A REFERENCE GUIDE FOR REQUALIFICATION OF GAS CYLINDERS

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Acknowledgement

This document has not been harmonized with other gas associations. It is based partly on the European Industrial Gases Association (EIGA) Doc. 79/13 E 'Cylinder retest stations' and AIGA thanks EIGA for permission to reproduce sections from the publication.

Table of Contents

1 Introduction

The periodic inspection and testing of a gas cylinder is an essential requirement for its continued and safe use. There are few items of industrial equipment that last for so many years. The safety record of these cylinders is excellent and reflects the integrity of the design, manufacturing and subsequent maintenance processes.

2 Scope and Purpose

This document is a reference guide on the key aspects of the periodic inspection and retesting of gas cylinders and gives a structure for the re-testing activity. It is intended specifically for those who are:

- Specifying the Periodic Inspection and Testing of Gas Cylinders
- Selecting Inspection and Testing Facilities
- Carrying out the Periodic Inspection and Testing Process

The following cylinder types are covered in the document:

- Seamless Steel
- Welded Steel
- Seamless Aluminium Alloy
- Welded Aluminium Alloy
- Dissolved Acetylene
- Composites
  - Steel Liners
  - Non Metallic Liners
  - Cylinders without Liners

Additional requirements, which may apply for specific applications such as medical, electronics, are not covered in this document.

3 Definitions

Terminology:

- *Shall* indicates that the procedure is mandatory. It is used wherever criterion for conformance to specific recommendation allows no deviation.
- *Should* indicates that a procedure is recommended.
- *May* and *Need not* indicate that the procedure is optional.
- *Will* is used only to indicate the future, not a degree of requirement.
- *Can* indicates a possibility or ability.

4 Background to periodic inspection and testing

The periodic inspection and testing of gas cylinders has been a requirement for many years in different countries and also as part of the legal requirements in some countries. Requalification should be treated seriously due to the potential risk to the end users and public.

The requirements to test and inspect gas cylinders have evolved as national requirements, with the test periods and the test frequencies being set by the national regulatory bodies.

Some degree of harmonisation in Europe had started with ADR and RID and this did establish common test periods, if not common test methods. In the 1980's ISO issued a number of testing standards for a variety of gas cylinder types. With the advent of the European and North American

Harmonisation programme for gas cylinders, EN, DOT and TC standards for cylinder testing were prepared in the 1990's. Some standards are now mandatory according to RID/ADR/ADN. This, along with the Transportable Pressure Equipment Directive, now means that there is a common approach to the technical standards for cylinder testing. Along with these harmonised technical requirements is a need for test stations to have a common approach for all aspects of cylinder testing including test facilities, training of personnel and a harmonised interpretation of these standards.

5 Periodic inspection and tests

5.1 List of procedures for periodic inspection and tests

Following are the recommended standards for carrying out above.

ISO 6406 Gas Cylinders - Seamless Steel Gas Cylinders – Periodic Inspection and Testing, [1]

ISO 10460 Gas Cylinders – Welded Carbon-Steel Gas Cylinders – Periodic Inspection and Testing, [2]

ISO 10461 Gas Cylinders - Seamless Aluminium Alloy Gas Cylinders – Periodic Inspection and Testing, [3]

ISO 10462 Gas Cylinders – Transportable Cylinders for Dissolved Acetylene – Periodic Inspection and Maintenance, [4]

ISO 10464 Gas Cylinders – Refillable Welded Steel Cylinders for Liquefied Petroleum Gas (LPG) – Periodic Inspection and Testing, [5]

ISO 11623 Transportable Gas Cylinders – Periodic Inspection and Testing of Composite Gas Cylinders, [6]

ISO 16148 Gas cylinders — Refillable seamless steel gas cylinders — Acoustic emission testing (AT) for periodic inspection, [24]

5.2 Cylinder requalification methods

Each cylinder shall be submitted for either a pressure test or an ultrasonic examination. The type of test method followed shall be in accordance to the national regulations. In the absence of a national regulation, methods referred to in this section which are appropriate to the design specification of the cylinder can be used.

- Proof Pressure Test – ISO 6406, ISO 10460, ISO 10461, ISO 10464, ISO 11623
- Hydraulic Volumetric Expansion Test - ISO 6406, ISO 10460, ISO 10461, ISO 10464, ISO 11623
  - Water Jacket Method
  - Direct Expansion Method
- Ultrasonic Examination – ISO 6406, ISO 10461, CGA C-20
- Acoustic Emission – ISO 16148
- For Acetylene cylinders – ISO 10462, see Section 7.3

6 Disposal of failed cylinders

Failed cylinders cannot be repaired and must be disposed of in a safe manner. The contents of the cylinder must also be disposed of by a method which is approved under local regulations.

