Other Gases			
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Inspection of Gas Cylinder Test Houses

1.0 Introduction

The *'Carriage of Dangerous Goods (Classification, Packaging and Labelling) and Use of Transportable Pressure Receptacles Regulations 1996'* (CDGCPL2) requires in Schedule 8, paragraph 4 that gas cylinders are examined properly and at appropriate intervals by a competent person.

The place where the competent person carries out the required examination is normally called a 'Test House' or 'Test Station' and guidance is available on both the methods and the periodicity of examination from the British standards BSEN1440, BSEN1968, BSEN1802, BSEN1803 and BSENISO 11623 and from the British Compressed Gas Association (BCGA) Code of Practice CP11 *Procedures Required to be in Use in Test Stations that Undertake the Periodic Inspection, Testing & Maintenance of Transportable Gas Containers. Revision 3: 1994.* and the European Industrial Gas Association (EIGA) Doc 79/01 *Cylinder Retest Stations* - free on web page www.eiga.org.

TD5 have inspected a number of these Test Houses where the operations and procedures have not been thoroughly carried out, giving rise to potentially dangerous cylinders being returned to service.

The withdrawn British Standard BS5430 in three parts set out how a gas cylinder should be examined and gave various periodicities based on the contents a particular gas cylinder had contained. This series of standards has been replaced by European Standards that are set out in a similar manner but have some different periodicities. Test Houses will now need to adapt their procedures for examination to take into account the appropriate BSEN. It is recommended to allow a 12 month period from 30 April 2002 for the completion of procedure review to the new European Standards (BSENs).

This DIN gives advice to those who inspect Test Houses operated by competent persons, following through the route that a gas cylinder should take when subject to periodic examination. This DIN does not look at processes such as machinery guarding, shot blasting and painting that are adequately addressed by other HSE publications. Neither does this DIN seek to replicate the requirements detailed in standards but highlights areas where recent inspections have revealed shortcomings that could lead to inadequate examination of gas cylinders. It should be noted that some Test Houses also carry out the filling of gas cylinders another aspect not covered by this DIN.

2.0 Training and qualification

As in any engineering process, the person carrying out the examination must be adequately trained and experienced to allow him to identify defects and to make judgements on their significance.

No formal qualifications are available for the person carrying out the periodic examination of gas cylinders but that person must be competent in the required examination techniques, have a good knowledge of the Regulations surrounding gas cylinders and have up to date knowledge on possible problem areas. The Standards give a series of photographs of typical inspected surface that show varying severity of defects. It is recommended that these photographs are expanded and displayed near to where the inspection takes place.

There are formal qualifications in the field of Non Destructive Testing (NDT), some of which may be appropriate for gas cylinder inspection. This will include BSEN 970 which is the European standard for visual examination and gives guidance on eye sight tests and illumination levels that each go towards achieving an adequate visual examination.

It is vital that any person carrying out the examination of a gas cylinder has adequate visual acuity and it is recommended that as a minimum each person carrying out visual examinations has an annual eye test by a qualified Ophthalmic Optician. Additional company based eye tests could include the visual detection of actual known defects.

3.0 Internal examination

It is extremely difficult to get a good view of the internal surfaces of a gas cylinder when looking through the small top opening.

It is essential that the internal surfaces are properly clean and dry before the examination starts and that the light used illuminates as much of the inside as possible - a dim light or a light that just shows up a small circle on the base is not suitable. It is also important to look at how the light source is connected to the power pack - a thick lead may look impressive but will severely restrict the available space for inspection. Mirrors can be used to see into the neck region.

There are Non-destructive Testing (NDT) techniques available but each has its own limitations. Any NDT procedures in use should be certified as suitable by a Level 3 qualified NDT operator and such a procedure should clearly state what the NDT can find and what it is not intended to find. The procedure should be used by an NDT operator qualified to at least Level 1 if supervised or at least level 2 if working unsupervised. The qualifications can be made to a centrally based scheme such as Personnel Certification in NDT (PCN) or an in-house scheme such as the American Society of Non-destructive Testing (ASNT). Internal inspection can be greatly enhanced by the use of a boroscope but any operator of such a device must be competent in its use as misinterpretation of images is commonplace.

TD5 are aware of the use of the following techniques for gas cylinder inspection, if others are encountered TD5 would be pleased to hear about them : Ultrasonic, Magnetic Particle, Eddy Current, Pulsed Eddy Current and Dye Penetrant**.**

4.0 Hydraulic test

The importance of pressure gauge calibration must be emphasised. Many test houses have been inspected where pressure gauges are never calibrated - this is a clear contravention of the requirements of the Standards but also has safety implications. By not using calibrated gauges the test house cannot be sure what pressure is being applied.

One successful calibration methodology is for the test house to have an externally calibrated master pressure gauge which is not used for routine pressure testing. This master gauge is calibrated by a suitably accredited test house once a year and a certificate of calibration obtained. The master gauge is then used weekly to check all other pressure gauges used in

the test house and a responsible person keeps records of all checks. The Master Gauge should be kept in a clean and secure location.

