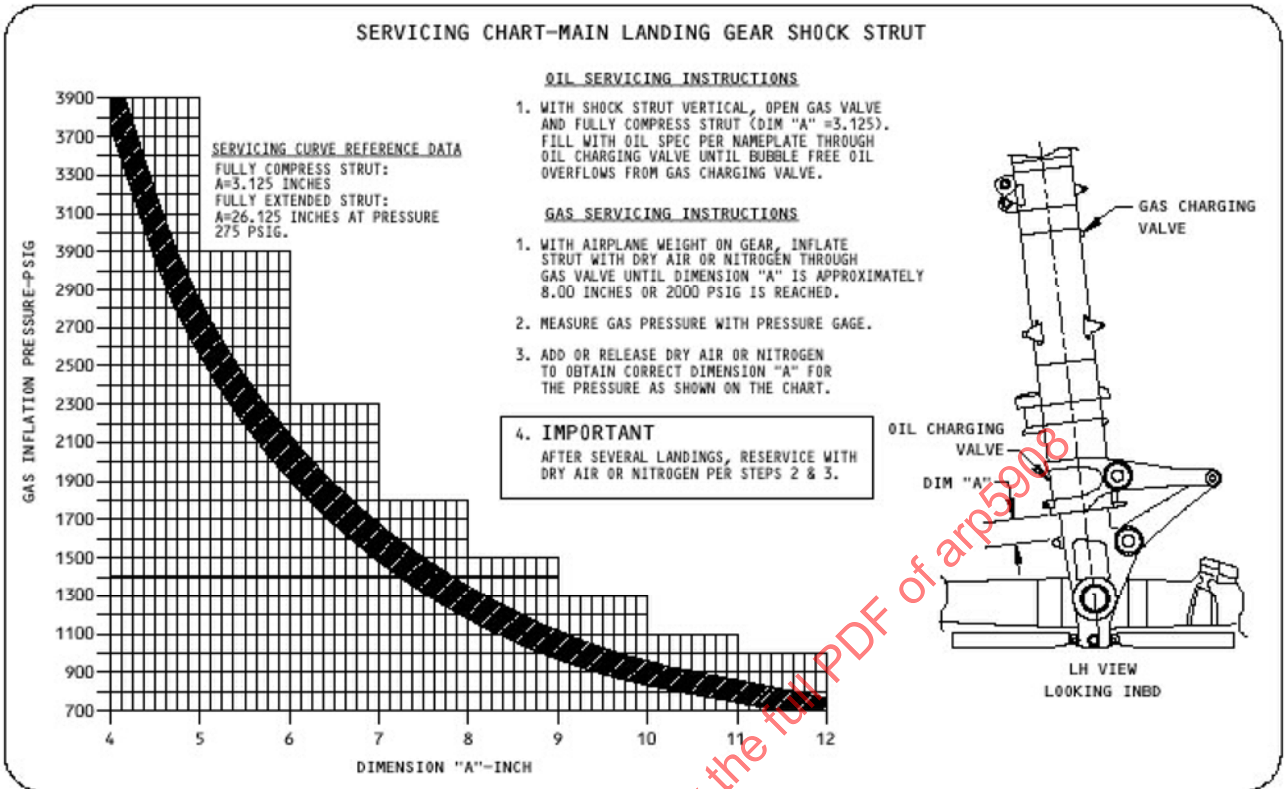


FIGURE 9 - SERVICING PLATE EXAMPLE – CHART FORMAT

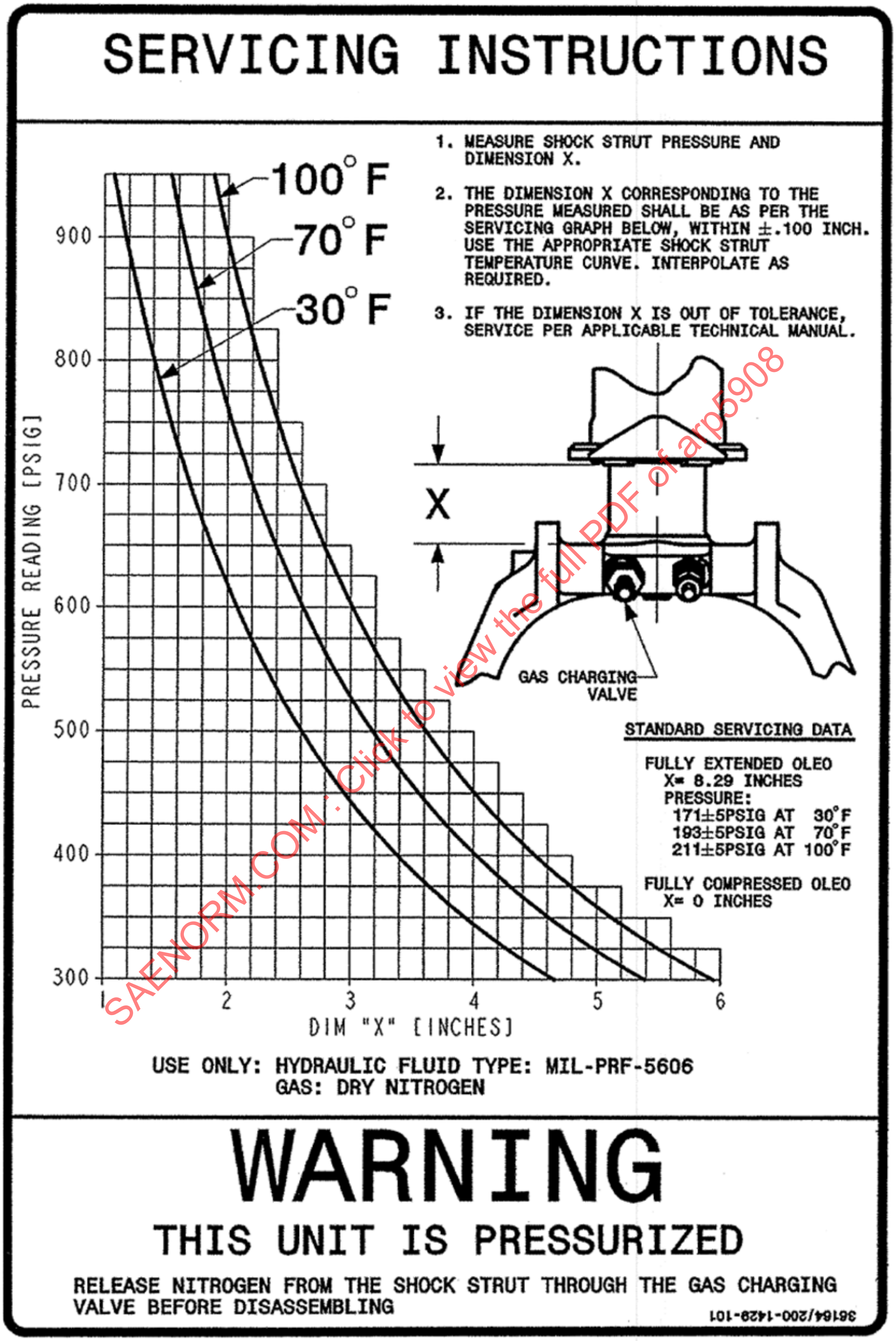


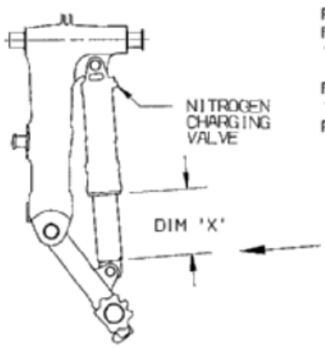
FIGURE 10 - SERVICING PLATE EXAMPLE – CHART FORMAT

SHOCK STRUT SERVICING INSTRUCTIONS

FOR USE AT TEMPERATURE 15°± 10°C.
FOR OPERATION OUTSIDE THIS RANGE REFER TO AMM

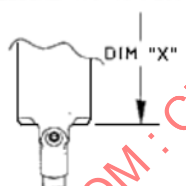
1. CHECK THE PRESSURE AND DIMENSION X. IF VALUES CORRESPOND TO THE TABLE, TASK IS COMPLETE. IF VALUES DO NOT CORRESPOND, FOLLOW THE PROCEDURE BELOW.
2. ATTACH NITROGEN SERVICING EQUIPMENT TO THE CHARGING VALVE.
3. LOOSEN 5/8" SWIVEL NUT OF THE GAS CHARGING VALVE.
4. SLOWLY INCREASE/DECREASE NITROGEN PRESSURE UNTIL PRESSURE AND DIMENSION X CORRESPOND TO THE TABLE.
5. TORQUE THE 5/8" SWIVEL NUT TO 125 in-lb. TORQUE TWO TIMES. LOOSEN THE NUT TO A FREE SWIVELING CONDITION AFTER EACH TORQUE APPLICATION. RETORQUE TO 50 in-lb.

OBTAIN A DIFFERENT DIMENSION X THAN USED IN STEP 4 AND CHECK THE CORRESPONDING PRESSURE FROM THE TABLE. IF THE VALUE DOES NOT CORRESPOND REFER TO AMM AND FULLY SERVICE THE SHOCK STRUT.



REFERENCE DATA
