

## Hydrostatic Testing of Aviation Components

### 1) What is Cylinder Requalification?

#### a. The process of inspecting and testing pressure cylinders

- i. Pressure cylinders must be inspected and tested at specific intervals to ensure that no conditions exist that preclude the cylinder from performing to its next inspection interval. Conditions which are inspected for include life limits, corrosion, damage, and cylinder integrity.

### 2) What is hydrostatic testing?

#### a. **Hydrostatic Testing** is described as the measurement of permanent and elastic expansion which are measures of cylinder integrity.

- i. **Elastic Expansion** is the expansion which occurs when the bottle is pressurized to maximum test pressure during the qualification test. Elastic Expansion beyond prescribed limits results in test failure.
- ii. **Permanent Expansion** is the expansion which remains after the pressure, which was introduced during the elastic expansion test, is relieved. As the pressure is released the cylinder contracts to its relaxed state which is where permanent expansion is measured. Permanent Expansion beyond prescribed limits results in test failure.

### 3) How is hydrostatic testing performed?

#### a. **Hydrostatic Testing** can be performed using either: a water jacket volumetric expansion test, or a hydraulic proof pressure test. AeTR uses water jacket volumetric expansion equipment.

#### b. **Attachment 1**

*The Hydrostatic test process described*

#### c. **Attachment 2**

*Photos of the Hydrostatic test equipment and process*

### 4) What agency regulates hydrostatic testing?

- a. The Department of Transportation regulates hydrostatic testing in the Code of Federal Regulations (CFR), Chapter 49, Part 180.201 to 180.217. The Pipeline and Hazardous Materials Safety Administration (PHMSA) regulates the licensing of companies that perform cylinder requalification. A company that performs hydrostatic testing must be originally qualified by the DOT, and then be recertified every 5 years. PHMSA regulations also require that persons performing requalification of cylinders must receive specialized training and be certified. In addition, hydro-test personnel must be recertified every 3 years.
- b. Transport Canada, CAN/CSA-B339, regulates the requirements for the design, qualification, manufacturing, inspection, testing, marking, requalification, reheat treatment, repair, and rebuilding of cylinders, spheres, and tubes for the transportation of dangerous goods for Canada. The Canadian regulations are very similar to the U.S. DOT regulations; however, US and Canadian approvals are independent of one another. A requalification agency can be one or both, AeTR is both.



**5) Are articles which have been hydrostatically tested released for return to service under the authority of the FAA?**

- a. Frequently yes, but only because work which is regulated by the FAA has occurred after the hydrostatic test which enables the repair station to release them for return to service under the FAA regulations.
- b. The hydrostatic test itself is neither controlled nor regulated by the FAA and is not eligible for FAA certification.
- c. AeTR’s DOT personnel affix a test certificate to the work order attesting to the acceptance of the cylinder after requalification testing.

**6) What are the testing intervals and life limits?**

- a. Intervals vary by bottle type and manufacturer, as well as by airframe application. A simplified chart of the current DOT published requirements follows:

<b><i>Type of Bottle</i></b>	<b><i>Testing Interval</i></b>	<b><i>Life Limit</i></b>
<b><i>Engine Fire Extinguisher</i></b>	<b><i>Every 5 years</i></b>	<b><i>No Life Limits On Engine Fire Bottles</i></b>
<b><i>Oxygen Bottles Marked DOT 3AA &amp; 3AL</i></b>	<b><i>Every 5 years</i></b>	<b><i>No Life Limit</i></b>
<b><i>Oxygen Bottles Marked DOT 3HT</i></b>	<b><i>Every 3 Years</i></b>	<b><i>24 Year Life Limit</i></b>
<b><i>Composite Oxygen Bottles(Mfg before 7/1/2006)</i></b>	<b><i>Every 3 Years</i></b>	<b><i>15 Year Life Limit</i></b>
<b><i>Composite Oxygen Bottles(Mfg after 6/30/2006)</i></b>	<b><i>Every 5 Years</i></b>	<b><i>15 Year Life Limit</i></b>
<b><i>Portable Fire Extinguisher</i></b>	<b><i>Visual Inspection 6 Years Hydro Every 12 years</i></b>	<b><i>Manufacturer Regulates Life Limits or Stamped W/ DOT Designation</i></b>
<b><i>Pneumatic Reservoir</i></b>	<b><i>Every 3-6 Years X-Ray Inspection When Needed Mag-Particle Inspect When Needed</i></b>	<b><i>Tavco - 15 Years Globe - No Life Limits HTL - 24 Years</i></b>