A clear procedure is required to describe the actions to be taken if pressure gauges are found to be out of calibration on the weekly test. This could involve retesting each cylinder examined during the previous week or, if over pressure is suspected, a full re examination of all cylinders.

5.0 Drying after Hydraulic Test

Test houses have been inspected where cylinders are left to dry in the workshop with no assistance. It is extremely important that all cylinders are completely dry as soon as possible after the hydraulic test**.** There have been many failures of cylinders that can be traced back to moisture remaining after hydraulic test, mixing with the cylinder contents to form an aggressive corrosive atmosphere.

Warm air drying rigs are available that heat the cylinders up to about 80^{o}C - this is well within the upper limits set by the Standards. However it should be noted that the new aluminium alloys are restricted to a maximum of 80^{o}C so temperature control is of vital importance on this type of cylinder. The warm air carries water vapour up and out of the cylinder opening leaving a completely dry atmosphere inside. One down side of the warm air rigs is that they are often supplied with insufficient guarding against contact with hot surfaces.

One test house was inspected where the cylinders were inverted and warm air blown in from the bottom. This method trapped warm moist air in the cylinder base and was not a suitable drying method.

Another test house inspected was using open flames, like an oven hob, to dry cylinders. Where control of heat input looks to be insufficient it is important to ascertain how the test house ensures that the temperature limits of 300^{o}C for steel cylinders, 120^{o}C for older aluminium cylinders and 80^{o}C for newer Aluminium alloy cylinders are not exceeded.

6.0 Cylinder valves

When valves are removed to allow examination of the internal surfaces of a cylinder there are two quite different approaches to how test houses deal with the removed valve. In one approach the valve is either completely overhauled or renewed and in the other approach the valve is externally cleaned and refitted.

BS5430 calls for the first approach and this is backed up when consideration is given to bursting discs. Carbon dioxide cylinders for example are fitted with a bursting disc that is set to fail if the pressure inside the cylinder reaches 190 bar. Bursting discs of this type are subject to fatigue loading throughout their life and it is impossible to tell how many fatigue cycles any such disc has seen. Therefore it is prudent to replace the bursting disc every 5 years when the valve is removed for examination rather than wait for it to fail in service. Carbon dioxide cylinders are often carried around in closed vans, the failure of a bursting disc in a confined space will, at a minimum, distract the driver but could lead to more serious consequences.

The BSENs go further and call for safety related components to be renewed at the time of the periodic examination. A draft prEN is in progress at present that looks at cylinder valve maintenance and testing. This will demand that any valve that is to be refitted is completely

overhauled and retested in line with the leak test requirements of BSEN 849 after it has been reassembled.

Most cylinder valves are low cost items for which high cost maintenance would not be appropriate. In these cases valve renewal at periodic examination is the preferred option. Valves for speciality gases can be very expensive making maintenance and test a more viable option. In either case the valve cannot, and must not be ignored.

Test houses where valves are routinely refitted without full inspection and overhaul should be asked to justify their approach against their HSWA Section 3 duties.

It is extremely important that cylinder valves are fitted into the cylinder using correct levels of torque. Over tightening of cylinder valves can cause excess stress levels in the cylinder neck and has led to failure in some instances. Examples have been seen where fitters use an open ended spanner and a pipe to tighten valves - this is clearly not acceptable. In other test houses it is clear that torque wrenches are not being calibrated so it cannot be certain what torque is being transmitted in the valve.

The test house must have some method of regularly checking that torque wrenches remain within calibration. This may be by use of a suitable accredited test body or by setting up their own simple calibration rig. In either case there should be documentary evidence that the torque wrenches are correctly calibrated. There should be a clear procedure to deal with any cylinders that may have been incorrectly torqued and the actions to take when a torque wrench is found to be out of calibration. A calibrated torque wrench should always be kept clean and secure so as not to get damaged in any way.

7.0 Grinding marks

Many cylinders have been seen, especially in the beverage gas industry, where the markings on the cylinder shoulder have been fully or partially removed by grinding. The stamping marks on the cylinder shoulder or data plate are vital strings of information. A filler must not fill any cylinder with gas unless he first checks from the markings on the cylinder that it is safe to do so.

The standards are clear on the actions to be taken if markings have been tampered with. There are methods available to restore the removed markings such as an acid etch or radiography but the test house must be 100% confident that the restored markings exactly match those that have been removed. Even if markings can be restored some grinding has been seen to be deep into the cylinder shoulder. Where grinding is not well profiled to the shoulder then the competent person would need to carry out detailed stress analysis to determine if the grinding effected the integrity of the cylinder. There is no justification for the removal of marks on a cylinder by grinding. If markings need to be obliterated, such as changes in the tare weight, the original marks should removed by over stamping with ‘XXX’ marks. Where a test house passes any cylinder with grinding marks clearly visible then they should be asked to justify their decision against their HSWA Section 3 duties.