FULLY COMPRESSED STRUT
'X'= .058 INCHES

FULLY EXTENDED STRUT
'X'= 10.438 INCHES
PRESSURE 470±15 PSI.



SERVICED WITH OIL AT 15 DEG C

X	STATIC PRESSURE			X	STATIC PRESSURE		
(IN)	MIN	NOM	MAX	(IN)	MIN	NOM	MAX
4.40	938	1019	1060	2.40	1507	1638	1704
4.30	956	1039	1081	2.30	1554	1689	1757
4.20	975	1059	1102	2.20	1604	1743	1813
4.10	995	1081	1125	2.10	1657	1801	1874
4.00	1015	1103	1148	2.00	1714	1863	1938
3.90	1036	1126	1172	1.90	1776	1930	2008
3.80	1058	1150	1196	1.80	1840	2000	2080
3.70	1081	1175	1222	1.70	1911	2077	2161
3.60	1105	1201	1250	1.60	1987	2159	2246
3.50	1131	1229	1279	1.50	2070	2249	2339
3.40	1158	1258	1309	1.40	2158	2345	2439
3.30	1185	1288	1340	1.30	2255	2451	2550
3.20	1214	1319	1372	1.20	2361	2566	2669
3.10	1244	1352	1407	1.10	2477	2692	2800
3.00	1277	1387	1443	1.00	2605	2831	2945
2.90	1310	1423	1480	0.90	2747	2985	3105
2.80	1345	1461	1520	0.80	2904	3156	3283
2.70	1382	1502	1563	0.70	3078	3345	3479
2.60	1422	1545	1607	0.50	3270	3554	3697
2.50	1463	1590	1654	0.50	3488	3791	3943

WARNING
RELEASE INFLATION PRESSURE IN STRUT BEFORE DISASSEMBLING

FIGURE 11 - SERVICING PLATE EXAMPLE – TABLE FORMAT