Following methods can be used to ensure that the cylinders can never be reused.

- Mechanical crushing of the cylinders
- Destroying the neck threads
- Cutting of the cylinder into two or more irregular pieces including the shoulder and removing the stamped markings
- Piercing in at least 3 places for thin walled cylinders
- Composite or fibre wrapped cylinders should not be cut by a flame

For disposal of acetylene cylinders, see AIGA 036/06, [7].

7 Test stations

Test stations shall be compliant with the requirements of the National Competent Authority.
Where no such authority exists, follow requirements of this document and standards referenced within this document

7.1 Test stations organisation

Personnel involved in the retesting of gas cylinders shall be suitably qualified for the purpose and the quality of the work shall be under no commercial pressure. Specific country regulatory requirements should be met with regard to the competency and number of years of experience required for the personnel operating the testing stations.

7.2 Test station facilities and procedures

7.2.1 General

a) There shall be adequate lighting, ventilation and workspace for the inspection and testing. Additionally the work areas shall be clean and free of debris.

b) Test stations shall be equipped to vent gases in a safe manner which shall direct gases released, away from the work place, to an area where no risk is presented, e.g. to a high level.

   Gas cylinders containing controlled substances, e.g. toxic, corrosive, ozone depleting and flammable gases, etc. shall only be handled at locations with specialist facilities to dispose of these products that meet applicable environmental and safety requirements.

7.2.2 Devalving and Revalving

Warning: Devalving of cylinders is a potentially hazardous activity if not carried out correctly. Before any cylinder is devalved a positive check shall be carried out to ensure there is no pressure in the cylinder; for guidance see EIGA Safety Information 18/04, [8] and ISO 25760, [9].

a) There shall be procedures and mechanisms in place to protect the operative against a cylinder under pressure being accidentally devalved. Specific guidance is given in ISO 25760, [9]. Valves shall not be repaired or removed while the cylinder is under pressure. There are no exceptions to this rule.

   It is critical that working procedures describe the process to check if a valve is functioning correctly or if it is blocked. Additionally some valves are designed to retain a small positive pressure in the cylinder, and care is needed to ensure that cylinders are completely vented when fitted with these valves; see ISO 25760, [9].

b) There shall be equipment to de-valve and re-valve cylinders. This equipment shall not damage the cylinder, e.g. during clamping, particularly of aluminium alloy or composite cylinders, or damage to the valve unnecessarily.

c) Revalving should be done with a specified torque appropriate to the type of cylinder, neck thread and valve. Refer to ISO 13341, [10] for details on torque, ISO 11114-1, [11] and ISO 11114-2, [12] for use of lubricants and sealing materials.

7.2.3 Inspection and cleaning

For hazardous gases, such as toxic and flammables, care shall be taken to ensure that cylinders have been adequately purged and/or evacuated to ensure that a hazardous atmosphere is not present prior to internal inspection and cleaning.

a) Test stations shall have access to both internal and external cleaning facilities. Examples of cleaning methods include shot blasting and high-pressure water jet cleaning. Where heat is applied to the cylinder, care shall be taken to ensure that the temperature limits specified are not exceeded, this specifically applies to aluminium alloy and composite cylinders, see e.g. ISO 10461, [3]

   Note**:** Aluminium alloy cylinders shall not be shot blasted due to their soft nature and the possibility of galvanic corrosion. Other cleaning methods, e.g. sand cleaning or wire brushing shall be carefully evaluated, preferably in conjunction with the cylinder manufacturer. For cleaning composite cylinders see ISO 11623, [6].

b) There shall be equipment to examine and clean cylinder neck threads that does not cause damage to the thread. There shall be thread gauges for checking neck threads as required, and taps for any refurbishment. In all cases there shall have been training of personnel in the use of these gauges.

c) There shall be equipment for the external and internal inspection of cylinders to ensure that a thorough inspection can be made. It is recommended that lamps be sufficiently protected in case the lamp breaks and ignites any residual gas. An alternative, successfully used by a number of organisations, is optical fibre lamps. The light shall be of a suitable intensity that allows all types of defects to be detected. The test station shall have access to equipment to measure the severity of defects where required.