*Airframe OEM’s can alter the DOT inspection requirements by publishing their own ICA (typically to shorter intervals than DOT allows) ICA for pressure vessels are typically found in Chapter 5 of OEM Maintenance Manual.*

***This table is not complete; the content has been abbreviated and simplified for presentation purposes. Please consult 49 CFR or the ICA for the article in order to ascertain or validate specific test intervals and/or life limits.***

**7) DOT and non-DOT specification cylinders**

**a. DOT cylinders**

- i. 49 CFR along with the Compressed Gas Association (CGA) are comprehensive documents which provide the complete specifications for manufacture, testing, use, repair, and life limits of DOT cylinders. DOT cylinders have the DOT type marked or stamped on the bottle. DOT cylinders are approved and regulated by the DOT.

**b. Non-DOT specification cylinders**

- i. The term, non-DOT specification cylinder does not mean that the cylinders are not regulated, approved, and/or controlled by the DOT; instead it refers to the design. Cylinder manufacturers produce a range of bottles which deviate from the DOT standards as published in 49 CFR. When such a cylinder is designed, the design is submitted to the DOT for approval, and when approved, the DOT issues an “Exemption” or a “Special Permit” to authorize the manufacture of the cylinder. The special permit documents the manufacturing approval, the test criteria, the life limit, any approved repair information, use information, etc. Although the cylinders are commonly referred to as non-DOT, they too are regulated and approved by the DOT.
- ii. Non-DOT specification cylinder simply means the bottle does not meet a specific, published, DOT designation. DOT and 49 CFR descriptions for hydrostatic testing still apply.

**8) How are cylinders marked after testing?**

- a. Typically, if a DOT cylinder is constructed of composite material, requalification markings are on a placard affixed to the cylinder. If a DOT cylinder is constructed of steel, requalification markings are metal stamped into the bottle.
- b. Requalification marking instructions are included in the exemptions and special permits for non-DOT exemption bottles, and take precedence over the 49 CFR standards.
- c. Requalification markings include: RIN, and the month and year the hydrostatic test was performed.
- d. A DOT steel bottle's metal stamp will look something like this:



**Some bottles have a metal ring on the neck as well as a stamp on the bottle for marking**

**9) What if a cylinder fails the test?**

- a. If a cylinder fails the requalification test, it must be condemned. In the condemnation process;
  - i. Steel cylinders are stamped with a series of X's over the DOT specification and the marked pressure, or "CONDEMNED" is steel stamped on the shoulder, top head, or neck.
  - ii. For composite cylinders and non DOT specification cylinders, a label with the word "CONDEMNED" is affixed to the cylinder and over coated with epoxy near, but not obscuring, the original cylinder manufacturer's label; or as an alternative to the stamp or labeling, at the direction of the owner, the re-qualifier may render the cylinder incapable of holding pressure (drill a hole in it).
- b. No person may remove or obliterate the "CONDEMNED" marking. In addition, the re-qualifier must notify the cylinder owner, in writing (Red Reject Tag OK) that the cylinder is condemned and may not be returned to service.

**10) Do fire bottles require hydrostatic testing?**

- a. Yes, handheld and mounted fire bottles require hydrostatic tests. Mounted fire bottle require a hydrostatic test to be performed every 5 years. Handheld fire bottles require a visual and internal inspection every 6 years and a hydrostatic test every 12 years per the National Fire Protection Association-10 rules.

**11) Should operators discharge them prior to shipping?**

- a. HAZMAT shipping is describes as any *hazardous material* that the Secretary of Transportation has determined is capable of posing an unreasonable risk to health, safety, and property when transported. We here at Aerospace Turbine Rotables are registered to ship hazardous materials with the Pipeline and Hazardous Materials Safety Administration (PHMSA).
- b. Fire bottles are considered hazardous in terms of shipping because the internal pressure exceeds what is deemed to be safe for shipping, not because of the Halon. Under no circumstances should a fire bottle be discharged for shipping purposes. Halon is a liquefied gas that has been found to be harmful to public health and the environment by destroying ozone in the upper atmosphere. If your company is not qualified to ship hazardous materials, it will be necessary to find someone in your area that is qualified and arrange the shipment of the hazardous item/s with them.
- c. The squib or cartridge that is installed on the bottle is considered hazardous only if it is shipped by itself. If the squib or cartridge is installed on the bottle with a shunt wire from one stud to the other, the squib is contained and is not considered hazardous, in terms of shipping.
- d. Oxygen cylinders are considered hazardous only if they have a charge over a certain pressure. The Code of Federal Regulations states; A Division 2.2 non-flammable gas, other than ammonia, anhydrous, and with no subsidiary hazard, at an absolute pressure less than 200 kPa (29 psi); at 20 °C (68 °F), is not considered hazardous in terms of shipping.