8.0 Stamp marking

The standards clearly require that the competent person uses a ‘Unique’ brand. Many examples have been seen recently that show test houses using letter stamps to indicate their names. Such practices are not acceptable as it would be very easy for anyone to copy the letters and thereby avoid subjecting their cylinders to periodic examination. Unique brands are readily available from metal stamp manufacturers.

9.0 Disposal of failed cylinders

The standards require that failed cylinders are made incapable of holding gas by cutting them into pieces, chopping holes into them or crushing etc. The act of disposal has safety implications which is outside the scope of this DIN. Recent inspections of test houses has shown that not all rejected cylinders are being destroyed as required. One test house stored failed cylinders in a corner, another put them into a skip and a third returned them to the owner marked as 'failed'.

Any cylinder that does not pass the competent person examination must be permanently destroyed by the test house. The test house should inform the owner of the cylinder that the cylinder will be destroyed and give him/her the opportunity to see the reason for the rejection, but the decision to destroy cylinders remains with the competent person and he/she **cannot** be influenced by financial or other business pressures from the cylinder owner.

There should be a clear disposal policy in place at the test house which should be easily audited. Any test house with no record of destroyed cylinders must be treated with caution.

10. Continuing competence

Many of the test houses visited were not members of the BCGA or any other relevant Trade Association. Although membership is not a requirement for a company to be classed as 'competent' it does make it more difficult for the company to keep abreast of current developments in Regulations and recent accidents/failures.

Test houses that were not members of BCGA did not know about an HSE led recall of a batch of Korean cylinders. One test house did not know about a recall of East German cylinders and a third was confused over the relationship between the TPED and British Standards.

If test houses are not members of BCGA and/or LPGA they need to clearly demonstrate how they keep abreast of current issues.

One test house inspected could demonstrate little understanding of Schedule 8 of CGDCPL2, had no clear cylinder drying procedure, no eye sight testing and no calibration checking procedures. Test houses that have been accredited by UKAS to BSEN 45004 for gas cylinder examination are checked annually that they do have the correct procedures in place covering all of the above issues. Spot checks are made to ensure that the procedures are put into use. Very few test houses have joined the voluntary UKAS accreditation scheme but all test houses should be working to similar standards if they are UKAS accredited or not.

The UKAS document dealing with the accreditation of test houses - RG3, which is available free at www.UKAS.com sets out the accredited methodology for proving competence. This calls for the test house to have access to suitably qualified Chartered Engineers, levels of inspector qualification and sample audits of the inspectors work. None of the test houses visited could have met the RG3 requirements and many had just one man who deemed himself to be competent.

11. Extending examination intervals using BSENs

BSEN 1968 gives the interval for carbon dioxide as '10^{h}'. The ^{h} relates to a footnote that explains that the cylinder can only go to 10 years under closely controlled conditions. The

main condition is that there is no possibility that any moisture gets inside the cylinder and that the filler has a clear procedure within his quality plan to ensure that it does not.

It is therefore a joint decision between the test house and the filler just what periodicity will be allowed. There is a commercial interest here on both sides - the test house will lose income from halving the number of inspections but the owner will save both money and inconvenience if cylinders are taken out of service less frequently. This decision can only be based on safety aspects and TD5 recommends that the current 5 year period is only increased for CO_2 cylinders where residual pressure valves are fitted or where the cylinders are filled and used in situations where water ingress is proven to be impossible.

12. Conclusions

The periodic examination by a competent person, as required by schedule 8 of CDGCPL2, is much more than just an external look and an hydraulic test. To ensure a competent examination a test house must closely follow the relevant British standards and be fully aware of any additional issues that may influence the result of the examination.

All test houses should be working to the same high standards to ensure that the level of safety of each gas cylinder, as it leaves the test house, is consistent across the Country.

ANNEX A - Relevant Standards.

BS5430 - Part 1:1990 Periodic inspection, testing and maintenance of transportable gas containers (excluding dissolved acetylene containers). Specification for seamless steel containers of water capacity 0.5 litres and above. WITHDRAWN

BS5430 - Part 2:1990 Periodic inspection, testing and maintenance of transportable gas containers (excluding dissolved acetylene containers). Specification for welded steel containers of water capacity 0.5 L up to 150 L. WITHDRAWN

BS5430 - Part 3:1990 Periodic inspection, testing and maintenance of transportable gas containers (excluding dissolved acetylene containers). Specification for seamless aluminium alloy containers of water capacity 0.5 litres and above. WITHDRAWN

BS EN 1440:1997 Transportable refillable welded steel cylinders for liquefied petroleum gas (LPG). Periodic requalification.

BS EN 1968:2002 Transportable gas cylinders. Periodic inspection and testing of seamless steel gas cylinders.

BS EN 1802:2002 Transportable gas cylinders. Periodic inspection and testing of seamless aluminium alloy gas cylinders.

BS EN 1803:2002 Transportable gas cylinders. Periodic inspection and testing of welded carbon steel gas cylinders.

BS EN ISO 11623 Transportable gas cylinders. Periodic inspection and testing of composite gas cylinders.