7.2.4 Specific requirements for retesting of composite cylinders with AA6061 liner

Investigations have shown that internal exposure to water for some composite cylinders with AA 6061 liner can lead to intercrystalline corrosion of the liner and hence can reduce the fatigue life of the cylinder by a factor of up to 40 times. See AIGA 073/13, [13].

Therefore the time of exposure of the liner to water used in the hydraulic test should be minimized. Ideally the time taken to fill the cylinder with water, carry out the hydraulic test and dry the cylinder should be no more than 2 hours.

Corrosion inhibitors could be added to the water if the 2 hour limit cannot be achieved in practice. This is not permissible for food and medical applications because GMP requires the use of potable water.

7.2.5 Weighing

When weighing is required a suitable weigh scale shall be used, for guidance on weigh scale accuracy, see ISO 11113, [14].

7.2.6 Test equipment

a) Test equipment, e.g. hydraulic testing and/or ultrasonic shall fully comply with the requirements of the appropriate testing standards and/or national regulatory requirements.

b) There shall be adequate supply and disposal facilities for the fluid used for testing including adequate water treatment where applicable.

Note: If the fluid is recycled, it shall be adequately filtered to prevent carry over of contaminants, such as rust. These filters shall be periodically cleaned.

A check shall be carried out on the pH value of the recycled water. Where both steel and aluminium alloy cylinders are tested, the risk of galvanic corrosion can be minimised by either using separate circuits or imposing additional requirements to the quality and filtering of the water. For additional requirements for aluminium alloy cylinders, see AIGA 073/13, [13]. In some cases, for example, medical oxygen cylinders, there may be a requirement to use drinking water quality for the hydro testing.

If the test fluid is flammable, e.g. when testing LPG cylinders, suitable precautions shall be taken to avoid the risk of an ignition of gas. Cylinders of different types e.g. high pressure and low pressure such as LPG should not be tested on the same test line. Adequate precautions shall be taken to ensure that there is no cross contamination.

c) The testing equipment shall be adequately shielded to protect personnel in the event of a release of test fluid, particularly in the case of pneumatic testing.

d) All equipment used should be calibrated periodically.

7.2.7 Drying

There shall be adequate drying equipment to ensure that there shall be no free moisture and that this dryness is maintained until the valve is fitted, see AIGA 062/09, [15]. For aluminium alloy cylinders, reference shall be made to ISO 10461, [3] for allowable time and temperature limits.

7.2.8 Painting

There shall be appropriate equipment to paint cylinders in accordance with environmental and any regulatory or country specific colour code requirements. For aluminium alloy cylinders, reference shall be made to ISO 10461, [3] for allowable time and temperature limits.

7.2.9 Repairs

Repairs to cylinders when required shall only be carried out in accordance with the relevant standards by trained and qualified personnel only. Major repairs, which include, for example welding and heat treatment, are normally only accepted on welded steel and welded aluminium alloy cylinders.

7.3 Acetylene Cylinders Periodic Inspection - Specific Requirements

a) Acetylene cylinders shall only undergo inspection at facilities specifically designated for the purpose. Acetylene inspection facilities shall be designed such that there is no source of ignition of gas.

b) Acetylene cylinders shall be vented in a safe manner prior to valve removal and the cylinder confirmed as being empty by weighing. It shall be checked that the valve is not blocked, see ISO 25760, [9].

c) Due to the risk of the build up of acetylene gas which can occur if there is a rise in the ambient temperature when a cylinder has been devalved and moved from a cold atmosphere to a warmer one, the inspection process shall be performed such that only the minimum number of cylinders are de-valved at any one point in the inspection process to avoid a build up of acetylene gas and a possible explosion. Cylinders shall be devalved with adequate operator protection, see ISO 25760, [9].

d) As some cylinders with monolithic masses use asbestos as a binder, no work should be carried out on the mass, which could cause asbestos fibres to be released.

e) All tools used in the inspection of acetylene cylinders shall not generate sparks, (spark resistant).

f) No portable electronic equipment that is not certified for use in an acetylene environment shall be used, e.g. mobile phones, remote control car keys, laptops etc.