**Attachment 1**  
**The Hydrostatic test process described**

- 1) All test equipment must be calibrated daily prior to first hydrostatic test (DOT requirement) (at specific pressures)
  - a. Temperatures (ambient)
  - b. Temperatures (water)
  - c. Wear/Use
  - d. Transducer correction values
- 2) Record the bottle. Which includes: test number, manufacturers date, serial number, manufacturer, size of bottle, and pre-determined test pressure (test pressure is typically 5/3 operating pressure).
- 3) Perform internal/external inspection per the inspection criteria.
- 4) Fill the test article (bottle) with water of the same temperature as is in the water jacket, affix the correct quick disconnect test fitting to the bottle.
- 5) Attach the bottle to the quick disconnect fitting located on the bottom of the tank's lid.
- 6) Lower the bottle into the tank and clamp the tank's lid down using the pneumatic lid clamps.
- 7) Fill the tank with water until the water is displaced into the beaker on the scale.
- 8) Let the scale settle for 10-30 seconds and zero the scale.
- 9) Turn the water supply on to the tank and fill the bottle with water, pressurize bottle to the test pressure and hold for a minimum of 30 seconds. Read the scale and record the total expansion.
- 10) Shut off the water supply and bleed the pressure off the bottle.
- 11) Read the scale and record the permanent expansion.
- 12) The total expansion minus the permanent expansion gives you the elastic expansion.
- 13) To determine the percent of permanent expansion, divide the permanent expansion by the total expansion.
- 14) Record if the bottle passed or failed.
- 15) Stamp or sticker the bottle with the hydrostatic test date and RIN.
- 16) Drain water.
- 17) Put the bottle on the bottle dryer.
- 18) Re-assemble as necessary.



**Attachment 2**

**Photos of the Hydrostatic test equipment and process**



Ability to control water temperature



Ability to control water pressure



Cylinder is placed in vise & filled with water



Quick disconnect installed



Cylinder is attached to water jacket lid



Cylinder is moved into position with hoist

**Attachment 2 (Continued)**

**Photos of the Hydrostatic test equipment and process**



Lid is lowered in place



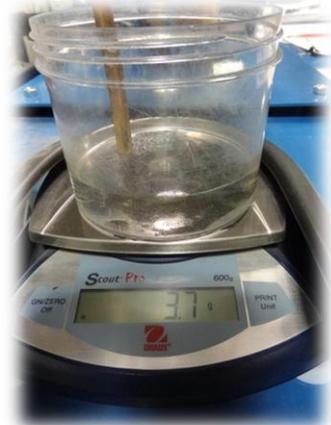
Lid is secured with pneumatic lid clamps



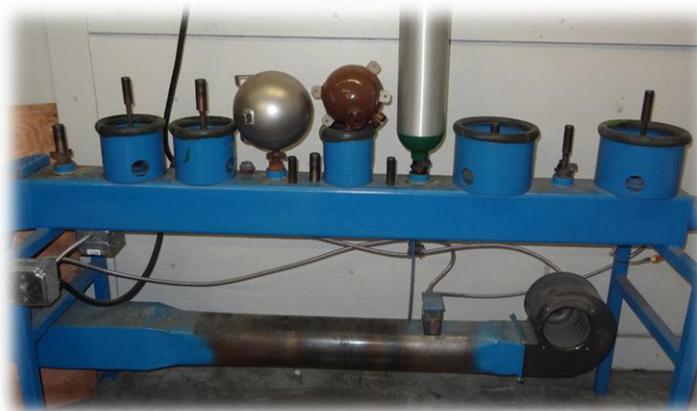
Water jacket and cylinder are filled. Scale is zero'd



5/3 operating pressure



Water displacement measured for determination of pass/fail



Cylinder drying manifold