7.4 Procedures

a) A system shall be in place to show that all procedures are followed and that no stage of the inspection process is omitted.

b) The procedures for the cylinder inspection process shall be part of a Quality System.

c) There shall be formal written operating instructions for all machinery and equipment.

d) For welded cylinders, there shall be equipment to invert the cylinder to enable the external base area to be visually inspected, (including fusible plugs,)

e) There shall be procedures to ensure that cylinders are internally inspected and dried before the valve is fitted.

f) There shall be procedures for the stamp marking of gas cylinders in accordance with relevant stamp standard marking for gas cylinders, e.g. ISO 13769, [16].

g) Current applicable standards shall be available on site for the activity concerned.

h) There shall be a planned maintenance and calibration programme for all relevant equipment.

i) There shall be a defined system for disposal of cylinders, see AIGA 036/06, [7] and also national standards.

7.5 Records

A cylinder periodic inspection and test results shall be recorded by the test station. Requirements as per national regulations shall be followed, wherever applicable

Refer to Section 15.7 from ISO 6406, [1].

7.6 Valves

a) There shall be suitable equipment and a system in place to ensure that the appropriate valves are fitted for the service of the gas cylinder and that the valves are installed in accordance with ISO 13341, [10] and/or national approved standard where available.. Including the stem thread matches the cylinder internal neck thread. Specifically, care shall be taken to ensure that the maximum permitted torque value is not exceeded

b) Where valves are reused, they shall be periodically inspected.

7.7 Qualification and Training of Personnel

a) There shall be a training scheme in place to ensure that all personnel are adequately trained for the tasks to be carried out.

b) There shall be periodic competency checks of all personnel.

8 Cylinder requalification period

A cylinder shall be due for periodic inspection and tests on its first receipt by a filler following the expiry of the interval established in national and international regulations

Provided that the cylinder has been subjected to normal conditions of use and has not been subjected to abusive and abnormal conditions that would render the cylinder unsafe, there is no general requirement for the user to return a gas cylinder before the contents have been used even though the periodic inspection and test interval may have lapsed.

It is the responsibility of the owner or user to submit the cylinder for periodic inspection and test within the interval specified by national or international regulations or as specified in the relevant cylinder design standard if this period is shorter. Reference shall be made to the manufacturer or inspection body if there is a question on the re-test period for specific gases.

No cylinder shall be refilled beyond the expiry date of requalification.

Requalification period of a cylinder shall follow national regulations as defined by competent authorities in the countries.

For compressed gases service, the UN recommended period for requalification is a 5.year interval. A 10 year interval may be used if the dryness of the product and that of the filled cylinder are such that there is no free water. This condition shall be proven and documented within a quality system of the filler. If these conditions cannot be fulfilled, alternative or more frequent testing may be appropriate, according to the recommendations.

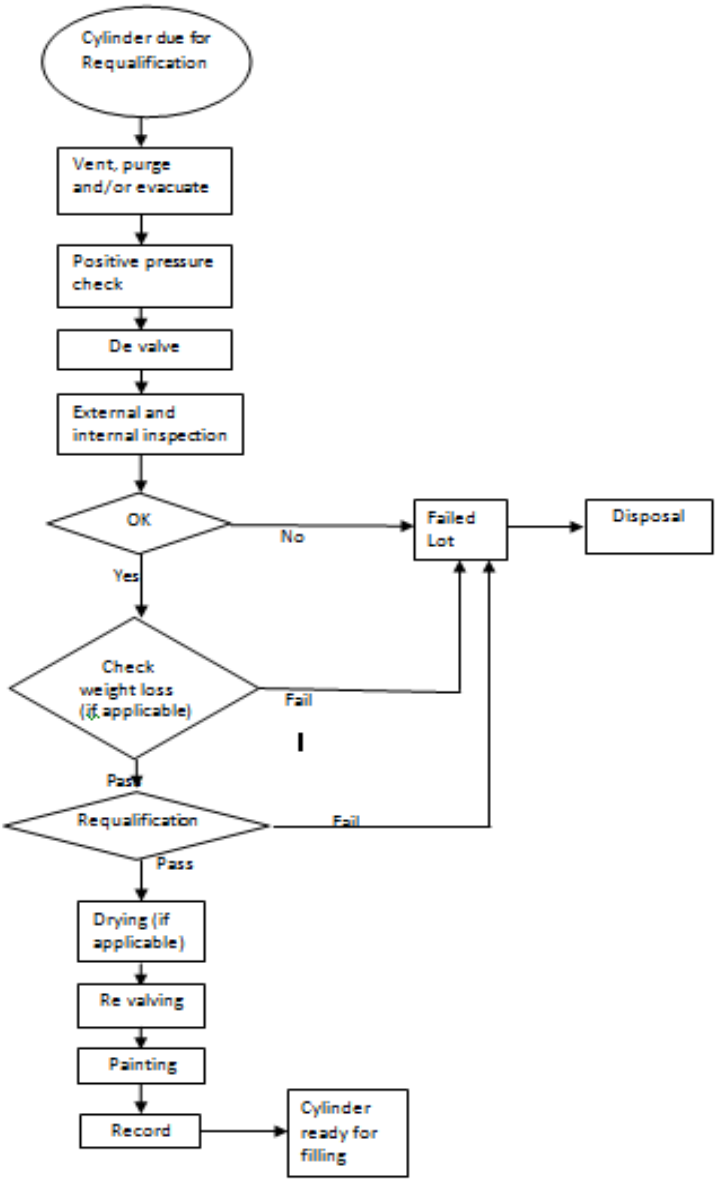
For UN 1001 acetylene, dissolved, the test period is 10 years.
For UN 3374 acetylene, solvent free, the test period is 5 years.

Under certain conditions, a shorter time interval for requalification may be required at all times, e.g. the dew point of the gas, polymerization reactions and decomposition reactions, cylinder design specifications, change of gas service, etc.

Recommendations for specific types of cylinders mentioned below are covered in the respective publications. See References

- Seamless Steel Cylinders
- Seamless Al Alloy Cylinders
- Composite Cylinders
  - Steel Liners
  - Non Metallic Liners
  - Cylinders without Liners
- Acetylene Cylinders

9 Flow Chart



10 References

The following were used as references in this publication.

1. ISO 6406 - Gas Cylinders – Seamless Steel Gas Cylinders – Periodic Inspection and Testing

2. ISO 10460 - Gas Cylinders – Welded Carbon Steel Gas Cylinders – Periodic Inspection and Testing

3. ISO 10461 - Gas Cylinders – Seamless Aluminium Alloy Gas Cylinders – Periodic Inspection and Testing

4. ISO 10462 - Gas Cylinders – Transportable Cylinders for Dissolved Acetylene – Periodic Inspection and Maintenance

5. ISO 10464 - Gas Cylinders – Refillable Welded Steel Cylinders for Liquefied Petroleum Gas (LPG) – Periodic Inspection and Testing

6. ISO 11623 - Transportable Gas Cylinders – Periodic Inspection and Testing of Composite Gas Cylinders

7. AIGA 036/06 - Guidelines for the Management of Waste Acetylene Cylinders

8. EIGA Safety Information 18 - Devalving gas cylinders

9. ISO 25760 - Gas Cylinders - Operational Procedures for the safe removal of valves from gas cylinders

10. ISO 13341 - Transportable Gas Cylinders Fitting of valves to gas cylinders

11. ISO 11114 -1 - Transportable Gas Cylinders – Compatibility of Cylinder and Valve Materials with Gas Contents – Part : 1 – Metallic Materials

12. ISO 11114 -2 - Transportable Gas Cylinders – Compatibility of Cylinder and Valve Materials with Gas Contents – Part : 2 – Non Metallic Materials

13. AIGA 073/13 - Tap Water Corrosion of Composites with AA 6061 Liners

14. ISO 11113 - Cylinders for Liquefied Gases (excluding Acetylene and LPG) – Inspection at Time of Filling.

15. AIGA 62/09 - Methods to avoid and detect internal gas cylinder corrosion

16. ISO 13769 - Gas Cylinders - Stamp marking

17. ISO 22434 - Transportable Gas Cylinders – Inspection and Maintenance of Cylinder Valves

18. EN ISO/IEC 17020 - Conformity Assessment. Requirements for the Operation of Various Types of Bodies Performing Inspection

19. CGA C-6 - Standards for Visual Inspection of Steel Compressed Gas Cylinders

20. CGA C-6.1 - Standards for Visual Inspection of High Pressure Aluminium Compressed Gas Cylinders

21. CGA C-6.3 - Standards for Visual Inspection and Requalification of Low Pressure Aluminium Compressed Gas Cylinders

22. CGA C-1 - Methods for Pressure Testing Compressed Gas Cylinders

23. EIGA 79/13 - Cylinder Retest Stations

24. ISO 16148 Gas cylinders — Refillable seamless steel gas cylinders — Acoustic emission testing (AT) for periodic inspection

25. CGA C-20 – Methods for Ultrasonic Examination of Metallic, DOT and TC 3-Series Gas Cylinders and Tubes